Abundance and distribution of Peary caribou and muskoxen on Axel Heiberg Island

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Final Report

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Summary

Axel Heiberg Island has previously been surveyed comprehensively for Peary caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*) only once, in 2007. At that time, the island appeared to support relatively large populations of Peary caribou (2,291, 95% CI [1,636:3,208]) and muskox (4,237, 95% CI [3,371:5,325]). To provide more recent population estimates, we conducted an aerial abundance survey of Axel Heiberg Island from March 25 to April 6, 2019. We flew approximately 6,169 km on transect, and observed 2,269 muskoxen in 204 groups and 6 Peary caribou in four groups. Our preliminary analysis gives an estimate of 3,772 (95% CI [3,001:4,742]) muskoxen, suggesting that muskox numbers have been stable since the last survey. The very small number of Peary caribou observed on the island means that we can only report a minimum count of caribou and not generate a population estimate. Infrequent monitoring makes it very difficult or impossible to determine conclusively what has happened to the Peary caribou population on Axel Heiberg Island since 2007; however, the near complete absence of caribou in March and April 2019 suggests that through some mechanism the Peary caribou population on the island has either moved away or declined dramatically.

Project objectives

Our project had two main objectives:

1. Estimate the abundance and distribution of Peary caribou and muskox on Axel Heiberg Island (muskox management unit MX-02, proposed Peary caribou management unit PC-02).
2. Estimate cow:calf ratios for Peary caribou and muskoxen on Axel Heiberg Island, as an indication of short-term population trends.

We completed objective 1 and have produced updated abundance and distribution information for Peary caribou and muskoxen on Axel Heiberg Island. We were unable to adequately complete objective 2 for two main reasons. For Peary caribou, the number of animals we observed was too low to draw any useful information from their composition. For muskox, we were able to classify 1893 of 2629 muskoxen we observed, but this was not a high enough proportion to determine useful demographic estimates. The 28% of muskox with "unknown" classification are likely skewed towards younger individuals that are less conspicuous (when compared to mature males and females), and so our composition data are probably biased. Most of the unknown muskoxen were in large (19+) groups where complete classification of the group from a helicopter is challenging due to the movement and defensive circling behaviour of the animals.

Materials and methods

We conducted the aerial survey using a distance sampling line-transect method (Buckland et al. 2001). We used a systematic line-transect design with random start location to establish east-west transects 5 kilometres apart parallel to lines of latitude. Transects were unbounded, in the sense that we did not employ a fixed transect width for collecting observations. Our survey approximately followed the transects of the previous aerial survey of Axel Heiberg Island conducted in 2007 (Jenkins et al. 2011). We did not survey the extensively glaciated and mountainous central portion of the island due to the low probability of caribou or muskox presence.

Following the completion of the survey, we estimated the density and abundance of muskox across the study area using three methods: conventional distance sampling (CDS), multiple covariate distance sampling (MCDS) and by using density surface models (DSMs) (Buckland et al. 2001, 2004; Miller et al. 2013). Distance sampling methods use the distances to observations of objects of interest (i.e., groups of Peary caribou and muskox) from the survey transects to estimate the abundance of those objects across an area (Buckland et al. 2001). When conducting aerial surveys, we are less likely to see animals that are further from the aircraft, and by using distance sampling methods, we can fit a detection function to the observation data that helps us to correct our abundance estimate for the animals that we might have missed. The estimates from CDS are derived from models in which the probability of detection depends only on distance from the transect (Buckland et al. 2001). With MCDS, we can model the probability of detection using distance along with other covariates. These covariates can be related to either the observed cluster (e.g., number of animals), the environment (e.g., topography), or the observer (Buckland et al. 2004).

We used the more complex DSMs to model the distribution of muskoxen as a function of environmental covariates across the island. To do this, we use a two-stage approach: in the first stage we fit a detection function to the distance data, and in the second stage used generalized additive models (GAMs) to fit a spatial model to the detection-corrected count data (Miller et al. 2013). Covariates can be included in either stage of the DSM, and we compared models with covariates in both the detection function (animal group size) and GAM (vegetation, elevation).

For each of the three methods above, we compared candidate detection functions using Akaike's Information Criterion (AIC) and evaluated models with relevant goodness-of-fit tests.

Results

Note that the abundance estimates reported here are preliminary. We do not anticipate the final results to differ substantially but some differences are possible. For the purposes of this document, we will only briefly summarize our results and reserve a more thorough discussion of model structure and evaluation for a later Government of Nunavut report on this project.

From March 25 to April 6, 2019 we flew roughly 12,363 km, of which approximately 6,169 km were on-transect. The additional distance flown was for ferry flights to and from transects and fuel caches. Despite four weather days where we couldn't fly (March 28 and 30 and April 1 and 3), we were able to complete all transects. We do not have any reason to suspect that the weather days compromised our results. During the survey we saw 2,629 muskoxen in 204 groups on transect. Average group size was 13 (± 11 SD), with a maximum group size of 66 individuals. We saw 6 total Peary caribou in four groups (two lone individuals and two pairs). The highest densities of muskoxen were in the lower-lying regions east of the Princess Margaret range (Fig. 1).

The extremely low number of Peary caribou observed prevents us from making any meaningful island-wide estimates. For muskox, our CDS and MCDS methods produced three competitive detection functions. We used model averaging to derive an estimate of 4,315 muskoxen (95% CI = [2,866:5,764], CV = 0.17) from these three models. Using the DSM approach, our most supported model estimated 3,772 muskoxen (95% CI [3,001:4,742], CV = 0.12), which strongly overlaps with the MCDS estimate. We selected the DSM estimate as our final estimate because it builds on the conventional distance sampling detection functions with a spatial model, and has an improved coefficient of variation (CV). The predicted densities for muskoxen across Axel Heiberg Island are shown in Figure 2.

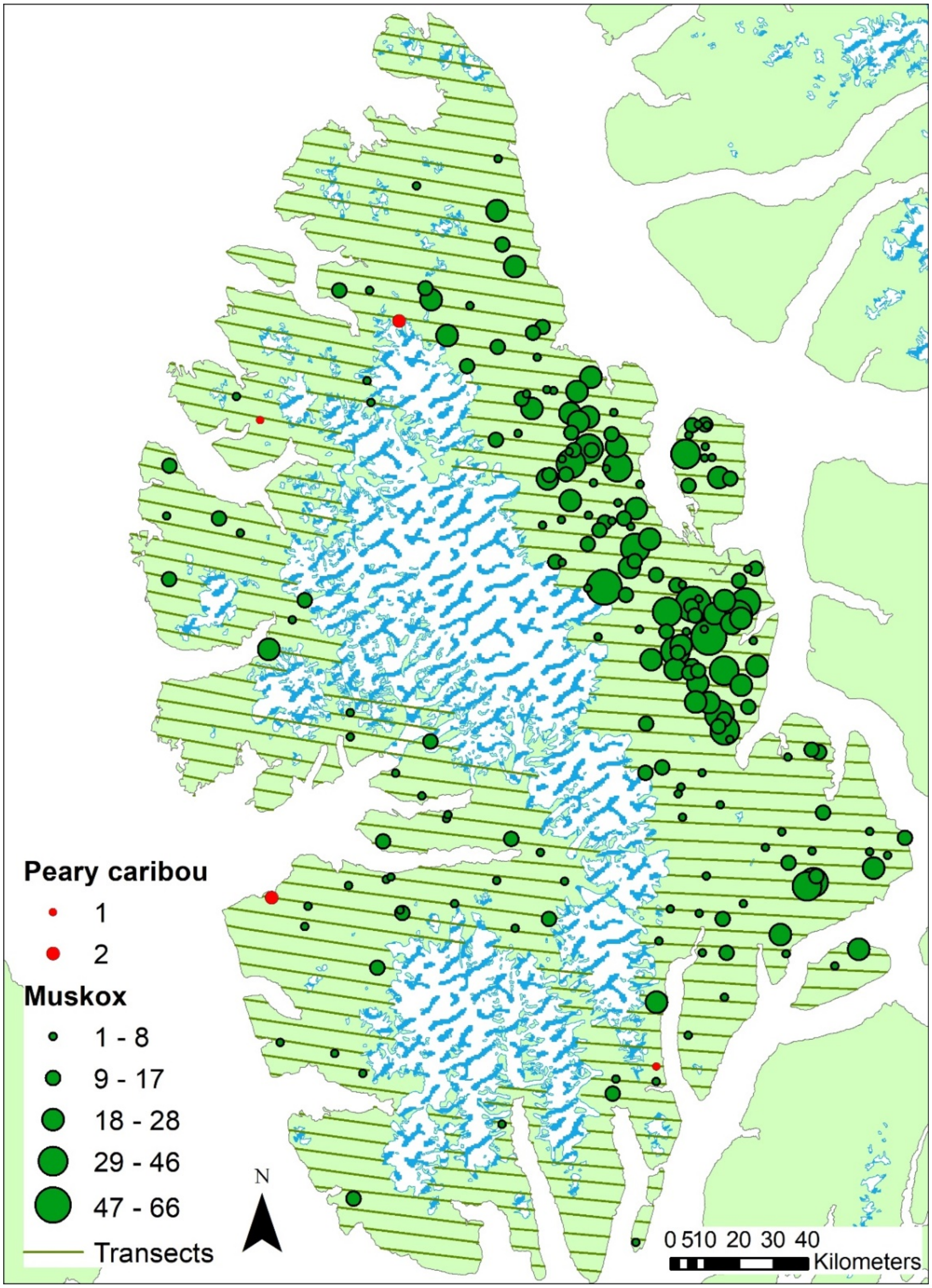

Fig 1. Summary of Peary caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*) aerial abundance survey of Axel Heiberg Island. Graduated circles indicate numbers of individuals within observed groups of caribou and muskoxen. The blue and white polygons show glaciated areas.

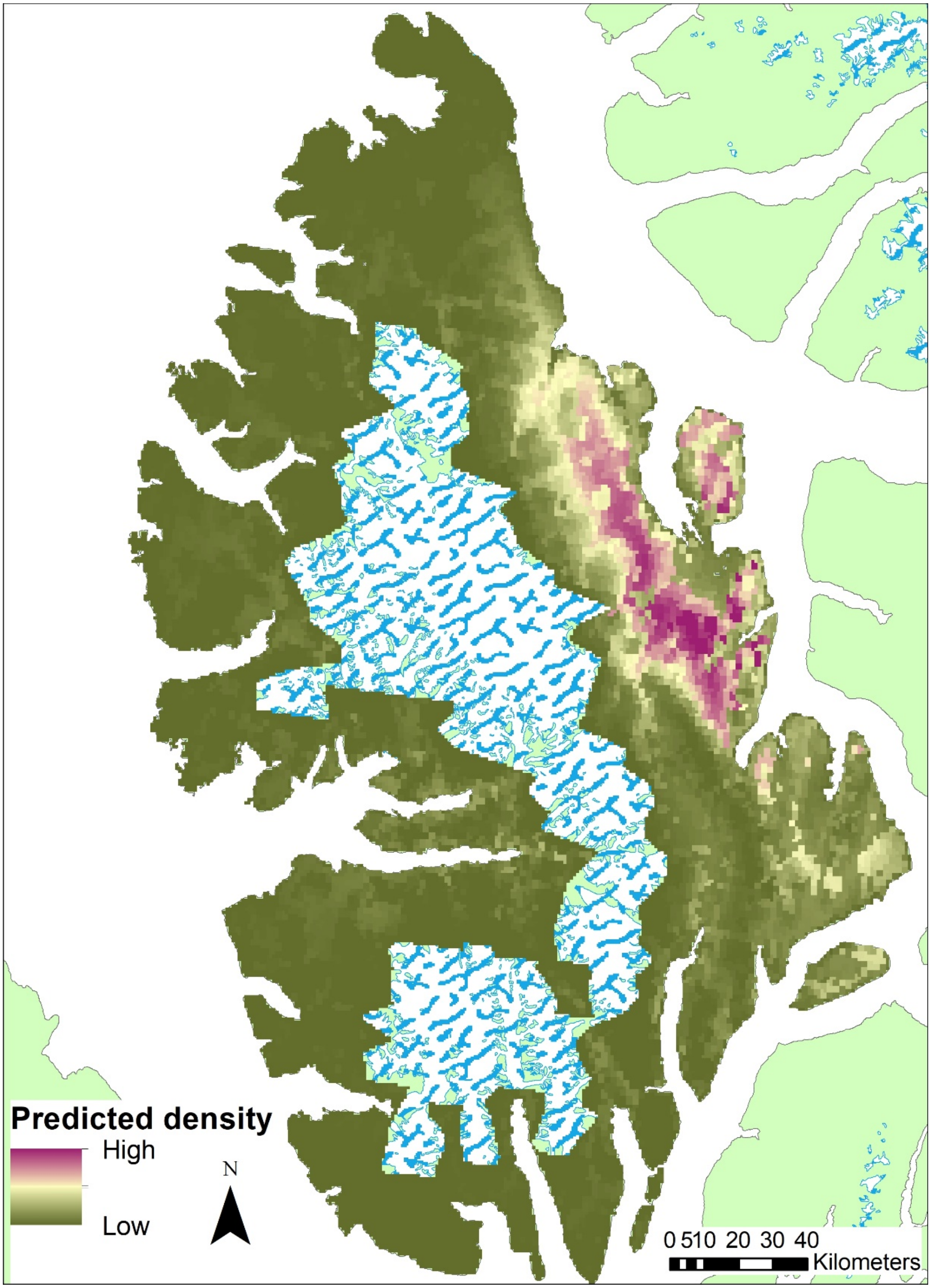

Fig 2. Predicted muskox (*Ovibos moschatus*) densities on Axel Heiberg Island derived from our most-supported density surface model. The blue and white polygons show glaciated areas.

Discussion and management implications

The previous survey of Axel Heiberg Island estimated 4,237 muskoxen (95% CI [3,371:5,325]), and so the results of our survey and analysis suggest that muskox numbers have likely been stable over the intervening period. The distributions of muskoxen across the island were similar between both surveys. The 2007 survey saw approximately 50% more muskox groups (301 [2007] vs. 204 [2019]), although average groups sizes were larger in 2019 (8 [2007] vs. 13 [2019]) (Jenkins et al. 2011). This difference was likely related to the timing of the survey, as muskox typically aggregate in larger groups in the winter, and the 2019 survey was conducted earlier in the year (Heard 1992; Reynolds 1993). Muskox population estimates before 2007 on Axel Heiberg Island are limited, and so any long-term trends are largely speculative. Tener (1963) estimated 1,000 muskox on the island based on a survey with less than 3% coverage, and a 1973 reconnaissance survey counted 866 muskoxen on eastern Axel Heiberg Island (Ferguson 1995). Based on these previous estimates, it seems more probable that muskoxen are stable or increasing rather than decreasing over the longer-term on Axel Heiberg Island.

It is similarly difficult to identify long-term trends for Peary caribou, but it is clear that since 2007 Peary caribou numbers on the island have declined dramatically. At the time of the 2007 survey, the estimated abundance of Peary caribou on Axel Heiberg Island (2,291, 95% CI [1,636:3,208]) comprised an estimated 57% of Peary caribou in Nunavut (Jenkins et al. 2011). Unfortunately given the lack of monitoring from 2007 to 2019, it is likely impossible to determine the mechanism through which the decline occurred with high certainty. The most prominent potential mechanisms are die-offs and movement of animals off of the island, likely resulting from poor environmental conditions (Miller and Gunn 2003; Mallory and Boyce 2018). Given the potential circumstances that could lead to such a change in abundance, some combination of these two mechanisms is likely. Though we do not have any evidence at present, we hypothesize that movements or die-offs at this scale would have been triggered by inclement environmental conditions, such as ground-fast ice or extremely poor forage conditions (Miller and Gunn 2003; Mallory and Boyce 2018). We are currently conducting further research to try and understand environmental conditions on Axel Heiberg Island from 2007-2019 in hopes that we might gain some clues regarding what might have led to the changes in caribou abundance. It is also worth noting that no increases in Peary caribou in adjacent areas, such as Central or Southern Ellesmere Island were observed during surveys in 2015 and 2016 (Anderson and Kingsley 2017; Fredlund et al. 2019). These results diminish the probability of large-scale emigration of Peary caribou from Axel Heiberg Island to these areas of Ellesmere Island, although it is possible that movements occurred after these surveys occurred.

The management implications from these results are limited due primarily to the extremely remote nature of Axel Heiberg Island. The island is uninhabited and rarely visited other than by researchers in the warmer months. Axel Heiberg Island is beyond the distance regularly travelled by harvesters from the nearest community of Grise Fiord (approximately 240 km away at the closest point of the island). For these reasons there are no immediate implications for either muskox or Peary caribou harvesting in management units MX-02 and PC-02 on Axel Heiberg Island. However, at national and territorial planning levels, these results are important considering the relatively high proportion of Nunavut's Peary caribou population previously attributed to Axel Heiberg Island. Any application of the results for management or recovery planning will be done through co-management with local input from potentially affected communities.

Report by Inuit participants

Jopee Kiguktak of Grise Fiord participated in our survey as an observer, but we do not have a report from him. He is a very experienced observer who was excellent at spotting animals as well as helping out with caribou and muskox composition.

Reporting to communities/resource users

We reported preliminary results from our survey via email to the Iviq HTO on April 12, 2019 and will be meeting with them in-person in October 2019. We discussed the results of our survey with the Resolute Bay HTA on July 2, 2019, and will be back to meet with them again in October 2019.

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