DISTRIBUTION AND ABUNDANCE OF MUSKOXEN (*Ovibos moschatus*) AND PEARY CARIBOU (*Rangifer tarandus pearyi*) ON PRINCE OF WALES, SOMERSET, AND RUSSELL ISLANDS, AUGUST 2016

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Version: 13 September 2016

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STATUS REPORT 2016-06
NUNAVUT DEPARTMENT OF ENVIRONMENT
WILDLIFE RESEARCH SECTION
IGLOOLIK, NU

Anderson, M. 2016. Distribution and abundance of muskoxen (*Ovibos moschatus*) and Peary caribou (*Rangifer tarandus pearyi*) on Prince of Wales, Somerset, and Russell islands, August 2016. Nunavut Department of Environment, Wildlife Research Section, Status Report 2016-06, Igloolik, NU. 27 pp.

Summary

We flew a survey of Prince of Wales, Somerset, Russell, Pandora, and Prescott islands (Muskox Management Zone MX-06), by Turbine Otter and Twin Otter in 82 hours between August 5 and 23, 2016, to update the population estimate for Peary caribou and muskoxen in the study area. The previous survey, in 2004, did not detect any Peary caribou, although ground surveys the following year found two groups of seven caribou on Somerset Island. The survey provided a population estimate of 3,052± SE 440 muskoxen on Prince of Wales and Somerset islands (including smaller satellite islands), with 1,569 ± SE 267 on Prince of Wales, Pandora, Prescott, and Russell islands, and 1,483 ± SE 349 muskoxen on Somerset Island. The 2016 survey results suggest a decline from the mid-1990s, but no clear decline from the 2004 estimates of 2,086 muskoxen on Prince of Wales/Russell islands (1,582-2,746, 95% CI) and 1,910 muskoxen on Somerset Island (962-3,792 95% CI; Jenkins et al. 2011). No Peary caribou were seen on the survey, but two Peary caribou were seen by hunters searching rugged terrain along the west coast of Somerset Island south of Aston Bay. The consistent lack of observations of Peary caribou suggest that the population has not recovered from the precipitous decline in the late 1980s and early 1990s.

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ᖁᓛᒎᓚᐅᕋᑦᑕ ᕿᖖᒐᐃᓛᑉ, ᑰᖕᒐᓇᕘᑉ, ᐃᓐᓂᓕᖅᓯᒪᕘᑉ, ᐊᖏᑦᑐᓕᐅᑉ ᕿᑭᖅᑕᐅᑉ, ᐊᒻᒪ ᕿᑭᖅᑕᕈᓘᑉ ᓇᐅᔭᓕᐅᑉ ᖁᓛᒍᑦ (ᐅᒥᖕᒪᖕᓂᒃ ᐊᐅᓚᑎᕐᕕᐅᓂᐅᕗᖅ ᐃᓂᐅᕗᖅ MX-06), ᐊᑕᐅᓯᓕᒃᑰᖅᓗᑕ 82-ᓄᑦ ᐃᑲᕐᕋᓄᑦ ᐅᑯᐊ ᐅᓪᓗᑦ ᐊᑯᓂᖏᓐᓂ ᐊᐅᒍᓯ 5 ᐊᒻᒪ 23, 2016-ᒥ, ᒫᓇᓕᓴᙳᖅᑎᓐᓇᓱᐊᖅᓗᖏᑦ ᐅᓄᕐᓂᕗᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᕗᑦ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᑦ ᐊᒻᒪ ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᖃᐅᔨᓴᕐᕕᐅᕗᒥ. ᓯᕗᓂᐊᒍᑦ ᖃᐅᔨᓴᕐᓂᐅᓚᐅᖅᓯᒪᕗᖅ, 2004-ᒥ, ᖃᐅᔨᕐᕕᐅᓚᐅᖏᑦᑐᖅ ᑐᒃᑐᑕᖅᑲᖅᓂᖕᒐᓂᒃ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᓐᓂᒃ, ᐊᕐᕌᒍᑎᓪᓗᒍ ᑭᓯᐊᓂ ᒪᓂᕐᑲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᕐᒥ ᒪᕿᐃᓂᒃ ᑐᒃᑑᕐᑲᑎᒌᓂᒃ 7 ᐅᓪᓗᑎᒃ ᓇᓂᓯᓚᐅᖅᓯᒪᕖᕙᓗᐊᑦ ᑕᐅᕙᓂ ᑰᒐᓇᕘᑉ ᕿᑭᖅᑕᖕᒐᓂ. ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᖃᐅᔨᔭᐅᕗᑦ ᐅᓄᕐᓂᐅᕗᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᕗᑦ 3,052± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖕᒐᓂ 440-ᐅᓪᓗᑎᒃ ᐅᒥᖕᒪᑦ ᑕᐅᕙᓂ ᕿᖖᒐᐃᓛᑉ ᐊᒻᒪ ᑰᒐᓇᕘᑉ ᕿᑭᖅᑕᖕᒐᓂ (ᐱᖃᓯᐅᑎᓪᓗᒋᑦ ᒥᑭᓐᓂᖅᓴᐅᕗᑦ ᕿᑭᖅᑕᒐᓇᐃᑦ), ᐃᒪᓐᓇᐅᑎᒋᓪᓗᑎᒃ 1,569 ± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖕᒐᓂ 267-ᖑᓪᓗᑎᒃ ᑕᐅᕙᓂ ᕿᖖᒐᐃᓛᑉ, ᐊᖏᑦᑐᓕᐅᑉ ᕿᑭᖅᑕᐅᑉ, ᕿᑭᖅᑕᕈᓘᑉ ᓇᐅᔭᓕᐅᑉ, ᐊᒻᒪ ᐃᓐᓂᓕᖅᓯᒪᕘᑉ ᕿᑭᖅᑕᖏᓐᓂ, ᐊᒻᒪᑦᑕᐅᖅ 1,483 ± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖕᒐᓂ 349-ᖑᓪᓗᑎᒃ ᐅᒥᒻᒪᑦ ᑕᐅᕙᓂ ᑰᒐᓇᕘᑉ ᕿᑭᖅᑕᖕᒐᓂ. 2016-ᒥ ᖃᐅᔨᓴᕐᓂᕕᓂᕐᓂᑦ ᐱᓯᒪᕗᑦ ᓇᓗᓇᐃᖅᓯᓯᒪᖕᒪᑕ ᐅᓄᕈᓐᓃᖅᐸᓪᓕᐊᕗᓂᒃ ᑕᐃᒪᖕᒐᑦ 1990-ᖏᓐᓂᑦ, ᑭᓯᐊᓂ ᐅᓄᕈᓐᓃᖅᐸᓪᓕᐊᓂᕋᐃᓯᒪᓇᑎᒃ ᓇᓗᓇᐃᖅᓯᒪᕗᒃᑯᑦ ᑕᐃᑲᖕᒐᙱᓐᓂᑦ 2004-ᒥᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᕗᑦ 2,086 ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᕿᖖᒐᐃᓛᑉ/ᐃᓐᓂᓕᖅᓯᒪᕘᑉᓗ ᕿᑭᖅᑕᖏᓐᓂ (1,582-2,746, 95% CI) ᐊᒻᒪ 1,910 ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᑰᒐᓇᕘᑉ ᕿᑭᖅᑕᖕᒐᓂ (962-3,792 95% CI; Jenkins et al. 2011). ᑕᑯᕗᖃᓚᐅᙱᑦᑐᖅ ᖁᑦᑎᒃᑑᑉ ᑐᒃᑐᖏᓐᓂᒃ ᐊᖑᓇᓱᒃᑎᓂᑦ ᕿᓂᖅᑐᓂᑦ ᒪᓃᑐᕈᕗᖕᒥ ᐅᐊᖕᓇᖅᐸᓯᐅᕗᒥ ᓯᓪᔭᖅᐸᓯᖕᒥ ᑰᒐᓇᕘᑉ ᕿᑭᑖᓂ ᓂᒋᐊᓂ Aston ᑲᖏᕐᓗᐊᓂ. ᓇᐅᑦᑎᖅᓱᖅᑕᐅᑦᑎᐊᖏᓐᓂᖏᓐᓄᑦ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᑦ ᓇᓗᓇᖏᓚᑦ ᑕᐃᒃᑯᐊ ᐅᓄᕐᓂᐅᕗᑦ ᖃᓄᐃᓕᕙᓪᓕᐊᓗᐊᖏᑦᑐᑦ ᐅᓄᕈᓐᓃᓗᐊᓚᐅᖅᓯᒪᓪᓗᑎᒃ ᑕᐅᕙᓂ 1980-ᖏᓐᓂ ᐊᒻᒪ 1990 ᐱᒋᐊᕐᓂᖏᓐᓂ.

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Introduction

Peary caribou (*Rangifer tarandus pearyi*) are a small, light-coloured subspecies of caribou inhabiting the Canadian Arctic Archipelago. They were listed as Endangered in Canada under the Species at Risk Act (SARA) in 2011, largely due to precipitous declines caused by severe weather events in the 1990s. Lack of scientific information and, across much of their range, lack of local knowledge about the populations, has made research and management of Peary caribou difficult. A federal Recovery Strategy is currently in draft form, based on a Knowledge Assessment drawing on Inuit Qaujimajatuqangit (IQ), local knowledge, and scientific information (Johnson et al. 2016). A territorial management plan is under review at the Nunavut Wildlife Management Board (DOE in prep). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) down-listed Peary caribou from Endangered to Threatened in November 2015, in recognition of recent population increases in important populations on Melville and Bathurst islands, and apparently stable population trends in other areas. Peary caribou are still listed under SARA as Endangered.

Historically, Prince of Wales Island, Somerset Island and the Boothia Peninsula supported a thriving population of Peary caribou at the southern edge of their range. Peary caribou migrated from winter ranges on Somerset Island and Boothia Peninsula to calve and spend the summer on Prince of Wales Island, Russell Island, and parts of Somerset Island to calve and spend the summer. Some Peary caribou also calved and spent the summer at the north end of the Boothia Peninsula. A late July survey in 1974 estimated 5,437 adults and calves on Prince of Wales Island (Fischer and Duncan 1976). In June 1975 there were 3,768, including calves (Fischer and Duncan 1976), and in July 1980 there were 3,952 (±474 SE not including calves; Gunn and Decker 1984). However, a 1995 survey counted only 5 animals (Gunn and Dragon 1998) and unsystematic helicopter searches in April 1996 found only 2 caribou on Somerset Island (Miller 1997). Miller (1997) suggested possibly as few as 100-200 caribou existed in the island complex at that time. The most recent survey, conducted by helicopter distance sampling, failed to locate any caribou on Somerset Island, although concurrent snowmobile ground surveys located 2 groups of 4 caribou, 1 set of tracks, and 1 feeding site on Somerset Island (Jenkins et al. 2011). The decline in Peary caribou on Prince of Wales and Somerset islands was predicted by Inuit familiar with the islands as a natural response to the high densities during the 1970s and early 1980s. Under favorable environmental conditions, a long, slow recovery of the populations on the islands is expected (Campbell 2006).

Peary caribou movements between Prince of Wales, Somerset, and the Boothia Peninsula occurred seasonally, and surveys of the Boothia have been infrequent, without distinguishing Peary caribou from mainland caribou. A geomagnetic survey conducted in summer/fall 2013 by Natural Resources Canada did not locate any Peary caribou on Boothia Peninsula/southern Somerset Island. Video footage of the survey is available, but the resolution is likely insufficient for using it to determine a population estimate of Peary caribou or muskoxen. Most Peary caribou from the inter-island/peninsula population would be expected to be on Prince of Wales and Somerset islands or their smaller satellite islands in August, so the Boothia Peninsula was not included in this survey. A different methodology may be required to allow Peary and barren-ground caribou to be accurately differentiated on the peninsula.

Muskoxen (*Ovibos moschatus*) are also present on the island group, and they have been increasing since the 1970s. In June 1974, Fischer and Duncan (1976) estimated 564 adult muskoxen on Prince of Wales Island, and none on Somerset or Russell islands. The islands were surveyed again in July 1975, with an estimate of 872 adult muskoxen on Prince of Wales Island

and none on Russell or Somerset Island (Fischer and Duncan 1976). In 1980, 29 muskoxen were seen on Somerset Island, none on Russell, and 1,126± SE 276 (1+ year old; Gunn and Decker 1984) on Prince of Wales. By 1995, the estimate for Prince of Wales Island (including Pandora Island) was 5,157± SE 414 (including calves), Russell Island had 102± SE 54 adult muskoxen, and Somerset Island had 1,140± SE 260 muskoxen (including calves; Gunn and Dragon 1998). The last survey, flown in 2004, estimated 1,582-2,746 (95%CI) adult muskoxen on Prince of Wales (including Pandora and Russell islands) and 962-3,792 adult muskoxen on Somerset Island (Jenkins et al. 2011). Hunters in Resolute Bay and Taloyoak report large numbers of muskoxen on the islands as well.

Study Area

Prince of Wales Island is mostly flat and low-lying, with abundant ponds and lakes in the south and western parts of the island, rising to rolling hills along the east coast and in the north, with a maximum elevation of 415 m ASL near Cape Hardy. Prescott and Vivian islands lie just east of Prince of Wales Island, separating Browne Bay from Peel Sound. Pandora Island, south of Prescott Island, is also in Peel Sound, at the mouth of Young Bay. Russell Island to the north is separated from Prince of Wales Island by the narrow Baring Channel. Somerset Island is dominated by a rolling barren plateau approximately 400 m ASL, deeply incised by river valleys. Productive lowlands around the Creswell River and Stanley Fletcher Basin transition into igneous hills along the west coast and south part of the island, where it is separated by narrow Bellot Strait from the Boothia Peninsula.

Mean July temperatures are 3-5°C in the north part of the study area, which is dominated by cushion-forb barrens on Somerset Island, and by cushion-forb barrens, cryptogam barrens, and prostrate dwarf shrub-graminoid tundra on Russell and Prince of Wales islands (Gould et al. 2003 and references therein). The southern part of the study area has mean July temperatures between 5-7°C. Southern Somerset Island is dominated by prostrate dwarf shrub-graminoid tundra and hemiprostrate dwarf shrub tundra (Gould et al. 2003). Southern Prince of Wales Island is dominated by prostrate dwarf shrub tundra, with some prostrate dwarf shrub-graminoid tundra and sedge-moss tundra (Gould et al. 2003).

The August 2016 aerial survey was flown to cover the same study area as the previous 2004 survey (Jenkins et al. 2011), by fixed-wing aircraft rather than helicopter. We used fixed-wing aircraft to address community concerns about the greater disturbance experienced by wildlife from helicopter overflights as well to improve our chances of safely completing the survey in an area prone to poor weather conditions.

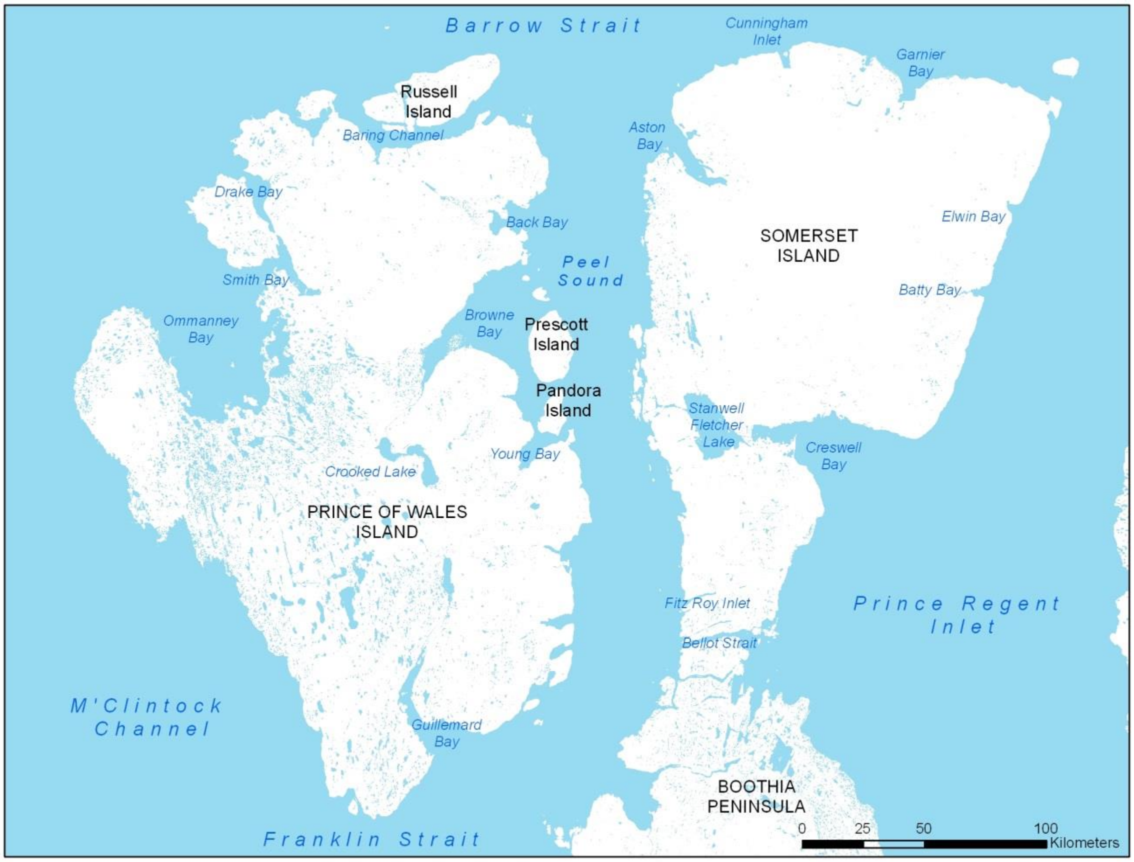

Figure 1. Major landmarks of the study area.

Methods

Aerial Survey

Survey transects (n=71, Appendix 1, Figure 2) were established to provide approximately 20% coverage in each stratum running east-west with a 800 m strip on either side of the aircraft. We stratified the study area by island only, with transects spaced 8.64 km apart on Prince of Wales Island and 10.16 km apart on Somerset Island.

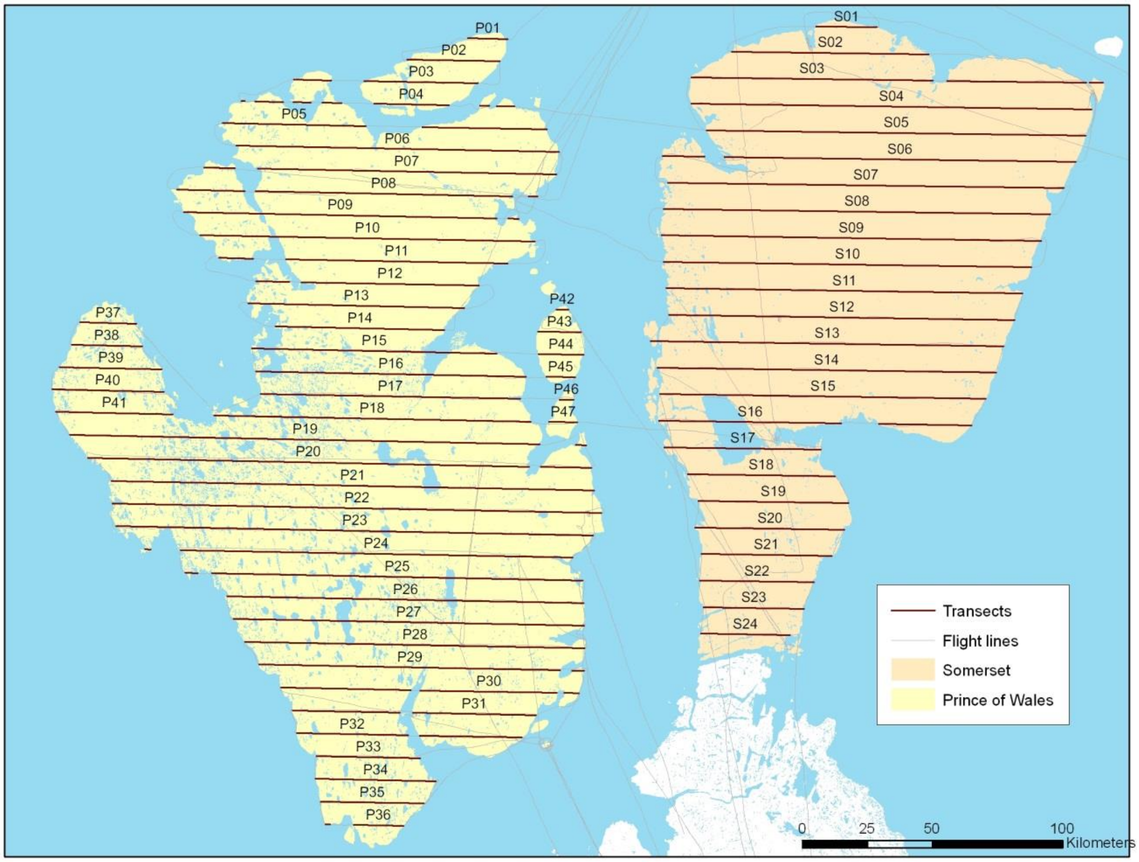

Figure 2. Transects and survey strata for Prince of Wales and Somerset islands, August 5-23, 2016. Transects on Prince of Wales are 8.64 km apart and transects on Somerset are 10.16 km apart.

To define the transect width, we marked survey aircraft wing struts following Norton-Griffiths (1978):

$$w = W\left(\frac{h}{H}\right)$$

where W is the strip width, H is the flight height, h is the observer height when the plane is on the ground and w is calculated, measured and marked on the ground to position wing strut marks (Figure 3). For this survey we used one mark representing 500 m, in anticipation of reduced detection of caribou beyond 500 m, and another mark for 800 m, to provide a strip for more readily detecting muskoxen. Fixed-wing strip transect sampling has been successfully used in the high arctic since 1961, and can be useful when observations are insufficient to determine the effective strip width required for distance sampling. An 800-m strip has been successfully used in the area previously for muskoxen on the islands (Gunn and Decker 1985, Gunn and Dragon 1998).

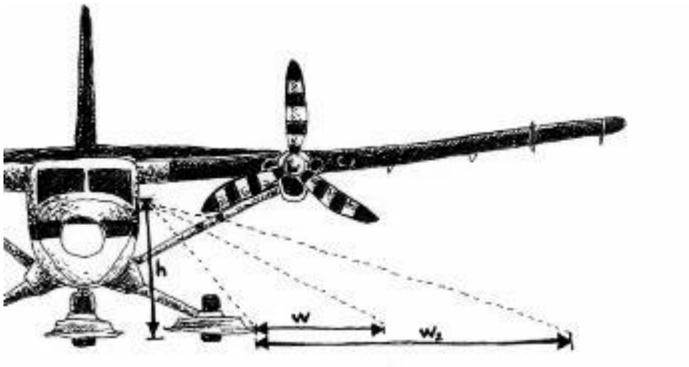

Figure 3. Derivation of wing strut marks for strip boundaries, where *w* and w_2 are calculated as described in the text, *h* is measured, and dotted lines indicate observer sightlines as modified from Norton-Griffiths (1978).

Most of the survey was flown with a DeHavilland Turbine Otter, but the air charter company was not able to stage out of Resolute, so the northern part of the survey area (transects P01-P14 and S01-S10) were flown with a DeHavilland Twin Otter with bubble windows stationed in Resolute. On both platforms we had 4-6 passengers (2 front observers, 2-4 rear observers, one of whom was also data recorder) in a co-operative double-observer set up (Campbell et al. 2012 for an overview of the methodology). Front and rear observers on the same side of the plane were able to communicate and all observations by front and rear observers were combined.

Transects were flown between 160-220 km/hr with higher speeds over flat uniform terrain where visibility was excellent. Surveys were only conducted on good visibility days to facilitate detection of animals, as well as for operational reasons to ensure crew safety. Flight height was set at 152 m (500 ft) using a radar altimeter. In rugged terrain, the flight height was adhered to as closely as possible within the constraints of crew safety and aircraft abilities.

Observations were recorded on a handheld Garmin Montana 650 global positioning system (GPS) unit, which also recorded the flight path every 15 seconds. Sex and age classification was limited, since the aircraft did not make multiple passes (to minimize disturbance), but adult/calf determination was possible for muskoxen and aided by binoculars and therefore recorded. However, the small size of calves and their close association with other animals in the herd made them difficult to count accurately when muskoxen were tightly grouped. Muskoxen were frequently spotted more than a kilometer off transect due to their large aggregations and dark colour, but depending on distance and topography, an accurate count could not always be determined for distant groups and they are not included in determination of adult-calf ratios. GPS tracks and waypoints were downloaded through DNR-GPS and saved in Garmin GPS eXchange Format and as ESRI shapefiles. Data was entered and manipulated in Microsoft Excel and ArcMAP 10.0 (ESRI, Redlands, CA).

Analysis

Flights linking consecutive transects were removed for population analysis and sections of transect crossing bays and inlets were removed, as these areas were not included in the area used for density calculations. Transect segments crossing lakes were retained and lake areas were not subtracted from the total area of the strata. Distances and lengths were calculated using a North Pole azimuthal equidistant projection centered over the study area at N73° and W96°;

areas were calculated using a North Pole Lambert azimuthal equal area projection centered on the same coordinates.

Although Jolly's (1969) Method II is widely used for population estimates from surveys, it is designed for a simple random survey design, rather than for a systematic survey of a patchy population. For comparison, population calculations following Jolly's Method II are provided in Appendix 3, along with calculations following a systematic stratified survey design (Cochran 1977). The muskoxen detected in this survey were patchily distributed and serially correlated, not randomly distributed. For systematic samples from serially correlated populations, estimates of uncertainty based on deviations from the sample mean are expected to be upwardly biased and influenced by the degree of serial correlation; high serial correlation implies that there is less random variation in the unsurveyed sections between systematically spaced transects than if serial correlation were low (Cochran 1977). Calculating uncertainty based on nearest-neighbor differences incorporates serial correlation, and the upward bias in the uncertainty is expected to be less than if it were calculated based on deviations from the sample mean. Nearest-neighbor methods have been used previously to calculate variance around survey estimates on the unweighted ratio estimate (Kingsley et al. 1981, Stirling et al. 1982, Kingsley et al. 1985, Anderson and Kingsley 2015).

The model for observations on a transect survey following Cochran (1977) is:

$$y_i = Rz_i + \varepsilon_i\sqrt{z_i}$$

Where y_i is the number of observations on transect *i* of area z_i, R is the mean density and error terms ε_i are independently and identically distributed. In this model, the variance of the error term is proportional to the area surveyed. The best estimate of the mean density $\hat{R}$ is:

$$\hat{R} = \frac{\sum_i y_i}{\sum_i z_i}$$

The error sum of squares, based on deviations from the sample mean, is given by:

$$\left(\sum_i \frac{{y_i}^2}{z_i}\right) - \frac{(\sum_i y_i)^2}{\sum_i z_i}$$

The finite-population corrected error variance of $\hat{R}$ is:

$$Var(\hat{R}) = \frac{(1-f)}{(n-1)\sum_i z_i}\left(\left(\sum_i \frac{{y_i}^2}{z_i}\right) - \frac{(\sum_i y_i)^2}{\sum_i z_i}\right)$$

Where f is the sampling fraction and n is the number of transects. The sampling fraction also provides the scaling factor for moving from a ratio (population density) to a population estimate. It is calculated as $(\sum z_i)/Z$, where Z is the study area and $\sum z_i$ is the area surveyed. The irregular study area boundaries mean that f varies from the 20% sampling fraction expected from a 1-km survey strip and 5-km transect spacing.

If we were to apply a model $y_i = Rz_i + \varepsilon_i$ instead, then the variance of the error term would be independent of z, so the variance would depend on the number of items in the sample, but not their total size. This would lead to a least squares estimate of R of $\sum zy / \sum z^2$, rather than the more intuitive density definition and model for R presented above.

To incorporate serial correlation in the variance, we used a nearest-neighbor calculation, with the error sum of squares given by:

$$\sum_{i=1}^{n-1} \left(\frac{y_i^2}{z_i} + \frac{y_{i+1}^2}{z_{i+1}} - \frac{(y_i + y_{i+1})^2}{z_i + z_{i+1}} \right)$$

i.e. the sum of squared deviations from pairwise weighted mean densities. The nearest-neighbor error variance of $\hat{R}$ is:

$$Var(\hat{R}) = \frac{(1-f)}{(n-1)\sum_i z_i} \sum_{i=1}^{n-1} \left(\frac{y_i^2}{z_i} + \frac{y_{i+1}^2}{z_{i+1}} - \frac{(y_i + y_{i+1})^2}{z_i + z_{i+1}} \right)$$

Both variance calculations were applied to the survey data. In addition, calculations for these strata based on Jolly's (1969) Method II and Cochran's (1977) systematic survey models are provided in the appendices for comparison. For the final estimate, we used the nearest neighbor variance.

Population growth rates were calculated following the exponential growth function, which approximates growth when populations are not limited by resources or competition (Johnson 1996):

$$N_t = N_0 e^{rt} \qquad \text{and} \qquad \lambda = e^r,$$

where N_t is the population size at time *t* and N_0 is the initial population size (taken here as the previous survey in 2008). The instantaneous rate of change is r, which is also represented as a constant ratio of population sizes, λ. When r >0 or λ >1, the population is increasing; when r <0 or λ <1 the population is decreasing. Values of r ~0 or λ ~1 suggest a stable population.

Results

We flew surveys August 5-23, 2016 for a total of 82.0 hours not including positioning time, 53.8 hours by single Otter and the remainder by Twin, with a total of 39.9 hours on transect. Incidental wildlife sightings are presented in Appendix 5 and daily flight summaries are presented in Appendix 4. Visibility was excellent for most survey flights, although some fog and low cloud on Russell Island and northwestern Somerset Island required a second pass to ensure the areas were covered. We did not see any caribou on the survey, although hunters travelling from Creswell Bay by ATV did see two caribou on the west coast of Somerset Island south of M'Clure Bay and north of Fiona Lake. They believed there were more in the river valleys in the area, but were unable to confirm due to the rough terrain. We saw 1,264 muskoxen (769 on Prince of Wales Island and 495 on Somerset Island), including off transect sightings. This included 519 muskoxen on transect (288 on Prince of Wales Island and 231 on Somerset Island). Spatial data presented in Figure 4 represents waypoints taken during the survey along transects and includes on- and off-transect sightings, and except for groups observed on the transect line, waypoints have error associated with the group's distance from the plane. While observations on transect are within 800 m, some muskox groups off transect were more than 2 km away.

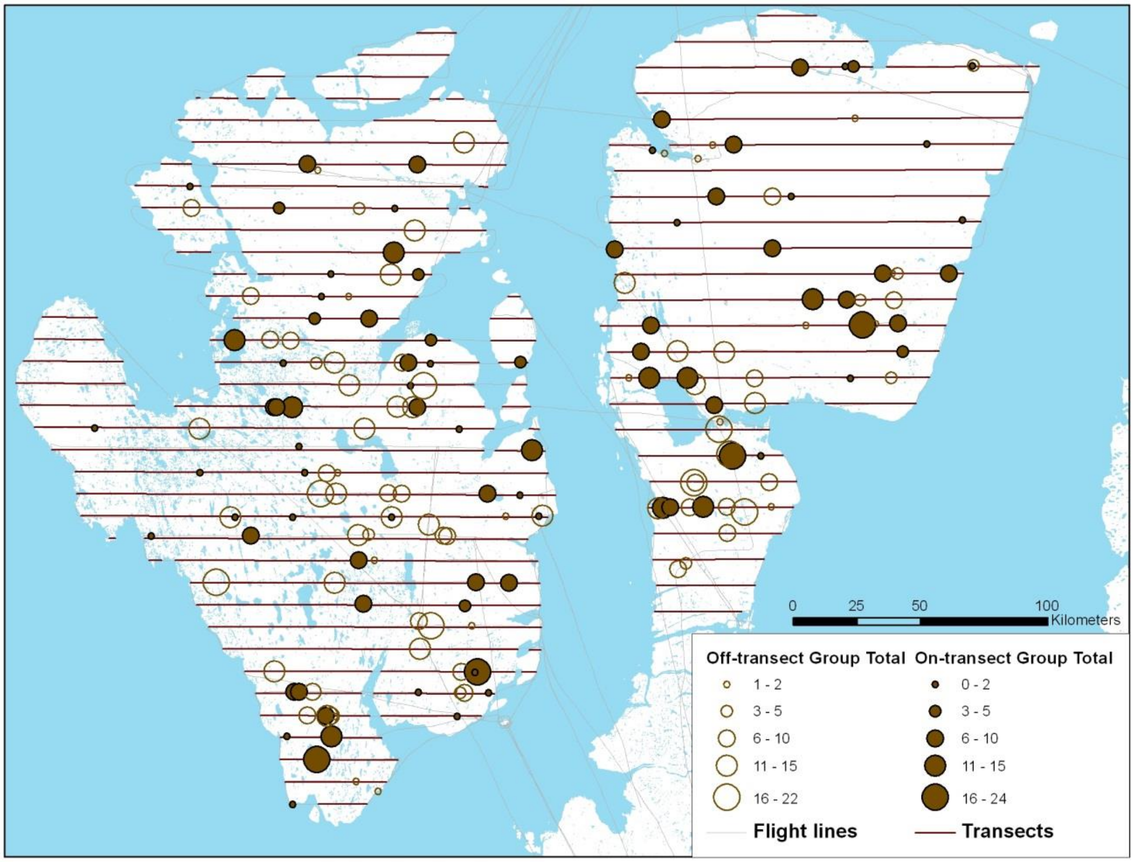

Figure 4. Observations of muskoxen on Prince of Wales and Somerset islands, August 2016, including observations on and off transect, and on ferry flights.

Abundance Estimates

Muskox population estimates and variances are presented in Table 1.

Table 1. Muskox population calculations for Prince of Wales and Somerset islands with variance calculated by nearest neighbor methods and by deviations from the sample mean.

	Prince of Wales		**Somerset**		**Total**	
Stratum area Z (km^2)	35592		25228		60820	
Surveyed area z (km^2)	6533		3929		10462	
Count, y	288		231		519	
Estimate, $\hat{Y}$	1569		1483		3052	
Density, $\hat{R}$ (muskox/km^2)	0.0441		0.0588		0.0496	
	Nearest Neighbor	*Deviations from sample mean*	*Nearest Neighbor*	*Deviations from sample mean*	*Nearest Neighbor*	*Deviations from sample mean*
Error Sum of Squares	21.125	21.527	21.424	19.725		
Var ($\hat{Y}$)	71157.6	72512.6	122096.1	112413.3	193253.7	184925.9
SE	267	269	349	335	440	430
CV	0.170	0.172	0.236	0.226	0.144	0.141

Since there were no observations of Peary caribou on the aerial survey in 2016, we were not able to calculate a population estimate. The observation of two caribou by hunters during the survey confirms that they are still present on the islands, but at such a low abundance that conventional aerial surveys are not able to detect them reliably or calculate a population estimate. A similar situation was encountered in 2004, when no caribou were seen on the aerial survey, but presence was confirmed during ground searches.

Population Trends

The variance associated with the population estimates in 2004 and 2016 makes it difficult to determine whether muskox populations are increasing, decreasing, or stable on Prince of Wales and Somerset islands. Using the population estimate for Prince of Wales Island (including Russell, Prescott, and Pandora islands) and Somerset Island in 2004 and 2016, the exponential growth rate *r* is -0.02 and the intrinsic growth rate λ is 0.98, which would suggest a slight decline. However, the 95% confidence intervals have large overlaps between 2004 and 2016 surveys: Somerset 2016 - 885-2,082 muskoxen, Somerset 2004 962-3,792 muskoxen; Prince of Wales 2016 – 1,121-2,017 muskoxen, Prince of Wales 2004 1,582-2,746 muskoxen.

Calf Recruitment

Yearlings could often be classified even in distant groups, but not consistently enough to facilitate accurate data collection. For this reason, only two age categories were used. Sixteen groups of muskoxen were too far away or grouped too closely to determine how many calves were present. However, we were able to classify the remaining 156 muskox groups as adults or calves, where adults were considered any animals over 1 year old. We classified the animals in these groups as 887 1+-year-old muskoxen and 192 calves, a calf to adult ratio of 0.214. Calves made up 17.8% of the population.

Group Size

We observed 172 groups of muskoxen, with group sizes ranging from single animals to 24 muskoxen, with an average of 7.3 muskoxen per group (SD=5.6). Considering only the 132 groups that were not single animals, the average group size was 9.3 muskoxen (SD=5.0).

Discussion

Population Trends - Caribou

Previous surveys of Prince of Wales and Somerset islands have used different survey platforms (Helio-Courier, Gunn and Decker 1984, Gunn and Dragon 1998; ground surveys, Jenkins et al. 2011; Bell 206 helicopter, Miller 1997, Jenkins et al. 2011; Turbine Otter and Twin Otter, this survey). They have also concentrated on different parts of the island, and been conducted at different times of year, which is an important consideration for a Peary caribou population that historically migrated between the islands and south to the Boothia Peninsula in winter.

Historically, Prince of Wales and Somerset islands supported a large population of Peary caribou. Although larger than Peary caribou further north on the Arctic Archipelago, they were still more closely related to Peary caribou than to the barren-ground caribou with which they shared winter range on Boothia Peninsula (McFarlane et al. 2014). Between 1928 and 1930 there was a die-off on Somerset Island, but caribou were still present and had increased by the late 1960s and reached high densities in the 1970s (IQ in Taylor 2005). In the 1950s and 1960s, hunters had to travel farther than Somerset Island to find Peary caribou, and reported finding some on Prince of Wales Island (IQ in Taylor 2005). By the 1970s, high densities of caribou were observed on Prince of Wales Island as well, and people became concerned that there were too many (IQ in Taylor 2005). In the 1980s and early 1990s, the population crashed by 98% from an estimated 6048 caribou in 1980 (Gunn and Decker 1984) to an estimated 100 caribou in 1995 (Gunn et al. 2006). When Prince of Wales and Somerset islands were flown in 1995, only 2 bulls and 3 cows were seen on Prince of Wales Island, and 2 cows on Somerset Island. In spring 1996, Miller (1997) flew extensive unsystematic helicopter searches of the islands and recorded only 2 caribou.

The decline was predicted by Inuit familiar with the caribou on these islands (IQ in Taylor 2005); however, the mechanism of the decline remains unknown. Gunn et al. (2006) examined possible reasons for the decline, and although no one factor was identified as the sole cause, the authors suggested it was likely due to a combination of low adult female survival and low calf and yearling recruitment, high annual harvest rates from Taloyoak and Resolute, and increasing predation pressure from a wolf population supported by an increasing and more sedentary muskox population. Reports of groundfast ice on Prince of Wales Island, likely in 1990 or 1991, may also have contributed to the decline (IQ in Taylor 2005, Gunn et al. 2006) and similar events have contributed to Peary caribou declines elsewhere in the Arctic Archipelago (Miller et al. 1975, Miller and Gunn 2003, Miller and Barry 2009). Mass movement of caribou off the islands is not believed to explain the decline (Gunn et al. 2006). Based on the known migration patterns, Boothia Peninsula would be the most likely place for island caribou to move, but although caribou on the Boothia Peninsula did increase over the time period of the Prince of Wales/Somerset decline, it was not enough to account for the decline (Gunn et al. 2006, Miller et al. 2007). Although caribou on Prince of Wales and Somerset islands cross north to Bathurst and Cornwallis islands and potentially west to Victoria Island or King William Island, no large influx of caribou on any of those islands was noted by harvesters or recorded during surveys at the time of the decline on Prince of Wales and Somerset islands (Gunn et al. 2006).

Regardless of the reasons for the original decline, caribou populations on Prince of Wales and Somerset islands have not recovered since the early 1990s, although some caribou are still present on the islands. The two caribou observed by local hunters were in an area where caribou had been previously encountered, and identified as important winter range by Russell and Edmonds (1977). There was no sea ice present around the islands group during August, including in Peel Sound, so we did not miss animals crossing between the islands over ice.

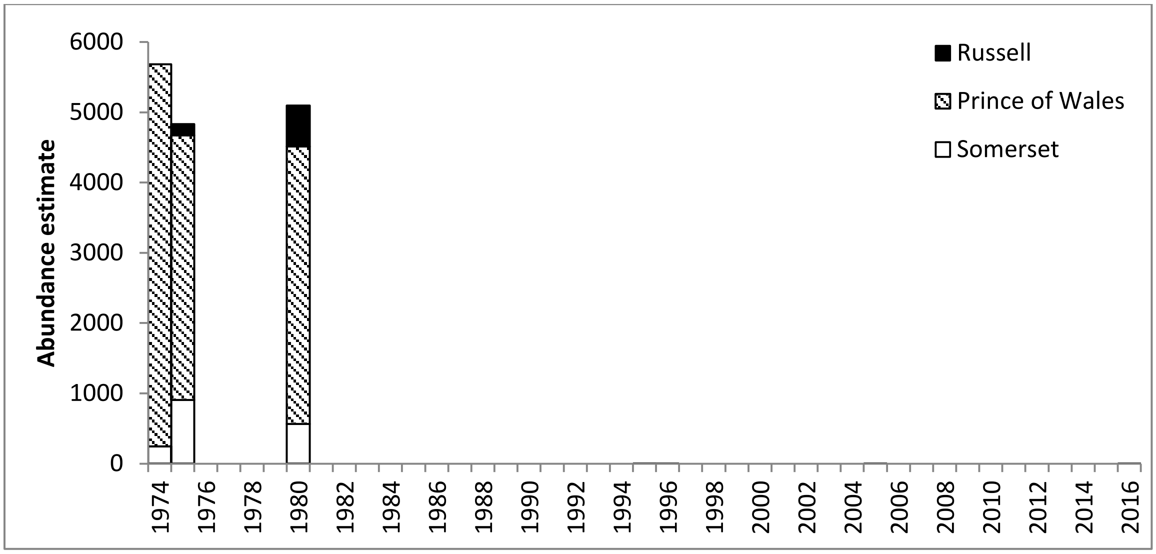

Figure 5. Population trends for Peary caribou on Prince of Wales, Somerset, and Russell islands, showing a catastrophic decline between 1980 and 1995. Surveys were conducted in June-July1974 and 1975 (Fischer and Duncan 1976), July 1980 (Gunn and Decker 1984), July-August 1995 (Gunn and Dragon 1998), April-May 1996 (Miller 1997), April 2004 and 2005 (Jenkins et al. 2011), and August 2016. Error bars are not shown and are not available for all estimates.

Although the 1985 estimate of Peary (or Peary-like) caribou on the Boothia Peninsula could account for some of the 'missing' Prince of Wales and Somerset island caribou, it is not clear how many Peary caribou persist on northern Boothia Peninsula. A survey in 2006 identified only one caribou that observers were confident was a Peary caribou, although the survey was not designed to differentiate between the two subspecies (Dumond 2006). No caribou were seen during aeromagnetic survey flights on northern Boothia Peninsula between Sept 7-Oct 4, 2013 (survey altitude was 150 m; W. Miles, Airborne Geophysics Section, Geological Survey of Canada, pers. comm.).If harvest levels in the 1980s and 1990s were maintained or increased, and if Peary caribou were selectively harvested, it is possible that the population on Boothia Peninsula was drawn down simultaneously with the Prince of Wales and Somerset islands caribou, even if some of them were resident on the Boothia Peninsula (Gunn and Ashevak 1990, Gunn and Dragon 1998, Gunn et al. 2006, Miller et al. 2007). Hunters in Taloyoak occasionally report catching smaller, fatter caribou with short faces and legs, but these characteristics are often mixed with classic barren-ground caribou traits.

Population Trends - Muskoxen

In 1975, Hubert (1975) estimated 2,381 muskoxen on Prince of Wales Island; Fischer and Duncan (1976) estimated 907 muskoxen for the same time frame, although their survey coverage was lower. Gunn and Decker (1984) estimated 1,126 ± SE 276 muskoxen on Prince of Wales Island in 1980, but they suggest that the actual number was likely closer to 850, given their knowledge of the available habitat. By 1995, the muskox population had increased dramatically to

5,259 ± SE 414 muskoxen (Gunn and Dragon 1998), but dropped to 2,086 by 2004 (1,582-2,746, 95% CI, Jenkins et al. 2011). Our estimate of 1,569 ± SE 267, without information on abundance or trends between surveys, could indicate that the population could be increasing after a period of low abundance, stable at slightly lower abundance, or continuing to decline. Continued monitoring is necessary to determine trend.

Two piles of skulls near the Union River suggested that muskoxen had previously been abundant and harvested on Somerset Island (Russell and Edmonds 1977). However, only 12 muskoxen were seen on Somerset Island in 1974. They expanded on Somerset Island to a population of 1,140 ± SE 260 in 1995 (Gunn and Dragon 1998), increased to 1,910 muskoxen in 2004 (962-3,792 95% CI, Jenkins et al. 2011), and appear to have declined slightly to 1,483 ± SE 335 muskoxen in 2016.

Although the population estimate for muskoxen on Prince of Wales and Somerset islands is lower than in 2004, there is uncertainty in whether this is a true declining trend. Considering the lack of monitoring in between the surveys, the overlap in confidence intervals, and the proportion of calves, in the muskox population on Somerset and Prince of Wales islands could be stable population or showing early signs of increase from an even lower population level.

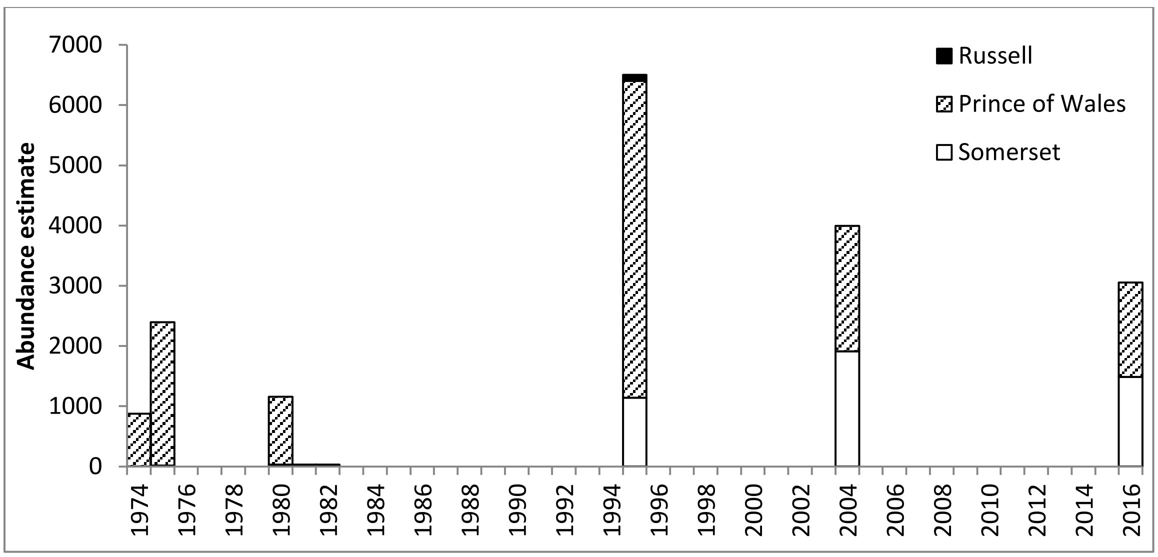

Figure 6. Population trends for muskoxen on Prince of Wales, Somerset, and Russell islands, showing an increase from the 1970s and a gradual decline since the mid-1990s.Surveys were conducted in June-July1974 and 1975 (Fischer and Duncan 1976), July 1980 (Gunn and Decker 1984), July-August 1995 (Gunn and Dragon 1998), April-May 1996 (Miller 1997), April 2004 and 2005 (Jenkins et al. 2011), and August 2016 (this report). Error bars are not shown and are not available for all estimates.

Muskox Distribution

On Prince of Wales Island, the areas around Back Bay, Browne Bay, and between Fisher and Crooked lakes were identified as muskox winter and summer range by Russell and Edmonds (1977) based on their observations in the mid-1970s, although only the eastern half of the island was surveyed. During more comprehensive surveys in 1980, muskoxen were still only seen on the eastern third of Prince of Wales Island (Gunn and Decker 1984). By 1995, they were found across Prince of Wales and Russell islands, but the eastern third of Prince of Wales Island was still the area with the highest density (Gunn and Dragon 1998). We saw muskoxen across the island, although not on the smaller satellite islands of Russell or Pandora, and they were almost absent from the western peninsula in the vicinity of the Rawlinson Hills. The distribution of muskoxen on Prince of Wales Island was similar to the distribution seen in 2004, although one muskox group was seen on Pandora Island and two groups were seen on Russell Island (Jenkins et al. 2011).

Muskox concentrations on Somerset Island recorded on this survey were in areas where they were also detected in 2004, with more sightings farther north on Somerset Island. The northeast part of the island is largely a barren plateau with little vegetation where few muskoxen were seen. Most sightings, and the largest groups, were encountered northwest from Creswell Bay to Fiona Lake and south of Creswell Bay where vegetation was more abundant.

Calf Recruitment
The recorded proportion of muskox calves in the population (17.8%) was slightly lower than that recorded for southern Ellesmere Island in summer 2014 (24%, Anderson and Kingsley 2015), but higher than the 10.5% calf production which Freeman (1971) estimated would be required to offset natural mortality based on observations in 1965 and 1967 on Devon Island. The proportion of calves is higher than the 2004 survey, but since that survey was conducted during calving season in April, the 2% calves recorded likely accounted for only part of the calf crop in 2004. No unusual mortality or calf crop losses have been noticed by harvesters. The proportion of calves may be biased low due to detectability, but the open terrain allowed us to classify most groups before muskoxen herded together and blocked calves from sight.

Group Sizes
Muskox groups are largest early in the spring and smaller as summer progresses (Freeman 1971, Gray 1973), with winter groups about 1.7 times larger than summer groups (Heard 1992). Muskoxen were encountered in herds of 2-24, with some lone adults seen as well, and averaged 7.3 muskoxen per herd, or 9.3 muskoxen per herd is single animals are discounted. This is slightly smaller than the 10.0 muskoxen per herd encountered by Freeman (1971) in the Jones Sound region and slightly smaller than herd sizes encountered in March 2015 on southern Ellesmere Island (8.9-12.1 muskoxen/group, 95% CI, Anderson and Kingsley 2015). The mechanisms behind group size variation are not well understood, and may vary by population as well as time of year.

Management Recommendations

Peary caribou and muskoxen are an important source of country food and cultural identity for Inuit. Consistent with the Nunavut Land Claims Agreement, the Management Plan for High Arctic Muskoxen of the Qikiqtaaluk Region, 2013-2018 (DOE 2014), the draft Management Plan for Peary Caribou in Nunavut (DOE in prep), and the draft Recovery Strategy for Peary Caribou in Canada (ECCC in prep), these management recommendations emphasize the importance of maintaining healthy populations of caribou and muskox that support sustainable harvest.

Under the Management Plan for the High Arctic Muskoxen of the Qikiqtaaluk Region, 2013-2018 (DOE 2014), Prince of Wales, Somerset, and Russell islands are considered a single management unit, MX-06, which was previously assigned a Total Allowable Harvest (TAH) of 20, allocated to Resolute. In September 2015, based on stable high densities of muskoxen in MX-06, the TAH was removed, and anyone can now harvest a muskox from MX-06. Considering the continued high densities of muskoxen, even with a slightly declining trend, implementing a TAH is not required for the continued sustainable use of muskoxen in MX-06, which are generally harvested at low levels (Anderson 2015). Harvest practices that maintain group cohesion and predator defense could still be considered, for example, limited the number of animals harvested from small groups.

It is highly recommended that a harvest reporting system be maintained even if the TAH is removed. This would allow biologists, community members, and decision-makers to track harvest patterns over time and to determine whether changes to management zones or harvest restrictions have the desired effect. As local knowledge and previous surveys have demonstrated, population changes can be rapid and unexpected if severe weather causes localized or widespread starvation or movement; so continuous monitoring and adaptive management is necessary even when populations are at high levels.

Harvest trends for muskoxen over the last decade suggest that hunters from Resolute Bay harvest fewer muskoxen than in the 1990s (Anderson 2016), but changes to the configuration of management zones in September 2015 appear to be encouraging more harvest in areas that were previously accessible but not included in a management unit, primarily Cornwallis Island near Resolute Bay. The major decline in caribou on Baffin Island and subsequent harvest restrictions have reduced the availability of country food for Baffin communities, including Arctic Bay, which has harvested muskoxen on Somerset in the past using tags transferred from Resolute Bay. The areas of Somerset Island most accessible from Arctic Bay had low muskox densities, as the habitat is largely unsuitable for muskoxen.

Since only two caribou were seen during the survey (and not even on the survey itself), it is clear that the population has not yet recovered. This was not surprising, since harvesters had not reported drastic changes in caribou abundance. Peary caribou are known to cross between Bathurst and Cornwallis islands to Somerset and Prince of Wales islands (IQ in Johnson et al. 2016). Not harvesting Peary caribou on Somerset and Prince of Wales islands might allow the new immigrants to establish themselves and the population to increase again. However, harvest is likely not the limiting factor for Peary caribou on Prince of Wales and Somerset islands at present, since they are rarely seen and harvest pressure is directed elsewhere. Harvesting more muskoxen in areas where caribou were historically found might provide the caribou with more suitable places to expand, since Inuit Qaujimajatuqangit recognizes that Peary caribou and muskoxen tend not to overlap.

Acknowledgements

Thank you to everyone involved in this survey, which seemed to switch to new contingency plans at least once a day. Thanks to the survey observers from Taloyoak and Resolute: Debbie Iqaluk, James Iqaluk, Thomas Kalluk, Belinda Oqallak, Eric Saittuq, Robert Quqqiaq, and Bill Ekalik, as well as Government of Nunavut summer student Etuangat Akeeagok and Polar Shelf summer student Keesha Allurut, who was also drafted into logistics when we unexpectedly overnighted in Arctic Bay. Thanks to Wayne Pollard for lending 4 undergraduate observers last-minute from the McGill University Arctic Field School (Eva Wu, Hana Moidu, Olivia Gau, and Lauren Thompson). Ookpik Air pilots Mike Bergmann and Alan Gilbertson flew the Turbine Otter part of the survey, and Kenn Borek Air pilots Troy Mckerrall and Alex Pelletier in the Twin Otter provided the much-anticipated countdown to the end of the last transect. Their assistance in classifying muskox before they grouped together was extremely helpful. Thanks to the Taloyoak HTO and Resolute Bay HTA for their guidance and support. Delilah Manik and Jimmy organized observers. Mike

Kristjanson, Tim McCaugherty, Glenn Parsons, Jodi MacGregor, Tanya Lemieux, and the rest of the team at Polar Continental Shelf Program provided logistical support for a survey that seemed to encounter some new exciting problem every day. Sometimes twice a day. Lisa-Marie Leclerc provided comments on an earlier draft of the report and communicated with Kitikmeot communities prior to the survey.

Funding for this work was provided by the Nunavut Department of Environment Wildlife Research Section, Environment and Climate Change Canada's Habitat Stewardship Fund (Project GCXE17C330), and the Nunavut Wildlife Research Trust (Project 2-16-09). The Polar Continental Shelf Program provided logistical support (Project 302-16). The work was completed under Government of Nunavut Wildlife Research Section permit 2016-055.

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Appendix 1. Prince of Wales and Somerset islands survey transects, 2016.

Table 2. Transect end points and strata on Prince of Wales, Somerset, and Russell islands for a fixed-wing survey, August 2016.

Transect	Stratum	Lon (West)	Lat (West)	Lon (East)	Lat (East)
1	Somerset	-93.7291	74.15611	-92.968	74.14743
2	Somerset	-94.798	74.07323	-92.3281	74.04721
3	Somerset	-95.3025	73.98443	-90.1791	73.9117
4	Somerset	-95.2975	73.89351	-90.3435	73.82454
5	Somerset	-95.1054	73.8019	-90.4406	73.73563
6	Somerset	-95.6479	73.71242	-90.5865	73.64785
7	Somerset	-95.5839	73.62132	-90.7573	73.56056
8	Somerset	-95.6292	73.53037	-90.9468	73.47359
9	Somerset	-95.6506	73.43935	-91.074	73.38509
10	Somerset	-95.6203	73.34822	-91.215	73.29681
11	Somerset	-95.5854	73.25704	-91.3403	73.20812
12	Somerset	-95.5549	73.16583	-91.4522	73.11907
13	Somerset	-95.7674	73.07499	-91.5983	73.03066
14	Somerset	-95.6841	72.98368	-91.7045	72.94136
15	Somerset	-95.6475	72.8924	-91.8391	72.85255
16	Somerset	-95.6578	72.80116	-92.0198	72.76452
17	Somerset	-95.5907	72.70975	-93.7768	72.69858
18	Somerset	-95.3206	72.61775	-93.6243	72.60556
19	Somerset	-95.1974	72.52597	-93.4769	72.51245
20	Somerset	-95.229	72.43472	-93.5282	72.42162
21	Somerset	-95.1572	72.34304	-93.6823	72.33191
22	Somerset	-95.1741	72.25168	-93.8884	72.24262
23	Somerset	-95.1367	72.16008	-94.007	72.1523
24	Somerset	-95.1631	72.06871	-94.1674	72.06227
1	Prince of Wales	-98.1143	74.09704	-97.6124	74.10107
2	Prince of Wales	-98.8542	74.01181	-97.698	74.02321
3	Prince of Wales	-100.247	73.9129	-97.9585	73.94386
4	Prince of Wales	-100.873	73.82293	-97.4929	73.87006
5	Prince of Wales	-101.076	73.74093	-97.0791	73.79508
6	Prince of Wales	-100.881	73.66766	-96.9246	73.71843
7	Prince of Wales	-101.244	73.5819	-96.9479	73.64099
8	Prince of Wales	-101.543	73.49703	-97.1679	73.56258
9	Prince of Wales	-101.434	73.42201	-97.386	73.48394
10	Prince of Wales	-101.211	73.34968	-97.1765	73.40772
11	Prince of Wales	-100.956	73.27784	-97.495	73.32836
12	Prince of Wales	-100.487	73.21024	-97.8302	73.24836
13	Prince of Wales	-100.557	73.13111	-97.9881	73.16948
14	Prince of Wales	-100.212	73.06036	-98.2089	73.08983

Transect	Stratum	Lon (West)	Lat (West)	Lon (East)	Lat (East)
15	Prince of Wales	-100.467	72.97756	-97.5817	73.01773
16	Prince of Wales	-100.39	72.9014	-97.2279	72.94247
17	Prince of Wales	-100.314	72.82519	-97.2842	72.86458
18	Prince of Wales	-100.832	72.73635	-97.1535	72.78773
19	Prince of Wales	-102.459	72.6153	-97.039	72.71071
20	Prince of Wales	-102.228	72.5442	-96.4311	72.63518
21	Prince of Wales	-101.929	72.4748	-96.3925	72.55762
22	Prince of Wales	-101.885	72.39804	-96.3039	72.48012
23	Prince of Wales	-101.813	72.32202	-96.3931	72.4023
24	Prince of Wales	-101.06	72.26366	-96.6206	72.32406
25	Prince of Wales	-100.982	72.18758	-96.5033	72.24666
26	Prince of Wales	-100.488	72.12092	-96.4805	72.16899
27	Prince of Wales	-100.396	72.04497	-96.4724	72.09126
28	Prince of Wales	-100.242	71.97024	-96.4566	72.01353
29	Prince of Wales	-100.064	71.8959	-96.4618	71.93574
30	Prince of Wales	-99.8025	71.82299	-96.5125	71.85781
31	Prince of Wales	-99.6589	71.74767	-96.9794	71.77828
32	Prince of Wales	-99.5932	71.67088	-97.1242	71.69969
33	Prince of Wales	-99.3587	71.59695	-98.2275	71.61265
34	Prince of Wales	-99.3477	71.51916	-98.0401	71.53673
35	Prince of Wales	-99.2754	71.44236	-98.1608	71.45753
36	Prince of Wales	-99.2058	71.36549	-98.3678	71.37723
37	Prince of Wales	-102.508	73.00371	-101.847	73.02254
38	Prince of Wales	-102.575	72.92373	-101.747	72.94737
39	Prince of Wales	-102.677	72.84262	-101.49	72.87619
40	Prince of Wales	-102.733	72.76286	-101.439	72.79963
41	Prince of Wales	-102.654	72.68731	-101.307	72.72508
42	Prince of Wales	-96.8937	73.17667	-96.7511	73.1772
43	Prince of Wales	-97.1005	73.09822	-96.5907	73.1002
44	Prince of Wales	-97.0877	73.02076	-96.5537	73.02278
45	Prince of Wales	-96.9878	72.9437	-96.646	72.94499
46	Prince of Wales	-96.8262	72.86682	-96.6557	72.8674
47	Prince of Wales	-96.9366	72.78878	-96.6058	72.78997

Appendix 2. Alternate population calculations.

Jolly Method II Calculations
In this report, we used a systematic sampling approach to analysis, since we were estimating abundance of a patch population rather than estimating density in a habitat (which varied across the study area). Other systematic aerial surveys have frequently used Jolly's Method II, and estimates derived from both analyses were similar. Population estimates for fixed-width strip sampling using Jolly's Method 2 for uneven sample sizes (Jolly 1969; summarized in Caughley 1977) are derived as follows:

$$\hat{Y} = RZ = Z\frac{\sum_i y_i}{\sum_i z_i}$$

Where $\hat{Y}$ is the estimated number of animals in the population, R is the observed density of animals (sum of animals seen on all transects $\sum_i y_i$ divided by the total area surveyed $\sum_i z_i$), and Z is the total study area. The variance is given by:

$$Var(\hat{Y}) = \frac{N(N-n)}{n}\left(s_y^2 - 2Rs_{zy} + R^2 s_z^2\right)$$

Where N is the total number of transects required to completely cover study area Z, and n is the number of transects sampled in the survey. s_y^2 is the variance in counts, s_z^2 is the variance in areas surveyed on transects, and s_{zy} is the covariance. The estimate $\hat{Y}$ and variance $Var(\hat{Y})$ are calculated for each stratum and summed. The Coefficient of Variation (CV = σ/$\hat{Y}$) was calculated as a measure of precision.

Table 3. Abundance estimates (Jolly 1969 Method II) for muskoxen on Devon Island, March 2016. *N* is the total number of transects required to completely cover study area *Z*, *n* is the number of transects sampled in the survey covering area *z*, *y* is the observed muskoxen, *Y* is the estimated muskoxen with variance Var(*Y*). The coefficient of variation (CV) is also included.

Stratum	**Y**	**Var(Y)**	**n**	**Z (km^2)**	**z (km^2)**	**N**	**y**	**Density (per km^2)**	**CV**
Prince of Wales	1569	58619.73	47	35591.87	6532.82	198	288	0.044	0.154
Somerset	1483	113988.75	24	25227.87	3928.63	154	231	0.059	0.228
Total	3052	172608.48	71	60819.74	10461.45	352	519	0.050	0.136

Stratified Systematic Survey Calculations
Following Cochran (1977), the abundance estimate for a systematic survey is given by:

$$\hat{Y} = \frac{S}{w} \times \sum n_i$$

Where $\hat{Y}$ is the population estimate, *S* is the transect spacing (5 km), *w* is the transect width (1 km), and n_i is the total number of animals observed on transect *i*, the sum of which is all animals observed on *I* transects in the survey. The configuration of the study area may mean that the actual sampling fraction (proportion of the study area that is surveyed) varies, which was partly why Cochran's ratio estimator was used instead, and why the estimate varied between methods and stratification regimes. The variance is based on the sum of squared differences in counts between consecutive transects:

$$Var(\hat{Y}) = \frac{\frac{S}{w} \times \left(\frac{S}{w} - 1\right) \times I}{2 \times (I-1)} \times \sum (n_i - n_{i-1})^2$$

Table 4. Abundance estimates for a stratified systematic survey (Cochran 1977) of muskoxen on Prince of Wales and Somerset islands, August 2016. *I* is the number of transects sampled.

Stratum	**Estimated Abundance $\hat{Y}$**	**Var($\hat{Y}$)**	**I**	**Transect Spacing S (km)**	**Transect Width w (km)**	**Observed Individuals y**	**Density (per km^2)**	**CV**
Prince of Wales	1555	77320.72	47	8.64	1.6	288	0.044	0.179
Somerset	1467	91885.27	24	10.16	1.6	231	0.059	0.207
Total	3022	169205.99	71			519	0.050	0.136

Appendix 3. Daily flight summaries for Prince of Wales and Somerset islands survey, August 2016.

Table 5. Summary by day of survey flights and weather conditions for March 2015 Peary caribou and muskox survey, southern Ellesmere Island.

Date	Time Up	Time Down	Time Up 2	Time Down 2	Time Up 3	Time Down 3	Time Up 4	Time Down 4	Flying Time	Transect Time	Comment
05-Aug-16	6:30	9:00	10:27	11:46	12:18	16:24	16:56	18:05	9:04	3:13	500' ceilings scattered fog and mist, mostly on west coast of Prince of Wales, up to 20kt wind
08-Aug-16	7:58	10:30	10:56	15:05	15:56	20:30			11:15	7:21	CAVU 10 kt wind from SE at Taloyoak
09-Aug-16	7:00	9:30	11:44	15:26	16:00	19:29	19:46	21:00	10:55	4:17	CAVU, some cirrus to north and fog starting on west coast Prince of Wales
10-Aug-16	15:17	17:55							2:38	0:00	CAVU
11-Aug-16	8:08	12:49	13:33	17:23	18:09	20:12			10:34	5:58	CAVU some fog on east side of Boothia Peninsula and some higher clouds at 8000' over Prince of Wales, some fog on west side
12-Aug-16	10:48	14:10	14:35	16:04	16:30	18:00	19:00	22:00	9:21	2:37	Fog on west coast of Somerset and Boothia but clear with some clouds at 800' north of Creswell Bay
15-Aug-16	15:40	21:05							5:25	3:41	
16-Aug-16	8:32	13:13	13:39	16:38	18:30	20:31			9:41	5:56	OVC with fog in the west, weather down in Resolute and forced to Arctic Bay for night
17-Aug-16	11:08	13:00							1:52	0:00	Fog and low ceilings coming in for Arctic Bay, up and down for Resolute but made it back
22-Aug-16	14:42	19:15							4:33	3:15	OVC 1500' down to 800' on hill at east side of island, 20-30 kt wind from N
23-Aug-16	9:02	11:14	11:14	13:02	13:34	15:00			5:26	3:37	OVC down to 800' with low cloud and fog on parts of Russell, broken over Somerset, wind light from south (not down at 11:14 just off and moving to Somerset)

Pilots – Mike Bergmann (Aug 5-9), Alan Gilbertson (Aug 11-12), Troy Mckerrall and Alex Pelletier (Aug 15-23); Navigator - Morgan Anderson

Observers:
Aug 5 – Morgan Anderson, Etuangat Akeeagok, Bill Ekelik, Eric Saittuq
Aug 8 – Morgan Anderson, Etuangat Akeeagok, Bill Ekelik, Eric Saittuq
Aug 9 – Morgan Anderson, Etuangat Akeeagok, Bill Ekelik, Eric Saittuq
Aug 11 – Morgan Anderson, Etuangat Akeeagok, Bill Ekelik
Aug 12 – Morgan Anderson, Etuangat Akeeagok, Bill Ekelik, Robert Quqqiaq
Aug 15 – Morgan Anderson, Etuangat Akeeagok, Debbie Iqaluk, Keesha Allurut, James Iqaluk
Aug 16 – Morgan Anderson, Etuangat Akeeagok, Debbie Iqaluk, Keesha Allurut, Thomas Kalluk
Aug 22 – Morgan Anderson, Thomas Kalluk, Belinda Oqallak
Aug 23 – Morgan Anderson, Belinda Oqallak, Eva Wu, Hana Moidu, Lauren Thompson, Olivia Gau

Appendix 4. Incidental wildlife observations.

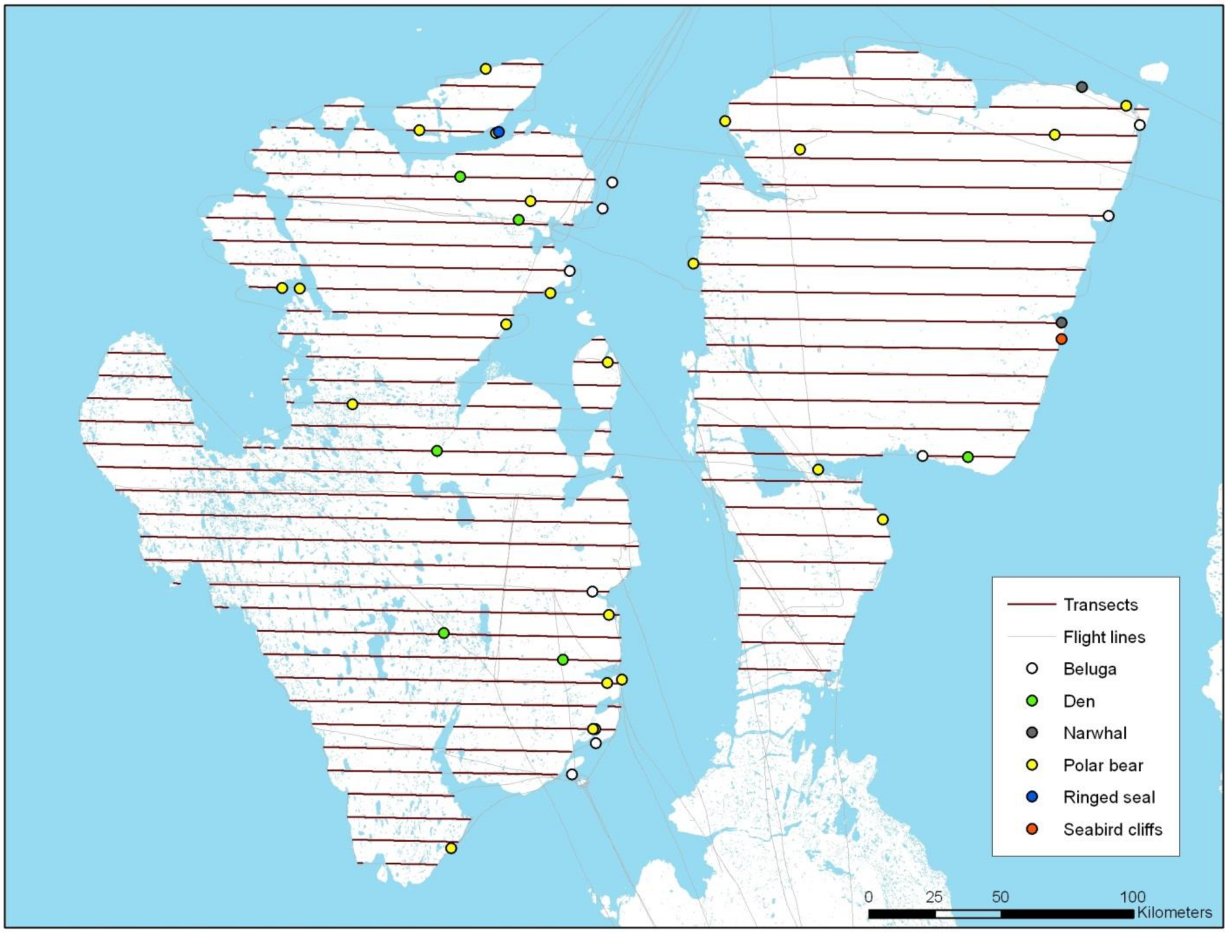

Figure 7. Incidental observations, Aug 5-23 2016, and flight lines for an aerial survey of Prince of Wales and Somerset islands. Some track lines are incomplete due to loss of satellite coverage. A total of 34 polar bears were observed, including 5 family groups. Some beluga pods were more than 60 individuals with many calves, and several of these pods were sometimes congregated in and around bays. Snowy owls were abundant on southern Prince of Wales Island but we did not mark them; snow geese were abundant on Prince of Wales Island but we did not mark them either. Dens appeared to be fox dens but could not be confirmed and some may have been used by wolves.