## NUNAVUT WILDLIFE MANAGEMENT BOARD

**Agenda: Regular Meeting No. RM003-2017**

**Monday, September 11, 2017 ( 9:00 AM- 8:00 PM )**

**NWMB Board Room, Iqaluit, Nunavut**

| | No: | Item: | Tab: | Presenter: | Maximum Time |
|---|---|---|---|---|---|
| *9:00 AM to 9:05 AM* | 1 | Call to Order and Opening Prayer | | Acting Chairperson | 5 Minutes |
| *9:05 AM to 9:10 AM* | 2 | Opening Remarks and Introductions | | Acting Chairperson | 5 Minutes |
| *9:10 AM to 9:15 AM* | 3 | Agenda: Review and Approval | 1 | Acting Chairperson | 5 Minutes |
| *9:15 AM to 9:20 AM* | 4 | Declaration of Conflict of Interest | | Acting Chairperson | 5 Minutes |
| *9:20 AM to 9:40 AM* | 5 | Wolverine Studies | 2 | DOE | 20 Minutes |
| *9:40 AM to 10:00 AM* | 6 | The Effect of Predation on the Calving Grounds of the Qamanirjuaq and Beverly Caribou | 3 | DOE | 20 Minutes |
| *10:00 AM to 10:15 AM* | | **BREAK** | | | |
| *10:15 AM to 10:45 AM* | 7 | Grizzly Bear Management Plan | 4 | DOE | 30 Minutes |
| *10:45 AM to 11:05 AM* | 8 | Grizzly Bear Sport Hunt Quota | 5 | DOE | 20 Minutes |
| *11:05 AM to 11:35 AM* | 9 | Qikiqtaaluk Wildlife Board: Muskox-Devon Island | 6 | QWB | 30 Minutes |
| *11:35 AM to 1:00 PM* | | **LUNCH** | | | |
| *1:00 PM to 1:45 PM* | 10 | Western Hudson Bay Polar Bear TAH | 7 | DOE | 45 Minutes |
| *1:45 PM to 2:30 PM* | 11 | Peary Caribou Management Plan | 8 | DOE | 45 Minutes |
| *2:30 PM to 3:00 PM* | 12 | Dolphin-Union Caribou Management Plan | 9 | ECCC/DOE | 30 Minutes |
| *3:00 PM to 3:15 PM* | | **BREAK** | | | |
| *3:15 PM to 3:30 PM* | 13 | DFO- Operational Updates | 10 | DFO | 15 Minutes |
| *3:30 PM to 3:45 PM* | 14 | DFO-Oceans Protection Plan Update | 11 | DFO | 15 Minutes |
| *3:45 PM to 4:00 PM* | 15 | DFO-Science Update | 12 | DFO | 15 Minutes |
| *4:00 PM to 4:25 PM* | 16 | DFO-Fisheries Act Closure in Eastern Arctic | 13 | DFO | 25 Minutes |
| *4:25 PM to 4:45 PM* | 17 | DFO-Sam Ford Fiord Arctic Char Quota Increase | 14 | DFO | 20 Minutes |
| *4:45 PM to 6:00 PM* | | **DINNER BREAK** | | | |
| *6:45 PM to 7:30 PM* | 19 | CSFL Turbot TAH Increase Request | 16 | CSFL | 45 Minutes |
| *6:00 PM to 6:45 PM* | 18 | Qikiqtaaluk Corporation role in Nunavut through the Commercial Fishery | 15 | QC- Harry Flaherty | 45 Minutes |
| *7:30 PM to 7:35 PM* | 20 | Adjournment | 17 | Acting Chair | 5 Minutes |

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information**: **X** **Decision**:

**Issue:** Estimates of wolverine density from mark-recapture DNA sampling, Aberdeen Lake, Kivalliq Region, Nunavut, 2013-14.

## Background:

- In Nunavut, the wolverine (*Gulo gulo*) is listed both as a furbearer and a big game species under the Nunavut Land Claims Agreement (NLCA). Wolverine is an important cultural and economic resource traditionally harvested by Inuit.

- Nunavut represents the north-eastern edge of wolverine distribution in Canada but there had not been any previous study to provide a rigorous population estimate for wolverines within the territory, nor is there any quantitative limit on their harvest by Inuit.

- Inuit observations and recent harvest reports suggest that wolverine numbers in Nunavut are either stable or slightly increasing and expanding their range eastward and northward.

- The Committee on the Status of Endangered Species in Canada (COSEWIC) has assessed the wolverine as “Special Concern”. Primary threats to wolverine persistence identified by COSEWIC include habitat fragmentation and loss due to human development and climate change. While this is true for most parts of the species’ southern range, the same threats are not as prevalent so far in Nunavut.

- Wolverines are found in relatively low densities, have low reproductive rate with low intrinsic rate of increase, are sensitive to human disturbance and require large secure areas to maintain viable populations. The recent decline in caribou abundance in parts of the wolverine’s range in the Canadian north is expected to have some indirect impact on wolverines in Nunavut.

- Inuit community concerns over the handling of wildlife gave rise to a need to adapt a culturally acceptable, non-invasive approach based on DNA-analysis with a field method that can benefit from Inuit hunter’s relevant skills and capacities, while providing local employment and training.

- To establish baseline population abundance and density estimates for long term regional monitoring, we used genetic analysis to identify individual wolverines from hair samples collected noninvasively by a science-driven study design and logistics facilitated by local hunters. From late March through early May 2013 and 2014, using snowmobiles, we sampled a grid of 209 posts baited with caribou meat and scent lures spaced in 4x4 km (16 $km^2$) cells for three 10-day sessions in a 3,344 $km^2$ area north of Aberdeen Lake (Fig 1).

## Current Status

- In total we detected 21 (9F:12M) individual wolverines over two years of sampling, including eight individuals identified in 2013 and recaptured in 2014. Spatially explicit capture-recapture (SECR) methods were used to estimate density and average number of wolverines on the grid at any given time. Average or resident wolverine density was 2.36 wolverines/1,000 $km^2$ (SE = 0.34) in 2013 and 1.66 wolverines/1,000 $km^2$ (SE = 0.29) in 2014. Estimates of superpopulation size (number of wolverines within the effective sampling area) were 21 (CI=18-26) in 2013 and 14 (CI=11-19) in 2014.

- In the West Kitikmeot, higher densities were estimated (6.85/1,000 $km^2$ at High Lake in 2008 and 4.80/1,000 $km^2$ at Izok Lake in 2012). However, both of these study areas were in the central Arctic characterized by generally higher productivity, and with no or occasional wolverine harvest.

- Our results contribute to baseline data for wolverine ecology in the eastern mainland Arctic tundra and will be used to generate regional population estimates.

- This collaborative research project with the Baker Lake Hunters and Trappers Organization (HTO) has provided valued training, employment and technical skills transfer to HTO members. This project provided employment to five HTO members (~400 person-days) throughout the field work (three members for the duration of the work and two members on an as needed bases).

## Recommendation

- Our results suggest that harvest monitoring and DNA based surveys by involving local hunters, offer a practical and cost-effective method to monitor wolverine populations in tundra situations while also providing HTO participation and collaboration.

- For a better understanding of wolverine population in the area, we recommend long term monitoring by involving local HTOs and industry. This study demonstrates the efficiency of joint research projects to inform management.

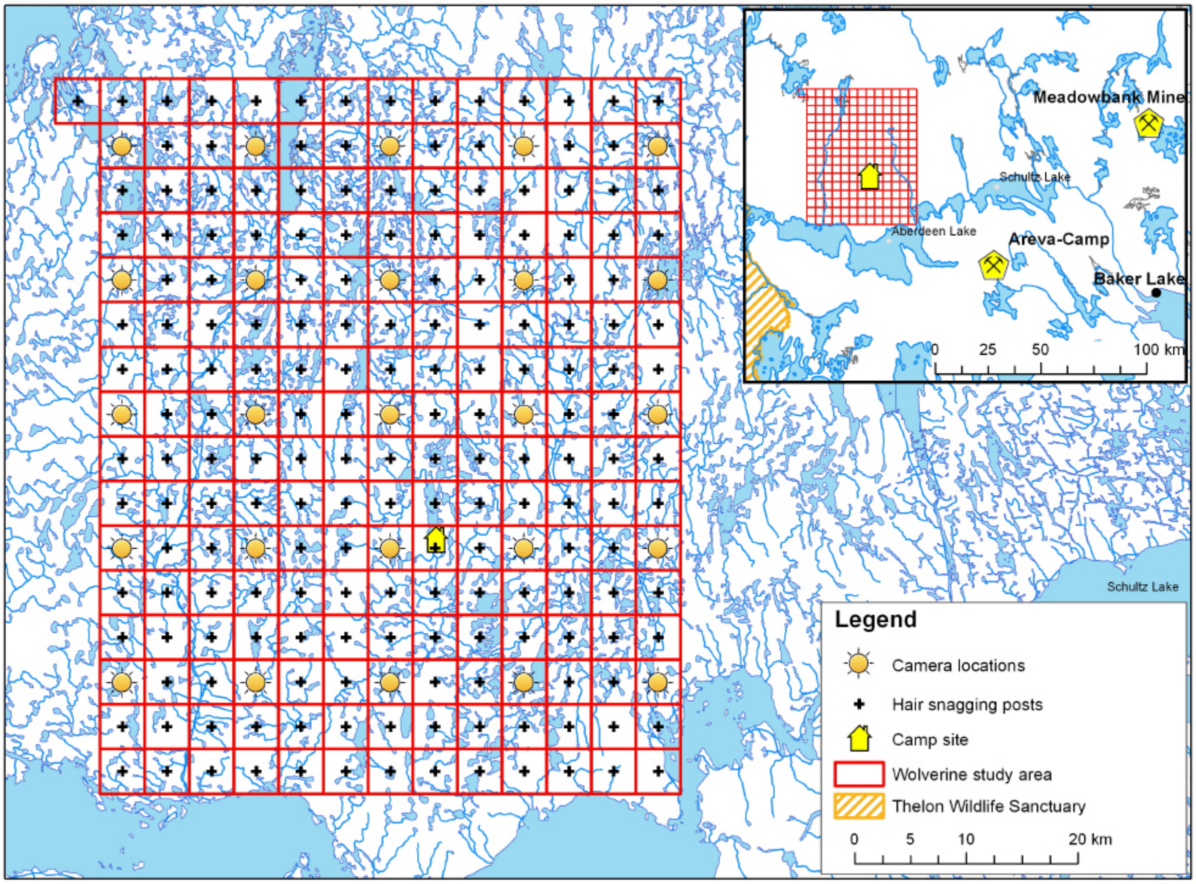


Figure 1. The Aberdeen Lake wolverine study area.

# Estimates of wolverine density from mark-recapture DNA sampling, Aberdeen Lake, Kivalliq Region, Nunavut, 2013-14


## Summary

This report presents results for a wolverine (*Gulo gulo*) DNA mark-recapture study in the Kivalliq region, Nunavut conducted to establish baseline population abundance and density estimates for long term regional monitoring. Wolverine is an important cultural and economic resource traditionally harvested by Inuit. We used genetic analysis to identify individual wolverines from hair samples collected noninvasively by a science-driven study design and logistics facilitated by local hunters. From late March through early May 2013 and 2014 we sampled a grid of 209 posts baited with caribou (*Rangifer tarandus groenlandicus*) meat and scent lures spaced in 4x4 km (16 $km^2$) cells for three 10-day sessions in a 3,344 $km^2$ area north of Aberdeen Lake. In total we detected 21 (9F:12M) individual wolverines over two years of sampling, including eight individuals identified in 2013 and recaptured in 2014. Spatially explicit capture-recapture (SECR) methods were used to estimate density and average number of wolverines on the grid at any given time. Average or resident wolverine density was 2.36 wolverines/1,000 $km^2$ (SE = 0.34) in 2013 and 1.66 wolverines/1,000 $km^2$ (SE = 0.29) in 2014. Estimates of superpopulation size (number of wolverines within the effective sampling area) were 21 (CI=18-26) in 2013 and 14 (CI=11-19) in 2014. Superpopulation estimates were close or slightly above the number of unique wolverines detected on the sampling grid for each year, which suggests sampling was effective in detecting all the wolverines on the grid as well as the immediate surrounding area.

Simulations of sampling designs (post spacing and grid size) suggest that increasing post spacing while reducing the number of posts sampled can increase wolverine sample size and precision of the estimate. Wolverines in the area exist at low densities and are being exposed to increasing levels of human activity, with existing or proposed mining and subsistence harvest. Our results contribute to baseline data for wolverine ecology in the eastern mainland Arctic tundra and can be used to generate regional population estimates for future monitoring. The estimates can be used to evaluate current harvest, can provide a quantitative basis to establish future sustainable harvest limits and will support inputs to the Nunavut Impact Review Board (NIRB) review process. This collaborative research project with the Baker Lake Hunters and Trappers Organization (HTO) has provided valued training, employment and technical skills transfer to HTO members. Our results suggest that by involving local hunters, DNA based surveys offer a practical and cost-effective method to monitor wolverine populations in tundra situations. For better understanding of wolverine population in the area, we recommend long term monitoring by involving local HTOs and industry. This study demonstrates the efficiency of joint research projects to inform management.



Key words: *Gulo gulo*, wolverine, DNA, density estimates, Aberdeen Lake, Kivalliq, Nunavut, population, spatially explicit capture-recapture.

## ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᖃᕝᕕᒑᕐᔪᐃᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ ᐃᒪᐃᑦᑐᒥᑦ, ᓇᓗᓇᐃᒃᑯᑎᖅᓯᐊᓪᓚᓚᐅᕐᓗᓂ-ᐱᓯᒃᑲᓐᓂᖅᐸᒡᓗᓂ DNA–ᖏᑎᒍᑦ ᖃᐅᔨᓴᖅᓯᓂᕐᒥᒃ, ᖃᒪᓂᕐᒥ, ᑭᕙᓪᓕᕐᒥᐅᓂ, ᓄᓇᕘᒥ, 2013-14

**ᐅᓂᒃᑲᐅᓯᐅᓂᖓ**

ᑖᓐᓇ ᐅᓂᒃᑲᐅᓯᖅ ᓴᖅᑭᑎᑦᑎᑕᖅ ᖃᐅᔨᒪᔭᐅᓕᖅᑐᓂᒃ ᖃᕝᕕᒑᕐᔪᖕᓄᑦ (*Gulo gulo*) DNA–ᖏᓐᓄᑦ ᓇᓗᓇᐃᒃᑯᑎᖅᓯᐊᓪᓚᓚᐅᕐᓗᓂ-ᐱᓯᒃᑲᓐᓂᖅᐸᒡᓗᓂ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᔪᒥᒃ ᑭᕙᓪᓕᕐᒥᐅᓂ, ᓄᓇᕘᒥ ᐱᓕᕆᐊᖑᓚᐅᖅᑐᒥ ᐋᖅᑭᒃᓯᒪᓕᖅᑎᑦᑎᔪᒪᓗᓂ ᐅᓄᖅᑎᒋᓂᖏᓐᓂ ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ ᖃᓄᕐᓗ ᐱᑕᖃᐅᖅᐸᒃᑎᒋᓂᖏᓐᓄᑦ ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᐊᕗᖓᑲᓪᓚᒃ ᐊᕕᒃᓯᒪᓂᖓᔭᐅᔪᒥ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐊᕐᓗᓂ. ᖃᕝᕕᒑᕐᔪᐃᑦ ᐱᒻᒪᕆᐅᕗᑦ ᐃᓕᖅᑯᓯᑐᖃᒃᑯᑦ ᕿᓇᐅᔭᓕᐅᕋᓱᖕᓂᕐᒧᓪᓗ ᐊᑐᖅᑕᐅᕙᒃᖢᑎᒃ ᐃᓕᖅᑯᓯᑐᖃᖅᑎᒍᑦ ᐊᖑᔭᐅᕙᒃᑐᖃᐅᓪᓗᑎᒃ ᐃᓄᖕᓂ. ᐊᑐᓚᐅᖅᐳᑦ ᑎᒥᖏᓐᓂᓘᖅᑐᒥᒃ ᖃᐅᔨᓴᖅᓯᓂᕐᒥᒃ ᓇᓗᓇᐃᓯᔪᒪᓪᓗᑕ ᐃᓛᒃᑰᖅᑐᓂᒃ ᖃᕝᕕᒑᕐᔪᕐᓂᒃ ᒥᖅᑯᖏᓐᓂᑦ ᖃᐅᔨᓴᕈᒃᓴᑎᒍᑦ ᑲᑎᑕᐅᓚᐅᖅᑐᑎᒍᑦ ᐸᒡᕕᓵᓇᔪᖅᑲᖏᓐᓗᓂ ᖃᐅᔨᓴᖅᓯᓂᒃᑯᑦ-ᑲᔪᓯᑎᑕᐅᔪᒥᑦ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᔪᒧᑦ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᔪᒧᑦ ᐱᓕᕆᔾᔪᑎᒋᔭᐅᔪᓄᓪᓗ ᑕᒪᓐᓇ ᑲᔪᓯᑎᑕᐅᓪᓗᓂ ᓄᓇᓕᖕᒥᐅᓂᑦ ᐊᖑᓇᓱᒃᑎᓂᑦ. ᒫᑦᓯᒥᑦ ᓄᖑᕈᔪᓕᕐᓂᖓᓂᑦ ᒪᐃᒧᑦ ᐱᕆᐊᓕᕝᕙᕐᓂᖓᓄᑦ 2013–ᒥᑦ 2014–ᒥᓗ ᖃᐅᔨᓴᐃᓚᐅᖅᐳᑦ ᐋᖅᑭᒃᑕᐅᓯᒪᔪᓂᒃ 209–ᓂᒃ ᓇᐸᖅᑎᖅᑕᐅᓯᒪᔪᓂᒃ ᓇᑎᔾᔨᖅᓯᒪᓪᓗᑎᒃ ᑐᒃᑑᑉ (*Rangifer tarandus groenlandicus*) ᓂᕿᖓᓂᑦ ᑎᐱᓕᖕᓄᓪᓗ ᓇᑎᐊᓄᑦ ᐅᖓᓯᒌᒃᑎᒋᓂᖅᑲᖅᖢᑎᒃ 4x4 ᑭᓗᒦᑕᓂᒃ (16–ᓂ ᑭᓗᒦᑕᓂᒃ$^2$) ᐃᓂᓂ ᐱᖓᓱᓄᑦ 10–ᓄᑦ ᐅᓪᓗᓄᑦ ᐱᓕᕆᓂᐅᔪᓄᑦ ᐃᓂᒥ ᐊᖏᓂᖃᖅᑐᒥ 3,344 km$^2$–ᓂᒃ ᐊᒃᑐᐊᓂ ᖃᒪᓂᐅᑉ ᑲᑎᕐᒧᒥᑦ ᖃᐅᔨᔭᖃᓚᐅᖅᐳᑦ 21–ᓂᒃ (9F:12M) ᐃᓛᒃᑰᖅᑐᓂᒃ ᖃᕝᕕᒑ2ᔪᕐᓂᒃ ᐊᕿᒡᒎᖕᓂ ᒪᕿᖕᓂ ᖃᐅᔨᓴᕐᓂᖃᖅᑎᓪᓗᑕ, ᐃᓚᒋᔭᐅᓪᓗᑎᒃ 8 ᐃᓛᒃᑰᖅᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᓚᐅᖅᑐᑦ 2013–ᖑᑎᓪᓗᒍ ᐱᔭᐅᒃᑲᓐᓂᖅᖢᑎᒡᓗ 2014–ᒥ. ᐃᓂᒃᑰᑦᑎᐊᖅᑎᕐᖢᒥᑦ ᐱᔭᐅᓯᓂᖅ–ᐱᔭᐅᒃᑲᓐᓂᖅᓯᓂᕐᓗ (SECR) ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᑐᖅᑕᐅᔪᕐᑲᓚᐅᖅᐸᖅ ᖃᐅᔾᔪᑕᐅᓇᖕᖢᑎᒃ ᖃᔅᓯᐸᔫᓂᖏᓐᓂᒃ ᖃᓄᖅ ᐅᓄᖅᑎᓪᓗᑎᒃ ᑲᑎᕐᒧᒥᓪᓗ ᖃᔅᓯᐅᓂᖓᕚᑕᖏᑦ ᖃᕝᕕᒑᕐᔪᐃᑦ ᑖᒥᓂ ᓈᓴᐃᕝᕕᐅᔪᒥ ᖃᖓᑐᐃᓐᓇᒃᑯᑦ. ᐃᒪᓐᓇᐅᒐᔪᓚᐅᖅᐳᖅ, ᐅᕙᓘᓐᓃᑦ ᖃᕝᕕᒑᕐᔪᐃᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ 2.36–ᖑᕐᑲᑦᑕᓚᐅᖅᐳᑦ /1,000 km$^2$ (SE = 0.34) 2013–ᒥ ᐊᒻᒪᓗ 1.66–ᖑᓪᓗᑎᒃ ᖃᕝᕕᒑᕐᔪᐃᑦ/1,000 km$^2$ (SE = 0.29) in 2014. ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᑕᕝᕙᓂᑦᑕᐃᓐᓇᖅ ᐅᓄᖅᑎᒋᓂᖏᑦ (ᖃᔅᓯᐅᓂᖓᔭᖏᑦ ᖃᕝᕕᒑᕐᔪᐃᑦ ᑖᒥᓂ ᐊᑐᖅᑕᐅᔪᒥ ᖃᐅᔨᓴᕐᕕᒃᑖᕐᕕᐅᕙᒃᑐᒥ) 21–ᖑᓚᐅᑦᐳᑦ (CI=18-26) 2013–ᒥ 14–ᖑᓪᓗᑎᒡᓗ (CI=11-19) 2014–ᒥ. ᐃᓂᒋᔭᐅᔪᒥ ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᖃᓂᒃᓴᓚᐅᖅᐳᑦ ᖁᑦᑎᖕᓂᖅᓴᐅᕌᕐᔪᒃᓗᑎᒡᓘᓐᓃᑦ ᖃᔅᓯᐅᓂᖓᔭᖏᓐᓂᑦ ᐃᓛᒃᑰᖅᑐᑦ ᖃᕝᕕᒑᕐᔪᐃᑦ ᖃᐅᔨᔭᐅᔪᑦ ᖃᐅᔨᓴᕐᕕᐅᔪᒥ ᐃᓂᒥ ᑕᒪᐃᓐᓄᑦ ᐊᑐᓂᑦ ᐊᕿᒍᕆᔭᐅᔪᓄᑦ, ᑕᒪᒃᑯᐊᓗ ᑕᑯᑎᑦᑎᓪᓗᑎᒃ ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᓂᐅᔪᖅ ᑲᔪᓯᖃᑦᑎᐊᓚᐅᕐᓂᕐᒪᓂᒃ ᖃᐅᔨᔾᔪᑕᐅᓪᓗᓂ ᑕᒪᐃᓐᓂᑦᑎᐊᖅ ᖃᕝᕕᒑᕐᔪᕐᓂᒃ ᑖᒥᓂ ᖃᐅᔨᓴᕐᕕᐅᔪᒥ ᐊᒻᒪᓗᑦᑕᐅᖅ ᑕᒪᑐᒪ ᖃᐅᔨᒃᓴᕐᕕᐅᔫᑉ ᖃᓂᖏᔭᖓᓂ ᐃᓂᒥ.

ᐊᑐᖅᑕᐅᖁᔭᕐᓂᖏᑦ ᖃᐅᔨᓴᖅᓯᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓇᓱᖅᑐᑦ (ᓇᐸᖅᑎᖅᑕᐅᓯᒪᔪᑦ ᐊᑯᑦᑐᓈᖅᑕᐅᓯᒪᓂᖏᑎᒍᑦ ᐱᓕᕆᕝᕕᐅᔪᓪᓗ ᖃᓄᖅ ᐊᖏᑎᒋᓂᖏᑎᒍᑦ) ᐃᒪᓐᓇᐅᑦᑑᔨᑎᑦᑎᕗᑦ, ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑎᓂᖅ ᓇᐸᑦᑎᑦᑕᐅᓯᒪᔪᑦ ᐊᑯᓐᓂᖏᓐᓂᒃ ᑕᐃᒪᐃᓕᕐᓂᕐᒥᓂᓗ ᐅᓄᕈᓐᓃᖅᑎᑦᑎᒋᐊᖅᖢᑎᒃ ᖃᔅᓯᐅᓂᖓᔭᖏᓐᓂᒃ ᓇᐸᖅᑕᐅᓯᒪᔪᑦ ᖃᐅᔨᕐᕕᐅᔪᑦ ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑎᔭᓐᓇᖅᐳᑦ ᖃᕝᕕᒑᔪᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓄᑦ ᓱᓕᓂᖅᓴᐅᓗᑎᒡᓗ ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ. ᖃᕝᕕᒑᕐᔪᐃᑦ ᑕᐅᕙᓂ ᐃᓂᒦᑦᑐᑦ ᐅᓄᙱᑦᑐᑯᓘᓪᓗᑎᒃ ᐱᑕᖅᐳᑦ ᓵᖅᑭᕝᕕᐅᕙᓪᓕᐊᓪᓗᑎᒡᓗ ᐅᓄᖅᓯᕙᓪᓕᐊᔪᓄᑦ ᐃᓄᖕᓂᒃ ᑕᐅᕙᓃᑦᑐᖃᓯᖅᐸᖕᓂᕐᓂᒃ, ᐱᑕᖅᐸᕿᖅᑐᓄᑦ ᐱᓕᕆᐊᖑᒪᓂᐊᖅᑐᓄᓪᓘᓐᓃᑦ ᐅᔭᕋᓐᓂᐊᕐᕕᐅᔪᒪᔪᓂ ᐊᖑᓇᓱᒃᐸᖕᓂᖃᖅᑐᒥᓗ ᐆᒪᔾᔪᑎᒋᓂᐊᕐᓗᑎᑦ. ᖃᐅᔨᔭᕗᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐃᑲᔪᖅᐳᑦ ᑐᙵᕕᔭᐅᔪᒥ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᓂᒃ ᖃᕝᕕᒑᕐᔪᐃᑦ ᖃᓄᐃᓕᖓᓂᖏᓐᓄᑦ ᑲᓇᖕᓇᖅᐸᓯᖕᒥ ᐅᑭᐅᖅᑕᖅᑐᒥ ᓇᐹᖅᑐᖅᑲᖖᒋᑦᑐᒥ ᑕᒪᓐᓇᓗ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᓱᓂ ᐋᖅᑭᒃᓯᔾᔪᑕᐅᓗᓂ ᐊᕕᒃᓯᒪᓂᖓᔪᐊᓂ ᖃᔅᓯᐅᓇᓱᒋᓈᓂᕐᓂᒃ ᓯᕗᓂᒃᓴᒥ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐅᔪᓕᒫᖅᑐᒧᑦ. ᖃᔅᓯᐅᓇᓱᒋᓈᓂᑦ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᐳᑦ ᖃᐅᔨᓴᖅᓯᓂᐊᕐᓗᓂ ᓖᓐᓇ ᐊᖑᓂᓴᐅᕙᒃᑐᓂᒃ, ᐱᑎᑦᑎᔪᓐᓇᖅᐳᑦ ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᑐᙵᕕᒋᔭᐅᓂᐊᖅᑐᒥᒃ ᐋᖅᑭᒃᓯᒪᓕᖅᑎᑦᑎᔪᒪᓪᓗᓂ ᓯᕗᓂᒃᓴᒥ ᖃᔅᓯᕌᕈᓇᕐᓂᕐᒧᑦ ᐃᓱᓕᑦᑕᕕᐅᓇᓱᖅᑐᓂᒃ ᐃᑲᔪᖅᑐᐃᓂᐊᖅᓱᓂᓗ ᐅᖃᐅᓯᐅᔪᓂᒃ ᓄᓇᕗᒻᒥ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᑕ ᕿᒥᕐᕈᐊᖅᓯᒃᑲᓐᓂᕐᓂᕐᒧᑦ ᐊᑐᖅᐸᒃᑕᖑᓂᒃ. ᑕᒪᓐᓇ ᐱᓕᕆᖃᑎᒌᒃᖢᓂ ᖃᐅᔨᓴᖅᓯᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᔪᖅ ᐱᓕᕆᖃᑎᒋᔭᐅᓪᓗᑎᒃ ᖃᒪᓂ'ᑐᐊᕐᒥᐅᓄᑦ ᐊᖑᓇᓱᒃᑎᓕᕆᔩᑦ (HTO–ᑯᑦ) ᐱᑎᑦᑎᖃᑦᑕᖅᓯᒪᕗᖅ ᐱᐅᓯᔭᐅᑎᐊᖅᑐᒥᒃ ᐊᔪᕈᓐᓂᖅᓴᖅᑎᑦᑎᓂᕐᒥᒃ, ᐃᖅᑲᓇᐃᔭᖅᑎᑦᑎᓂᕐᒥᒃ ᐱᓕᕆᔾᔪᑎᓄᓪᓗ ᓅᑎᑦᑎᓂᕐᒥᒃ ᐊᖑᓇᓱᒃᑐᓕᕆᔩᒃᑯᑦ ᐃᓚᒋᔭᖏᓐᓄᑦ. ᖃᐅᔨᔭᕗᑦ ᐃᒪᓐᓇᐅᖅᑑᔨᑎᑦᑎᕗᑦ, ᐃᓚᐅᑎᑦᑎᓂᖅ ᓄᓇᓕᖕᒥᐅᓂᒃ ᐊᖑᓇᓱᒃᑎᓂᒃ, DNA=ᒥᒃ ᑐᙵᕕᓕᑦ ᖃᐅᔨᓴᕐᓂᑦ ᒪᓂᒪᑎᑦᑎᕗᑦ ᐊᑐᖅᑕᐅᑦᑎᐊᕈᓐᓇᖅᑐᓂᒃ ᐊᑭᑐᓗᐊᙱᑦᑐᓂᒡᓗ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐊᕐᓗᓂ ᖃᕝᕕᒑᕐᔪᐃᑦ ᖃᔅᓯᐅᓂᖓᔭᖏᓐᓂᒃ ᓇᓚᐅᑦᑐᖅᑲᙱᑦᑐᒥ. ᐱᐅᓂᖅᓴᖅᑯᑦ ᑐᑭᓯᐅᒪᔪᒪᓗᓂ ᖃᕝᕕᒑᕐᔪᐃᑦ ᖃᔅᓯᐅᓂᖏᓐᓄᑦ ᑕᐅᕙᓂ ᐃᓂᒥ, ᐃᒪᓐᓇᐅᖅᑑᓇᓱᖅᐳᑦ, ᐊᑯᓂᐅᔪᒥᒃ ᓇᐅᑦᑎᖅᓱᖅᓯᖅᑑᓗᑕ ᐃᓚᐅᑎᓪᓗᒥᑦ ᓄᓇᓕᖕᓂ ᐊᖑᓇᓱᒃᑐᓕᕆᔨᕐᔪᐊᖅ ᕿᓇᐅᔭᓕᐅᕋᓱᖕᕕᐅᕙᒃᑐᓪᓗ. ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᑕᑯᑎᑦᑎᕗᖅ ᑲᔪᓯᖃᑦᑎᐊᕈᓇᕐᓂᕐᓂᒃ ᑲᑐᔾᔨᐅᓪᓗᑎᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᔪᑦ ᑐᓴᖅᑎᑦᑎᔪᒪᓂᐊᕐᓗᓂ ᐊᐅᓚᑦᑎᓯᒋᔭᐅᔪᓂᒃ.

ᐅᖃᐅᓯᓪᓗᐊᑕᐃᑦ: *Gulo gulo*, ᖃᕝᕕᒑᕐᔪᒃ, DNA–ᖑᓂᕆᖅᑕᐅᔪᖅ, ᖃᓄᖅ ᐱᑕᖅᑎᒋᓂᖏᑎᒍᑦ ᖃᔅᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ, ᖃᒪᓂᕐᒥ, ᑭᕙᓪᓕᕐᒥ, ᓄᓇᕗᒻᒥ, ᖃᔅᓯᐅᓂᖓᔭᖏᑦ, ᐃᓂᒥᒃ ᐊᑐᓪᓚᑲᒡᓗᓂ ᐱᓯᖅᑲᑦᑕᕐᓂᖅ–ᐱᒃᑲᓐᓂᖅᓯᖅᑲᑦᑕᕐᓂᖅ.

# Estimates of wolverine density from mark-recapture DNA sampling, Aberdeen Lake, Kivalliq Region, Nunavut, 2013-14

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## Summary

This report presents results for a wolverine (*Gulo gulo*) DNA mark-recapture study in the Kivalliq region, Nunavut conducted to establish baseline population abundance and density estimates for long term regional monitoring. Wolverine is an important cultural and economic resource traditionally harvested by Inuit. We used genetic analysis to identify individual wolverines from hair samples collected noninvasively by a science-driven study design and logistics facilitated by local hunters. From late March through early May 2013 and 2014 we sampled a grid of 209 posts baited with caribou (*Rangifer tarandus groenlandicus*) meat and scent lures spaced in 4x4 km (16 $km^2$) cells for three 10-day sessions in a 3,344 $km^2$ area north of Aberdeen Lake. In total we detected 21 (9F:12M) individual wolverines over two years of sampling, including eight individuals identified in 2013 and recaptured in 2014. Spatially explicit capture-recapture (SECR) methods were used to estimate density and average number of wolverines on the grid at any given time. Average or resident wolverine density was 2.36 wolverines/1,000 $km^2$ (SE = 0.34) in 2013 and 1.66 wolverines/1,000 $km^2$ (SE = 0.29) in 2014. Estimates of superpopulation size (number of wolverines within the effective sampling area) were 21 (CI=18-26) in 2013 and 14 (CI=11-19) in 2014. Superpopulation estimates were close or slightly above the number of unique wolverines detected on the sampling grid for each year, which suggests sampling was effective in detecting all the wolverines on the grid as well as the immediate surrounding area.

Simulations of sampling designs (post spacing and grid size) suggest that increasing post spacing while reducing the number of posts sampled can increase wolverine sample size and precision of the estimate. Wolverines in the area exist at low densities and are being exposed to increasing levels of human activity, with existing or proposed mining and subsistence harvest. Our results contribute to baseline data for wolverine ecology in the eastern mainland Arctic tundra and can be used to generate regional population estimates for future monitoring. The estimates can be used to evaluate current harvest, can provide a quantitative basis to establish future sustainable harvest limits and will support inputs to the Nunavut Impact Review Board (NIRB) review process. This collaborative research project with the Baker Lake Hunters and Trappers Organization (HTO) has provided valued training, employment and technical skills transfer to HTO members. Our results suggest that by involving local hunters, DNA based surveys offer a practical and cost-effective method to monitor wolverine populations in tundra situations. For better understanding of wolverine population in the area, we recommend long term monitoring by involving local HTOs and industry. This study demonstrates the efficiency of joint research projects to inform management.

Key words: *Gulo gulo*, wolverine, DNA, density estimates, Aberdeen Lake, Kivalliq, Nunavut, population, spatially explicit capture-recapture.

# ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᖃᕝᕕᓘᕐᐊᐃᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ ᐃᒪᐃᑦᑐᒥᑦ, ᓇᓗᓇᐃᒃᑯᑦᑎᖅᓯᐊᓪᓚᓚᐅᕐᓗᓂ- ᐱᓱᒃᑲᓂᖅᐸᒡᓗᓂ DNA−ᖏᑎᒍᑦ ᖃᐅᔨᓴᖅᓯᓂᕐᒥᒃ, ᖃᒪᓂᕐᒥ, ᑭᕙᓪᓕᕐᒥᐅᓂ, ᓄᓇᕗᒻᒥ, 2013-14

**ᐅᓂᒃᑲᐅᓯᐅᓂᖓ**

ᑖᓇ ᐅᓂᒃᑳᓯᖅ ᓴᖅᑭᑦᑎᑐᖅ ᖃᐅᔨᒪᔭᐅᓕᖅᑐᓂᒃ ᖃᕝᕕᓘᕐᕗᓄᑦ (*Gulo gulo*) DNA−ᖏᓐᓄᑦ ᓇᓗᓇᐃᒃᑯᑦᑎᖅᓯᐊᓪᓚᓚᐅᕐᓗᓂ- ᐱᓱᒃᑲᓂᖅᐸᒡᓗᓂ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᕙᒥᒃ ᑭᕙᓪᓕᕐᒥᐅᓂ, ᓄᓇᕗᒻᒥ ᐱᓕᕆᐊᖑᓚᐅᖅᑐᒥ ᐋᖅᑭᒃᓱᒪᓕᖅᑎᑦᑎᕙᒪᓗᓂ ᐅᓄᖅᑎᒋᓂᖏᓐᓂ ᖃᓯᐅᓂᖏᓐᓄᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ ᖃᓄᕐᓗ ᐱᑕᖃᐅᖅᐸᒃᑎᒋᓂᖏᓐᓄᑦ ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᐊᕗᖓᑲᓪᓚᒃ ᐊᕕᒃᓯᒪᓂᕆᔭᐅᕙᒥ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐊᕐᓗᓂ. ᖃᕝᕕᓘᕐᕙᐃᑦ ᐱᒻᒪᕆᐅᕗᑦ ᐃᓕᖅᑯᓯᑐᖃᒃᑯᑦ ᑮᓇᐅᔭᓕᐅᕋᓱᖕᓂᕐᔪᓪᓗ ᐊᑐᖅᑕᐅᕙᒃᑐᑎᒃ ᐃᓕᖅᑯᓯᑐᖃᖅᑎᒍᑦ ᐊᖑᔭᐅᕙᒃᑐᖃᐅᓪᓗᑎᒃ ᐃᓄᖕᓂᑦ. ᐊᑐᓚᐅᖅᐳᑦ ᑎᒥᖏᓐᓂᓘᖅᑐᒥᒃ ᖃᐅᔨᓴᖅᓯᓂᕐᒥᒃ ᓇᓗᓇᐃᓯᕙᓪᓗᑕ ᐃᓛᒃᑰᖅᑐᓂᒃ ᖃᕝᕕᓘᕐᕗᓂᒃ ᒥᖅᑯᖏᓐᓂᑦ ᖃᐅᔨᓴᒃᓴᑎᒍᑦ ᑲᑎᑕᐅᓚᐅᖅᑐᑎᒍᑦ ᐸᒃᕕᓵᕆᕙᖕᖏᖅᑐᓂ ᖃᐅᔨᓴᖅᓯᓂᒃᑯᑦ-ᑲᕙᓯᑎᑕᐅᕙᒥᑦ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᕙᓗᑦ ᐋᖅᑭᒃᓯᖅᑕᐅᓯᒪᕙᓗᑦ ᐱᓕᕆᔾᕙᑎᒋᔭᐅᕙᓄᑦᑐ ᑕᒪᓐᓇ ᑲᕙᓯᑎᑕᐅᑦᑐᓂ ᓄᓇᓕᖕᒥᐅᓂᑦ ᐊᖑᓇᓱᒃᑎᓂᑦ. ᒫᑦᓯᒥᑦ ᓄᖑᐹᕙᓕᕐᓂᖓᓂᑦ ᒪᐃᒧᑦ ᐱᒋᐊᓕᓵᕐᓂᖓᓄᑦ 2013−ᒥᑦ 2014−ᒥᒧ ᖃᐅᔨᓴᐃᓚᐅᖅᐳᑦ ᐋᖅᑭᒃᑕᐅᓯᒪᕙᓂᒃ 209−ᓂᒃ ᓇᑉᐸᖅᑎᖅᑕᐅᓯᒪᕙᓂᒃ ᓇᑲᔾᔨᖅᓯᒪᓪᓗᑎᒃ ᑐᒃᑑᑉ (*Rangifer tarandus groenlandicus*) ᓂᕿᖓᓂᑦ ᑎᐱᓕᖕᓄᑦᑐ ᓇᑲᐊᓄᑦ ᐅᖓᓯᒌᒃᑎᒋᓂᖃᖅᓱᑎᒃ 4x4 ᑭᓗᒦᑕᓂᒃ (16−ᓂ ᑭᓗᒦᑕᓂᒃ[2]) ᐃᓂᓂ ᐱᖓᓱᓄᑦ 10−ᓄᑦ ᐅᓪᓗᓄᑦ ᐱᓕᕆᓂᐅᕙᓄᑦ ᐃᓂᒥ ᐊᖏᓂᖃᖅᑐᒥ 3,344 km$^2$−ᓂᒃ ᐊᒡᒍᐊᓂ ᖃᒪᓂᐅᑉ ᑲᑎᔾᔪᑎᑦ ᖃᐅᔮᔭᖃᓚᐅᖅᐳᑦ 21−ᓂᒃ (9F:12M) ᐃᓛᒃᑰᖅᑐᓂᒃ ᖃᕝᕕᓘ 3 ᕗᖓᓂᒃ ᐊᕿᒎᖓᓂ ᒪᕿᙵᓂ ᖃᐅᔨᓴᕐᓂᖅᑎᓪᓗᑕ, ᐃᓚᒋᔭᐅᓪᓗᑎᒃ 8 ᐃᓛᒃᑰᖅᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᓚᐅᖅᑐᑦ 2013−ᖑᑎᓪᓗᒍ ᐱᔭᐅᒃᑲᓂᖅᓱᑎᒡᓗ 2014−ᒥ. ᐃᓂᒃᑰᑎᐊᖅᑎᔾᔪᑎᑦ ᐱᔭᐅᓯᓂᖅ−ᐱᔭᐅᒃᑲᓂᖅᓯᓂᕐᓗ (SECR) ᐊᑐᖅᑕᐅᕗᓇᖅᑐᓂᒃ ᐊᑐᖅᑕᐅᕗᖅᑲᓚᐅᖅᐳᖅ ᖃᐅᔮᕝᕙᑕᐅᓇᓱᒃᓱᑎᒃ ᖃᓯᐸᓘᓂᖏᓐᓂᒃ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓪᓗᑎᒃ ᑲᑎᔾᔪᑎᓪᓗ ᖃᓯᐅᓂᓇᕙᒃᑖᖏᑦ ᖃᕝᕕᓘᕐᕙᐃᑦ ᑕᒫᓂ ᓈᓴᐃᕝᕕᐅᕙᒥ ᖃᖓᑐᐃᓐᓇᒃᑯᑦ. ᐃᒪᓐᓇᐅᒐᕙᓚᐅᖅᐳᖅ, ᐅᕝᕙᓘᓐᓃᑦ ᖃᕝᕕᓘᕐᕙᐃᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ 2.36−ᖑᖅᑳᓚᐅᖅᐳᑦ /1,000 km$^2$ (SE = 0.34) 2013−ᒥ ᐊᒻᒪᓗ 1.66−ᖑᓪᓗᑎᒃ ᖃᕝᕕᓘᕐᕙᐃᑦ/1,000 km$^2$ (SE = 0.29) in 2014. ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᑕᕝᕙᓂᑦᑕᐃᓐᓇᖅ ᐅᓄᖅᑎᒋᓂᖏᑦ (ᖃᓯᐅᓂᕆᔭᖏᑦ ᖃᕝᕕᓘᕐᕙᐃᑦ ᑕᒫᓂ ᐊᑐᖅᑕᐅᕙᒥ ᖃᐅᔨᓴᕝᕕᒃᑖᕝᕕᐅᕙᒃᑐᒥ) 21−ᖑᓚᐅᑦᐳᑦ (CI=18-26) 2013−ᒥ 14−ᖑᓪᓗᑎᒡᓗ (CI=11-19) 2014−ᒥ. ᐃᓂᒋᔭᐅᕙᒥ ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ ᖃᓂᒃᓴᓚᐅᖅᐳᑦ ᖁᑦᑎᖕᓂᖅᓴᐅᕌᖅᕙᒃᓱᑎᒡᓘᓐᓃᑦ ᖃᓯᐅᓂᕆᔭᖏᓐᓂᑦ ᐃᓛᒃᑰᖅᑐᑦ ᖃᕝᕕᓘᕐᕙᐃᑦ ᖃᐅᔮᔭᐅᕙᑦ ᖃᐅᔨᓴᕝᕕᐅᕙᒥ ᐃᓂᒥ ᑕᒪᐃᓐᓄᑦ ᐊᑐᓂᑦ ᐊᕿᒎᒋᔭᐅᕙᓄᑦ, ᑕᒪᒃᑯᐊᓗ ᑕᑯᑎᑦᑎᓪᓗᑎᒃ ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᓂᕆᔭᐅᕙᖅ ᑲᕙᓯᖅᑎᐊᓚᐅᕐᓂᖓᓂᒃ ᖃᐅᔮᔾᕙᑕᐅᓪᓗᓂ ᑕᒪᐃᓐᓂᑦᑎᐊᖅ ᖃᕝᕕᓘᕗᓂᒃ ᑕᒫᓂ ᖃᐅᔨᓴᕝᕕᐅᕙᒥ ᐊᒻᒪᓗᑦᑕᐅᖅ ᑕᒪᑐᒪ ᖃᐅᔨᓴᕝᕕᐅᕙᖕ ᖃᓂᖏᔭᖓᓂ ᐃᓂᒥ.

ᐊᑐᖅᑕᐅᖖᒍᐊᕐᓂᖏᑦ ᖃᐅᔨᓴᖅᓯᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᓇᔭᖅᑐᑦ (ᓇᑉᐸᖅᑎᖅᑕᐅᓯᒪᕙᑦ ᐊᑯᑦᑐᓈᖅᑕᐅᓯᒪᓂᖏᑎᒍᑦ ᐱᓕᕆᕝᕕᐅᕙᓪᓗ ᖃᓄᖅ ᐊᖏᑎᒋᓂᖏᑎᒍᑦ) ᐃᒪᓐᓇᐅᑦᑯᔨᑎᑦᑎᕗᑦ, ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑎᓂᖅ ᓇᑉᐸᑦᑎᑦᑕᐅᓯᒪᕙᑦ ᐊᑯᓐᓂᖏᓐᓂᒃ ᑕᐃᒪᐃᓕᕐᓂᕐᒥᓂᒧ ᐅᓄᕈᓐᓃᖅᑎᑦᑎᕆᐊᖅᑐᑎᒃ ᖃᓯᐅᓂᕆᔭᖏᓐᓂᒃ ᓇᑉᐸᖅᑕᐅᓯᒪᕙᑦ ᖃᐅᔨᓴᕝᕕᐅᕙᑦ ᐊᖏᒡᓕᒋᐊᖅᑎᑦᑎᕙᓇᖅᐳᑦ ᖃᕝᕕᓘᕙᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓄᑦ ᓱᓕᓂᖅᓴᐅᓗᑎᒡᓗ ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ. ᖃᕝᕕᓘᕙᐃᑦ ᑕᐅᕙᓂ ᐃᓂᒦᑦᑐᑦ ᐅᓄᙱᑦᑐᑯᓘᓪᓗᑎᒃ ᐱᑕᖅᐳᑦ ᓴᖅᑭᕝᕕᐅᕙᓪᓕᐊᓪᓗᑎᒡᓗ ᐅᓄᖅᓯᕙᓪᓕᐊᕙᓄᑦ ᐃᓄᖕᓂᒃ ᑕᐅᕚᓐᑦᑐᖅᑲᓪᓚᖕᐸᖕᓂᖕᒋᓂᒃ, ᐱᑦᑎᖅᐸᑉᐱᖅᑐᓄᑦ ᐱᓕᕆᐊᖑᒪᓂᐊᖅᑐᓄᓪᓘᓐᓃᑦ ᐅᔭᕋᓂᐊᕝᕕᐅᕙᒪᕙᓂ ᐊᖑᓇᓱᒃᐸᖕᓂᕆᔭᐅᕙᒥᒧ ᐆᒪᔾᕙᑎᒋᓂᐊᕐᓗᑎᑦ. ᖃᐅᔨᔭᕗᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐃᑲᕙᖅᐳᑦ ᑐᙵᕕᔭᐅᕙᒥ ᑎᑎᕋᖅᑕᐅᓯᒪᕙᓂᒃ ᖃᕝᕕᓘᕐᕙᐃᑦ ᖃᓄᐃᓕᖓᓂᖏᓐᓄᑦ ᑲᓇᖕᓇᖅᐸᓯᖕᒥ ᐅᑭᐅᖅᑕᖅᑐᒥ ᓇᕿᖅᑐᖅᑲᖖᒋᑦᑐᒥ ᑕᒪᓇᓗ ᐊᑐᖅᑕᐅᕙᓇᖅᐸᓗᓂ ᐋᖅᑭᒃᓯᔾᕙᑕᐅᓗᓂ ᐊᕕᒃᓯᒪᓂᕆᔭᐅᕙᓂ ᖃᓯᐅᓇᓱᒋᓐᓈᓂᕐᓂᒃ ᓯᕗᓂᒃᓴᒥ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐅᕙᓖᖅᑐᒧᑦ. ᖃᓯᐅᓇᓱᒋᓐᓈᓃᑦ ᐊᑐᖅᑕᐅᕙᓇᖅᐳᑦ ᖃᐅᔨᓴᖅᓯᓂᐊᕐᓗᓂ ᒫᓐᓇ ᐊᖑᓂᓇᔭᐅᕙᒃᑐᓂᒃ, ᐱᑎᑦᑎᕙᓇᖅᐳᑦ ᖃᓯᐅᓂᖏᓐᓄᑦ ᑐᙵᕕᒋᔭᐅᓂᐊᖅᑐᒥᒃ ᐋᖅᑭᒃᓯᒪᓕᖅᑎᑦᑎᕙᓪᓗᓂ ᓯᕗᓂᒃᓴᒥ ᖃᓯᕿᐳᓇᕐᓂᕐᒧᑦ ᐃᓱᓕᑦᑕᕝᕕᐅᓇᔭᖅᑐᓂᒃ ᐃᑲᕙᖅᑐᐃᓂᐊᖅᐸᓂᓗ ᐅᖃᐅᓯᐅᕙᓂᒃ ᓄᓇᕗᒻᒥ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔨᕐᑕ ᕿᒥᕿᐊᖅᓱᒃᑲᓂᕐᓂᕐᒧᑦ ᐊᑐᖅᐸᒃᑕᖑᓂᒃ. ᑕᒪᓐᓇ ᐱᓕᕆᖃᑎᒌᒃᐸᓗᓂ ᖃᐅᔨᓴᖅᓯᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᕗᖅ ᐱᓕᕆᖃᑎᒋᔭᐅᓪᓗᑎᒃ ᖃᒪᓂ'ᑐᐊᕐᒥᐅᓄᑦ ᐊᖑᓇᓱᒃᑐᓕᕆᔩᑦ (HTO−ᑯᑦ) ᐱᑦᑎᖅᑲᑦᑕᖅᓯᒪᔪᖅ ᐱᐅᒋᔭᐅᑎᐊᖅᑐᒥᒃ ᐊᕙᕈᓐᓃᖅᓴᖅᑎᑦᑎᓂᕐᒥᒃ, ᐃᖅᑲᓇᐃᔭᖅᑎᑦᑎᓂᕐᒥᒃ ᐱᓕᕆᔾᕙᑎᓄᑦᑐ ᓈᑎᑦᑎᓂᕐᒥᒃ ᐊᖑᓇᓱᒃᑐᓕᕆᔨᒃᑯᑦ ᐃᓚᒋᔭᖏᓐᓄᑦ. ᖃᐅᔨᔭᕗᑦ ᐃᒪᓐᓇᐅᖅᑯᔨᑎᑦᑎᕗᑦ, ᐃᓚᐅᑎᑦᑎᓂᖅ ᓄᓇᓕᖕᒥᐅᓂᒃ ᐊᖑᓇᓱᒃᑎᓂᒃ, DNA=ᒥᒃ ᑐᙳᕕᓖᑦ ᖃᐅᔨᓴᖅᓃᑦ ᒪᓂᒪᑎᑦᑎᕗᑦ ᐊᑐᖅᑕᐅᑦᑎᐊᕈᓐᓇᖅᑐᓂᒃ ᐊᑭᑐᓗᐊᙱᑦᑐᓂᒡᓗ ᐊᑐᖅᑕᐅᕙᓐᓇᖅᑐᓂᒃ ᓇᐅᑦᑎᖅᓱᖅᓯᓂᐊᕐᓗᓂ ᖃᕝᕕᓘᕐᕙᐃᑦ ᖃᓯᐅᓂᕆᔭᖏᓐᓂᒃ ᓇᑉᐸᖅᑐᖅᑲᖖᒋᑦᑐᒥ. ᐱᐅᓂᖅᓴᒃᑯᑦ ᑐᑭᓯᐅᒪᕙᒪᓗᓂ ᖃᕝᕕᓘᕐᕙᐃᑦ ᖃᓯᐅᓂᖏᓐᓄᑦ ᑕᐅᕙᓂ ᐃᓂᒥ, ᐃᒪᓐᓇᐅᖁᔨᓇᔭᖅᐳᑦ, ᐊᑯᓂᐅᕙᒥᒃ ᓇᐅᑦᑎᖅᓱᖅᓱᔨᓗᑕ ᐃᓚᐅᑎᓪᓗᑎᑦ ᓄᓇᓕᖕᓂ ᐊᖑᓇᓱᒃᑐᓕᕆᔨᑦᔪᕙᐅᕙᑦ ᑮᓇᐅᔭᓕᐅᕋᓱᒡᕕᐅᕙᖅᑐᓗ. ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᑕᑯᑎᑦᑎᕗᖅ ᑲᕙᓯᖅᑎᑦᑎᐊᕈᓇᕐᓂᖏᓐᓂᒃ ᑲᑐᔾᔭᐅᑦᑐᑎᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᕙᑦ ᑐᓴᖅᑎᑦᑎᕙᒪᓂᐊᕐᓗᓂ ᐊᐅᓚᑦᑎᔨᒋᔭᐅᕙᓂᒃ.

ᐅᖃᐅᓯᑦᑐᐊᑕᐃᑦ: *Gulo gulo*, ᖃᕝᕕᓘᕐᕗᒃ, DNA−ᖑᓂᖃᖅᑕᐅᕙᖅ, ᖃᓄᖅ ᐱᑕᖅᑎᒋᓂᖏᑎᒍᑦ ᖃᓯᐅᓇᓱᒋᔭᐅᓂᖏᑦ, ᖃᒪᓂᕐᒥ, ᑭᕙᓪᓕᕐᒥ, ᓄᓇᕗᒻᒥ, ᖃᓯᐅᓂᕆᔭᖏᑦ, ᐃᓂᒥᒃ ᐊᑐᓪᓚᕆᒡᓗᓂ ᐱᓱᖅᑕᑦᑕᕐᓂᖅ−ᐱᒃᑲᓂᖅᓯᖅᑕᑦᑕᕐᓂᖅ.

# Itqurnarutait qakvingnik aulaniqaqtunik talvani naunaitkuhiqhimayunik - nanigiaqtauhimayunik Idjuhianik pukugianganik, Aberdeen Lakemi, Kivalliq Aviktuqviangani, Nunavut, 2013mi-14mun

## Naittumik

Uvani iniqhimayunik titiraq aituihimayuq naunairutikharnik qalvingnik (*Gulo gulonik*) IDJUHINGNIK aulaniqaqtunik talvani naunaitkuhiqhimayunik - nanigiaqtauhimayunik qauyihaidjutikharnik talvani Kivallirmi aviktuqviangani, Nunavunt aulatitivakhimayut naunaiyaiyaangat amigaitilaangit aulavingitlu nallautiqhimayut hivutunigaalukmik atuqtangitni aviktuqvingmi munagihimaaqtunik. Qalviit akhurnaqtuq pitquhiliqinikkut maniliurutikharnik hanaqidjutikhaq pitquhiliqinikkut anguyauvakhimayut Inungnin. Atuqhimaanginaqtugut idjutikhangit ihivriudjutikharnik ilitagiyaanganik kituliqaak qalviit talvanga nuyait pukuktauhimayunik ilaungitunik talvanga nallunaqtunik ilituqhainiaqhimayunik qauyihaidjutikharnik havakhimayut naunaitkutingniklu uqagiikhimayunik nunalaani anguniaqtuliqiyikkungit. Nuungutiqviangani Qiqaiyaqvia talvunga Qiqaiyaqluarvia 2013mi 2014milu katitiqtuivakhimayut naunaitkutikharnik nunam nayugaani taima 209nik napaqutinik niriniaqhimayunik tuktunik (*Rangifer tarandus groenlandicusnik*) niqinik naidjutingniklu inikhalikhimayut taima 4 X 4nik ungahiktilaarutiqakhutik (16nik kilaamiitanik$^{2nik}$) nayugviinik taima pingahunik 10nik - ubluanik aulatitivakhimayut taima 3,344nik ungahiktilaarutiqakhutik kilaamiitanik$^{2nik}$ hanigaini tununganirmi Aberdeen Lakemin. Tamaat katitiqhimayunik munagipluta pivakhimayugut 21nik (9F:12M-nik) qalvingnik talvuuna malrungnik ukiunganik katitiqtuivakhimayugut naunairutingnik, ilauplutik aitnguyut qalvingnik ilitagiyauhimayunik talvuuna 2013mi piyauvaffaaqtunlu talvuuna 2014mi. Ungahiktilaangit nanigiaqtauhimayut nanigiaqtauffaaqhimayutlu (SECR) atuqtangit atuqtauvakhimayut nallautigianganik ungahiktilaanganik qaffiutilaangitlu nampait qalviit talvani nayugaani talvaniitkaluaqtun. Naunaiqhimayut nayugaingit qalviit ungahiktilaarutikhangit imaatun itun 2.36 qaviingit/1,000 km$^2$ (SE = 0.34) in 2013 unalu 1.66 qalviit/1,000 km$^2$ (SE = 0.29) 2014mi. Nallautiqhimayuq anginirmik amigaitilaangat angikliyumiqhimayut (qaffiuyut qalviit talvani ihuatqiyauyumik atuqtauhimaaqtun ihivriuqtauyaangat nayugaini) imaatun itun 21 (CI=18-26) 2013mi unalu 14 (CI=11-19) 2014mi. Anginirmik amigaitilaangat nallautiqhimayut aadjikiivyaktun mikiumik angiyut nampait avaliqangitunik qalviit munagiyauhimayut ihivriuqtauvakhimayut talvani nayugaani ukiuk tamaat, taima ihumaliurutiqaqtun ihivriuqtauhimayut ihuagiyauvakhimayuq munagiyaangat tamainik qalvingnik talvani nayugaani taimaitutun qillaminuaq hanigaqaqtunik nayugaini.

Havagiikhimayut ihivriuqtauyukharnik havakhimayut (napaqutit hanigaingit nayugait amigaitilaangat) ihumaliurutiqaqhimayuq taima amigaiqyumiqtitiyukhat napaqutait nayugait taima ikikliyumigianganik napaqutait ihivriuqtauvikhat amigaikyumiqtitiniaqtun naunaitumik nallautiqhimayunik. Qalviit talvani nayugaini aulayut taima ikitun nayugainik tautungnarniaqtunlu amigaikyumiqhimayut taima inuit

hulilukaakvingitni, aulahimaaqtunik tukhiqtauhimaaqtunlu uyaraqhiuqtunik anguniaqhimaaqtuniklu. Naunaiyagiikhimayut ihivriudjutit aituihimayut taima nayugaingit naunaitkutikharnik qaviit nayugait talvnai kivataani nunami Ukiuktaqtuniitunik nunami atuqtaugiaqaqtunik aulatitiyaangat aviktuqvingniitunik inugaingit nallautiqhimayut hivunikharni munagiyauyaangat. Tamna nallautiqhimayut atuqtaugiaqaqtun ihivriugianganik aulayut anguniaqtauvakhimayut, tunigiaqaqtun qafffiutilaaqharnik naunaiqhimayut hivunikhaptingni anguniarutikharnik ikayuutiniaqtuqlu ihumagiyauyut talvanga Nunavut Ayungnautiqaqqan Ihivriuqtukharnik Katimayiit (NIRB) ihivriuqtukharnik aulavikhangit. Una havaqatigiikharnik ihivriuqtunik talvani Qamanittuaq Anguniaqtuliqiyikkut (HTO) tunihimaaqpaktun ayuiqhautikharnik, havaktitivakhutiklu ayuittiarutikharnik qaritauyaliqidjutikharnik nuutigianganik HTOkutnun ilauyunun. Ihivriuqhimayaqut naunairutiit ihumaliurutiqaqtuq taima iluatitilugit nunalaani anguniaqtit, Idjuhikhangit (DNA) naunaiqhimayut ihivriudjutikhangit aituihimaarniaqtun naunaitumik akituvalaangitumik hanaqidjutikharnik munagiyaangat qalviit amigaitilaangit nunami aulayunik. Taima ihuatqiamik ilitugidjutikharnik qalvingnik amigaitilaanganik talvani nayugaini, ihumayugut hivutunirmik munagidjutikharnik taima ilautitilugit HTO-kut havagviingitlu. Una ihivriudjutikhaq naunaiyaivakhimayuq ihuagiyauhimayut havaqatigiikhutiklu ihivriuqtaunikkut havaaqhat ilitugipkaiyaangat munagiyauyunik.

Naunaitun tainiit: *Gulo gulo*, qalvik, IDJUHIIT (DNA), Ungahiktilaarutiit nallautiqhimayunik, Aberdeen LakeMI, Kivalliq, Nunavut, amigaitilaangit, ungahiktilaangit nayugait anguyauvakhimayut – anguyauffaaqpakhimayutlu.

# Estimation de la densité de la population de carcajous basée sur les échantillons d'ADN provenant de l'opération de marquage-recapture près du lac Aberdeen, région du Kivalliq, Nunavut, 2013-2014

## Sommaire

Ce rapport présente les résultats d'une étude  de l'ADN à la suite d'une opération de marquage-recapture de carcajous (gloutons) dans la région du Kivalliq au Nunavut. Cette opération fut menée afin d'établir l'indice d'abondance et la densité de la population aux fins de monitorage à long terme. Le carcajou représente une ressource économique et culturelle traditionnellement récoltée par les Inuits. Nous avons fait appel à l'analyse génétique pour procéder à l'identification individuelle des carcajous à partir d'échantillons de poils recueillis de manière non invasive selon une stratégie scientifique et avec l'aide logistique des chasseurs locaux. De la fin mars au début mai en 2013 et 2014, nous avons disposé 209 pièges appâtés avec de la viande de caribou (*Rangifer tarandus groenlandicus*) et des leurres odoriférants répartis sur des parcelles de 4 km x 4 km (16 $km^2$) durant trois périodes de 10 jours chacune, couvrant une zone de 3 344 $km^2$ au nord du lac Aberdeen. Au total, nous avons recensé 21 (9F:12M) carcajous au cours des deux années d'échantillonnage, y compris huit individus identifiés en 2013 et capturés à nouveau en 2014. Des méthodes de capture-recapture spatialement explicites ont été utilisées pour estimer la densité et la population moyennes des carcajous dans chaque parcelle à tout moment. La moyenne de carcajous résidents était de 2,36 individus par 1 000 $km^2$ (SE = 0.34) en 2013 et de 1,66 carcajou par 1 000 $km^2$ (SE = 0.29) en 2014. Les estimations de superpopulation (nombre de carcajous au sein de la zone d'échantillonnage) étaient de 21 (CI=18-26) en 2013 et de 14  (CI=11-19) en 2014. Les estimations de superpopulation se situaient près ou tout juste au-dessus du nombre de carcajous individuels détectés dans la parcelle d'échantillonnage chaque année, ce qui suggère que l'échantillonnage s'est avéré efficace pour détecter tous les carcajous de la parcelle ainsi que dans la zone limitrophe.

Des simulations concernant le concept des échantillonnages (espacement des pièges et superficie des parcelles) donnent à penser que le fait d'accroitre l'espace entre les pièges tout en réduisant leur nombre pourrait augmenter le nombre d'échantillons et améliorer la précision des estimations. La population de carcajous dans la région est de faible densité et sera de plus en plus exposée à une activité humaine en croissance compte tenu de la présence de mines existantes ou proposées ainsi que de la récolte de subsistance. Les résultats obtenus contribuent à l'établissement de données de base sur l'écologie des carcajous dans la région est de la toundra arctique continentale et pourront être utilisés pour générer des estimations de la population de la région dans le cadre de monitorages à venir. Les estimations peuvent être utilisées pour établir les limites de récolte durable et serviront à appuyer le processus d'examen de la Commission du Nunavut chargée de l'examen des répercussions (CNER). Cette recherche, réalisée en collaboration avec l'organisation des chasseurs et trappeurs (OCT) de Baker Lake, s'est avérée une occasion d'offrir de la formation, de l'emploi et d'un transfert de compétences techniques aux membres de l'OCT. Nos résultats tendent à démontrer que l'implication des chasseurs locaux dans les enquêtes basées sur l'ADN constitue une approche à la fois pratique et économique pour procéder au suivi des populations de carcajous dans la toundra. Afin de mieux comprendre la population de carcajous dans la région, nous recommandons un monitorage à long terme qui implique tant les OCT que l'industrie. Cette étude démontre l'efficacité de projets de recherche mixtes pour renseigner la bonne gestion.

Mots-clés: *Glouton*, carcajou, ADN, estimation de la densité, lac Aberdeen, Kivalliq, Nunavut, population, capture-recapture spatialement explicite.

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## 1.0 INTRODUCTION

In Nunavut, the wolverine (*Gulo gulo*) is listed both as a furbearer (Schedule 5.2) and big game (Schedule 5.1) under the Nunavut Land Claims Agreement (NLCA). This non-hibernating, resident, solitary carnivore of Arctic tundra is an important cultural and economic resource traditionally harvested by Inuit. Nunavut represents the north-eastern edge of wolverine distribution in Canada. There is no precise population estimate yet for wolverines within the territory of Nunavut, nor is there any quantitative limit on their harvest by Inuit. Nevertheless, wolverine densities are believed to be moderate in the western mainland but low on the Arctic islands and in the eastern mainland (Slough 2007; Species at Risk Committee 2014). Inuit observations and recent reports suggest that wolverine numbers in Nunavut are either stable or slightly increasing (Awan et al. 2014; COSEWIC 2014). They also appear to be expanding their range eastward and northward (Awan et al. 2012; COSEWIC 2014).

The Committee on the Status of Endangered Species in Canada (COSEWIC) has assessed the wolverine as "Special Concern" across the Canadian range in 2014 (COSEWIC 2014). The species was also recently petitioned for listing under the US Endangered Species Act (Stewart et al. 2016). Primary threats to wolverine persistence identified by COSEWIC include habitat fragmentation and loss due to development and climate change. While this is true for most parts of the species' southern range, the range fragmentation and habitat loss issues that affect southern populations may have limited effect so far on wolverines in Nunavut. However, there has been an increase in wolverine-human conflicts associated with recent mineral development projects, and there are indications of recent declines in wolverine numbers in the central barrens (Boulanger and Mulders 2013ab; Agnico Eagle Mines 2014; Species at Risk Committee 2014). Such scenarios can be expected to increase in Nunavut with the amount of development projects growing over time (NIRB 2012).

Arctic climates and ecosystems are changing at some of the fastest rates on earth (McLennan et al. 2012). It is believed that wolverines are demographically vulnerable and susceptible to impacts from climate change (Inman et al. 2012) and it has been suggested that species adapted to cold, snowy environments are particularly vulnerable to the impacts of predicted warming trends on the snowpack (McKelvey et al. 2011). Climate change impact is preeminent in the southern part of the wolverine range, and this impact is expected to increase northward (Inman et al. 2012). McKelvey et al. (2011) hypothesized that the geographic extent and connectivity of suitable wolverine habitat in western North America will decline with continued global warming. However, Webb et al. (2016) described that wolverines may be more flexible in their habitat selection and likely developed local adaptations depending on habitat type and resource availability. Various studies (Copeland et al. 2010; Peacock 2011; McKelvey et al. 2011) highlighted wolverine's requirement of snow cover for reproductive dens and identified wolverines obligate association with persistent spring snow cover for successful reproductive denning. Magoun and Copeland (1998) noted that at least 1 m of snow, distributed uniformly or accumulated in drifted areas, should be present throughout the denning period (February until May). Peacock (2011) believed that location of wolverine reproductive dens under deep snow provides insulating warmth to newborn kits and protection against predators. How climate change might influence spring snow cover and affect larger ungulates remains uncertain (COSEWIC 2014).

The wolverine is both a scavenger and predator throughout its range, caching food in boulder fields, snowbanks, or bogs for later use (Banci 1987; Mulders 2000; Mattisson et al. 2016). Within the Arctic ecosystem, caribou is an important species sustaining much of the tundra biodiversity, and trends in their numbers are important in the structure and functioning of the tundra ecosystem (Gunn et al. 2011). Wolverine diet analysis studies on the tundra (Mulders 2000; Awan et al. 2012; Mattisson et al. 2016; L'Hérault et al. 2016) revealed that wolverines rely predominantly on migratory caribou (*Rangifer tarandus*) and wolverine reproduction is limited by winter food availability (Persson 2005). The recent decline in caribou abundance in parts of the wolverine's range in the Canadian north (Gunn et al. 2011; Adamczewski et al. 2015) is expected to have some effect on wolverines in Nunavut. However, such potential effect is difficult to identify or quantify since we do not know how resident wolverine population may respond demographically to variation in prey abundance (Dalerum et al. 2009). Nunavut contributes substantial numbers to the national harvest and ecological data for tundra wolverine are sparse, especially in the north-eastern edge of distribution. Similar to other northern parts of the wolverine range, the Nunavut mainland is comprised of large undisturbed areas situated away from communities harvesting range. These areas with no or limited harvest act as reservoirs or refugia (source) to maintain or repopulate hunted populations (sink) of wolverines around the communities (Mulders 2000; Cardinal 2004; Krebs et al. 2004; Golden et al. 2007; Species at Risk Committee 2014; Gervasi et al. 2016). As these areas become more accessible due to resource development and increased use of highly efficient four-stroke snowmobiles by local hunters, populations of wolverines become more susceptible to overharvesting and disturbance. Given the current situation, there is a need to estimate the number of wolverines and monitor their trend, particularly in a changing Arctic.

The wolverine is an elusive species, occurring at low densities (Mulders 2000; Royle 2011; Boulanger and Mulders 2013ab), maintaining large home ranges (Mulders 2000; Dumond et al. 2012), and having long dispersal movements (Inman et al. 2012). Various techniques have been used to estimate wolverine population abundance or trends. In Arctic Alaska and southern Yukon, Magoun (1985) and Banci (1987) estimated wolverine density using telemetric monitoring. Landa et al. (1998) estimated minimum population size by monitoring natal dens in Scandinavia. Recently, researchers have used deoxyribonucleic acid (DNA) from hair collected at bait sites in the central barrens in the Northwest Territories (NWT) and in Alberta to estimate wolverine density (Mulders et al. 2007; Boulanger and Mulders 2008; Boulanger 2012; Boulanger and Mulders 2013ab; Fisher et al. 2013). Lofroth and Krebs (2007) and Royle et al. (2011) generated density estimates of wolverines captured on motion-detection cameras in British Columbia and southeast Alaska, respectively. Both aerial (Becker 1991; Becker et al. 1998; Golden et al. 2007) and ground (Golder 2007) snow track surveys were also used in open habitats in Alaska and NWT to index wolverine abundance and density estimates. However, Mulders et al. (2007) described that wolverine abundance indices obtained through snow track surveys are prone to observer bias and are affected by variable snow conditions, and error rates are difficult to assess. Boulanger and Mulders (2008) conducted the DNA-based mark-recapture studies in the Canadian Arctic at Daring Lake and the Ekati and Diavik mines in the Lac de Gras region. They estimated a density for females from 2.7 to 6.2 and for males from 1.3 to 4.5 wolverines/1,000 km² in 2003–2006. However, in Nunavut, we lack crucial information about their abundance and ecology, hampering justification and management of its harvest (Lee and Niptanatiak 1993).

Similar to other large carnivores, live-capture and tracking of the elusive wolverine which occurs at naturally low density in the remote tundra is expensive and time-consuming (Dumond et al. 2012). The NLCA established Hunters and Trappers Organizations (HTO) and Regional Wildlife Organizations (RWO) with specific roles and authorities, and through these organizations Inuit are co-partners in Nunavut wildlife management, including wildlife research. In Nunavut, harvest of wolverine and other furbearers for clothing and income is a seasonal and traditional activity, where opportunity for other employment is chronically scarce. Further, Inuit community concerns over wildlife handling gave rise to a need to adapt a culturally acceptable, non-invasive approach based on DNA-analysis with a field method that can benefit from Inuit hunter's relevant skills and capacities (Inuit Tapiriit Kanatami 2016), while providing local employment and training. Furthermore, Boulanger and Mulders (2008) and (Golder 2007) argue that DNA-based methodologies are more powerful and robust for monitoring wolverine populations than track count methodologies. Recent studies have demonstrated that the hair-snagging sampling technique in a mark-recapture framework is feasible for wolverine and grizzly bear (*Ursus arctos*) in the tundra habitat (Mulders et al. 2007; Dumond et al. 2012, 2015), this was the approach selected in the present study to estimate density and monitor wolverine populations in the Kivalliq region.

## 1.1 Objectives

The primary objective of this project was to estimate wolverine population size and density utilizing Inuit hunter's relevant skills and capacities to develop a community-based monitoring protocol through a combination of culturally acceptable (non-invasive) scientific methods and hunters knowledge. This project is intended to be the basis for long-term monitoring of the species.

The specific objectives of the study were:

- Estimate wolverine population size and density within the Aberdeen Lake study area;
- Establish baseline wolverine population data which can be used for long-term population monitoring;
- Consider alternative designs to increase power to detect change in future sampling efforts; and
- Provide field work training, technology skills transfer and employment to HTO members and increase collaboration between government and resource users.

# 2.0 METHODS

## 2.1 Study Area

The study area was located north of Aberdeen Lake about 120 km northwest of Baker Lake (64° 48.715N, 98° 51.282W), and includes 3,344 km$^2$ in the Southern Arctic Ecozone and Back River Plain ecoregion (Fig. 1). The study area selection was based upon wolverine sightings, harvest pattern information collected from local hunters and elders, and opinion of knowledgeable biologists.

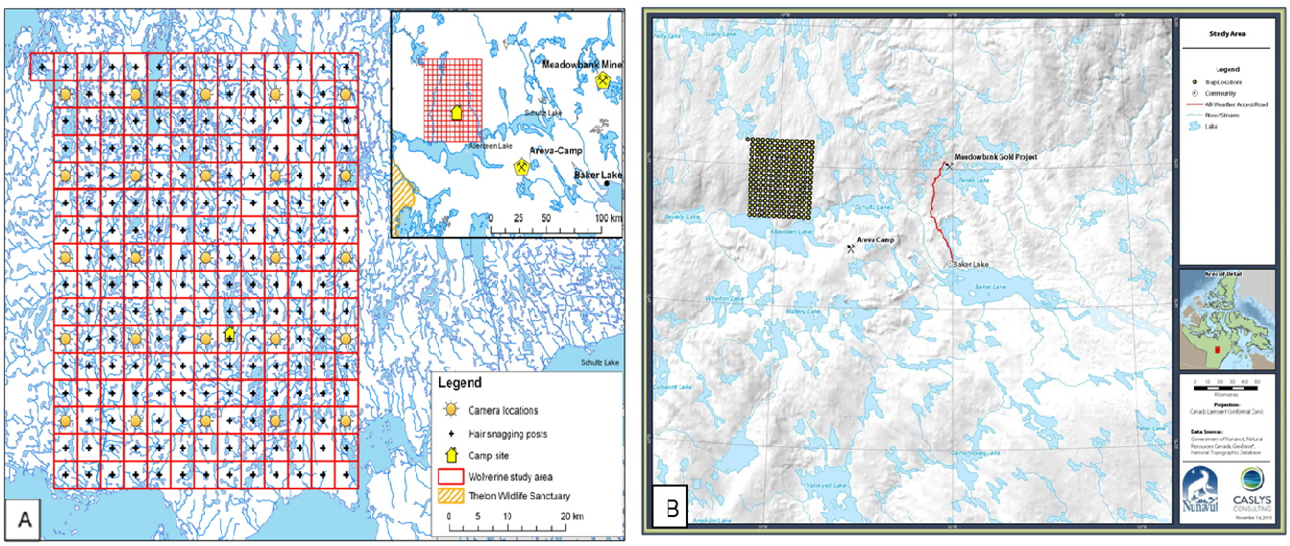


Figure 1. The Aberdeen Lake wolverine study area (A) and DNA grid in relation to Baker Lake and mining areas (B).

The ecoregion is marked by cool summers and very cold winters. The mean annual temperature is approximately -10.5°C with mean summer and winter air temperatures of 5.5°C and -26.5°C, respectively. Mean annual precipitation ranges from 200–300 mm. Elevation in the study area ranged from sea level to 300 m. The Back River Plain ecoregion is classified as having a low Arctic ecoclimate. The vegetation is characterized as shrub tundra, consisting of dwarf birch (*Betula nana*), willow (*Salix* spp.), northern Labrador tea (*Rhododendron tomentosum*), Dryas spp., and

Vaccinium spp. The ecoregion has high mineral potential (Ecological Stratification Working Group 1995).

We obtained snowfall data from the Environment Canada weather station in Baker Lake. Monthly snowfall in 2014 was 63% below average and 53% less than 2013 (Fig. 2). In 2014 there was little or no snow at higher elevations and spring thaw occurred early and rapidly.

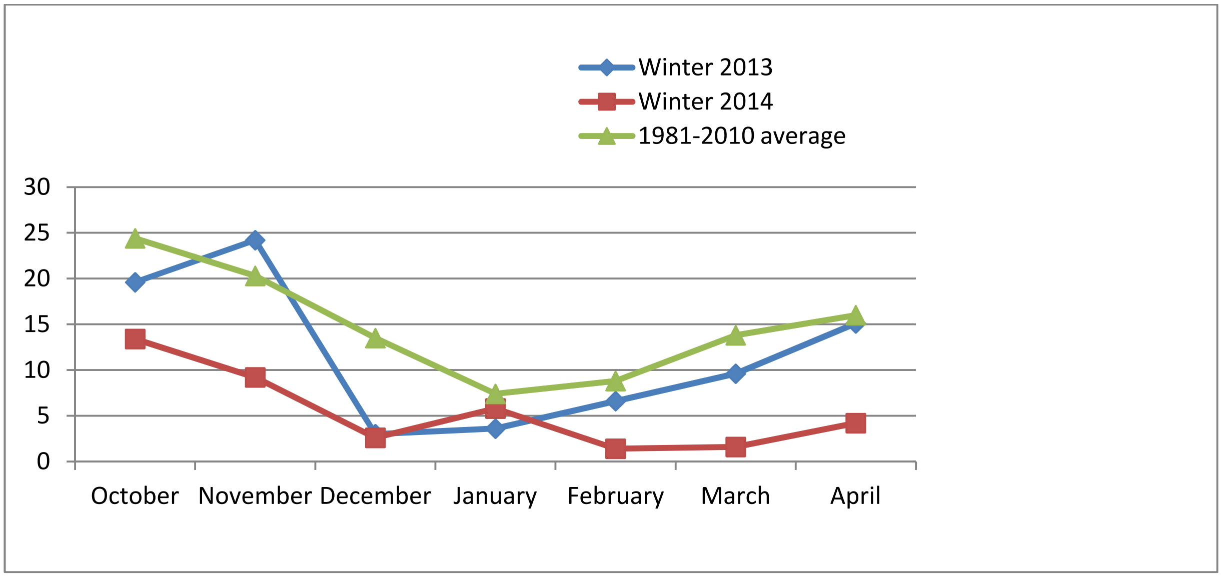


Figure 2. Monthly snowfall (cm) in Baker Lake, NU.

The Ahiak caribou herd migrates annually through the study area (Campbell et al. 2014). Muskoxen (*Ovibos moschatus*) also provide important food items for wolverine. Other prey species may include rodents, Arctic hare (*Lepus arcticus*), Arctic ground squirrels (*Spermophilus parryii*), voles and lemmings (*Muridae*), ptarmigan (*Lagopus* spp) and migratory bird species (Mulders 2000; Samelius et al. 2002; Dalerum et al. 2009; Awan et al. 2012). Other carnivores in the area included Arctic fox (*Vulpes lagopus*), red fox (*V. vulpes*), wolf (*Canis lupus*), and grizzly bears.

Hunters from Baker Lake and other Kivalliq communities have been harvesting wolverines and other furbearers from the study population. Moderate to heavy subsistence wolverine harvest occurs around the study area (mostly southeast of the grid) from November to May with a peak in March and April when the wolverine fur is in prime condition, days are longer and snowmobile travel is easier. The average annual reported wolverine harvest for Baker Lake (2010-2012) was 14 (range 11-18), biased toward males (73%) and sub-adults comprise 67% of the reported harvest. The majority of wolverine harvest occurred northwest of Baker Lake along the Thelon River and Schultz Lake area (Awan and Szor 2014). Since the study area is located on the northern periphery of wolverine distribution with ongoing subsistence harvest for fur, we predicted low wolverine density in the study area. Wolverines in the study area potentially are being exposed to increasing levels of industrial development. The operational Meadowbank Gold Mine is located approximately 110 km east of the study area, with a 110 km all-weather access road from mine to community of Baker Lake (Fig. 1B). Meadowbank Gold Mine is planning to expand its operations about 50 km further northwest of its Meadowbank mine. Another exploration camp, with proposed Areva uranium mine is located about 40 km southeast of the study area (Fig. 1B), although this mine is currently not proceeding.

### 2.2 Field methods

We conducted DNA sampling north of Aberdeen Lake during spring 2013 and 2014 following the non-invasive procedure developed by Mulders et al. (2007) for tundra wolverines. This study was designed to involve local hunters in the collection of samples, with three Baker Lake HTO members hired as part of the field research team. The DNA grid (Fig. 1A) was sampled from March 31st to May 7th in 2013 and March 28th to May 5th in 2014. During this time, 209 bait posts were sampled in a systematic sampling grid with 4x4km grid cells, each hosting a post in the cell centre. Each hair snare bait post consisted of a ~1.6m long and 10x10 cm post wrapped with barb-wire and anchored in packed snow (Appendix 1). Bait (~250g caribou meat) and a combination of commercial lures (Beaver Castor and Long Distance Call, O'Gorman Lures, Montana, USA) were attached to the top of the post with haywire. A GPS position of each bait post was recorded. Each post was visited 3 times at about 10-day intervals using snowmobiles. At each visit, all visible hairs were collected and the wood post was cleaned using a propane torch to remove any remaining hair. Each individual clump of hair was removed from the post and placed in labeled individual coin envelopes (post number, location on post and date) for storage. A fresh set of bait and lures was installed after every check. The number of caribou, muskoxen, and other prey species sighted or wildlife signs observed were recorded during the post set-up and while driving between posts to check for hair samples.

Twenty-five motion triggered digital cameras (Reconyx PC-800 Hyperfire Professional IR, Holmen, WI) were installed facing bait posts within the sampling grid to capture wolverine activity (Fig. 1A). The cameras documented wolverine sightings date and time of the visit, time spent at the hair snagging post, and captured images of other animals visiting the post. We considered only camera events when they captured wolverine approaching and departing from the post.

Upon the end of each field season, the samples were sent to Wildlife Genetics International (WGI), Nelson, BC for individual wolverine identification. From 2013 samples, we analyzed two samples per collection event (post/session combination) when there was more than one sample of suitable quality available. If possible, we selected the two samples from different sides of the post and used a minimum quality threshold of one guard hair root or five underfur hair samples. In 2014, all potential wolverine samples that contained at least one guard hair root or five underfur were analyzed. DNA was extracted using QIAGEN DNeasy Tissue kits, aiming to use 10 clipped guard hair roots, when available. Individual wolverines were identified using a ZFX/ZFY gender marker and the seven microsatellite markers, as applied to other wolverine projects in the tundra (Mulders et al. 2007; Dumond et al. 2012).

Due to low snow depth and an early melting season in 2014 a subset of posts (approximately every 3rd column of posts) was sampled in the 3rd session, 65% of posts were flat on the ground during the third session checkup and had strands of hair rather than large clumps of hairs trapped in the barbwire. Because of this, data were summarized in terms of wolverine numbers as a function of active detectors. In addition, approximate paths of wolverines based upon unique post detections per session were plotted.

### 2.3 Estimates of wolverine density and population size

#### 2.3.1 Baseline model analysis

Spatially explicit capture-recapture (SECR) methods (Efford 2004, Efford et al. 2004, Efford et al. 2009, Efford 2011) were used to estimate density and population size of wolverines. Spatially explicit methods model both the first and subsequent detections of wolverines at posts, while accounting for the spatial configuration of posts in the landscape. The detection and redetection locations of wolverines on the grid partially identify a partial sample of where wolverines traversed both on and off the grid during sampling. Spatially explicit methods basically attempt to estimate the most likely spatial patterning and movement of wolverines on the grid from detection histories observed across the grid. More precisely, the detection probabilities of wolverines at their home range center ($g_0$), spatial dispersion of movements ($\sigma$) around the home range center, and density are estimated. An assumption of this method is that wolverine's home range can be approximated by a circular symmetrical distribution of use (Efford 2004). The actual shape and configuration of the sampling grid is used in the estimation process. This accounts for the effect of study-area size and configuration on the degree of closure violation and subsequent density estimates.

To avoid bias in estimates, a sex-specific detection and scale model was initially run to determine the effective sampling area of the grid and the dimensions of the SECR mask (a grid of points that lie on the grid and surrounding area in which density is estimated). The estimate of effective sampling area is proportional to the scale of movement ($\sigma$) estimated by the SECR model. This step indicated that the grid area needed to be buffered by 30 km to ensure non-biased estimates. A SECR mask of points spaced at 2 km intervals was overlaid on the study area and the 30 km buffer area around the study area. The SECR model then estimated density for each mask point.

For the baseline SECR analysis, a set of sex and year-specific SECR models were run to assess sex and year-specific movement and detection rate parameters. The basic approach was to first model variation in g0 and σ to obtain a base model for 2013 and 2014. The most supported base model was then used to obtain a parsimonious model that described yearly and sex-specific variation in density. Models were evaluated in terms of relative support information theoretical model selection, using sample size adjusted $AIC_c$ scores (Akaike Information Criteria) to define the most parsimonius model (lowest $AIC_c$ score; Burnham and Anderson 1998).

These estimates were then used to assess sampling efficiency and wolverine movements. Density and superpopulation estimates were then derived from the most supported SECR model (Efford and Fewster 2013). These were assessed in terms of precision as well as whether the number of wolverines in the area was sufficient for monitoring purposes. SECR analyses were conducted using the package *secr* (Efford 2014b) in the R software program (R Development Core Team 2009). Map plots were created using QGIS software (QGIS Foundation 2015).

### 2.3.2 Inference about spatial and temporal trends in wolverines

### 2.3.3 Temporal trends

The support of models that assumed that density did not change between years was compared to the support of models that estimated year-specific variation and sex/year-specific variation in density to assess dominant forms of variation in density during the surveys.

### 2.3.4 Spatial trends

The baseline SECR models were used to determine whether the distribution of wolverines on the grid could be described by its habitat features. For this analysis, the SECR mask was populated with remote sensing habitat covariates based upon a 1 kilometer buffer around each SECR mask centroid. The 1 km buffer effectively sampled the area that each mask centroid sampled therefore providing a way to associate density with habitat features. The ecological land classification (ELC) of the Kivalliq region (Campbell et al. 2012) and Northern Land Cover remote sensing habitat maps were considered for the analysis. Unfortunately, the ELC map only covered half of the study area and therefore the Northern Land Cover was used for the analysis. Northern Land Cover classes were pooled down to classes for SECR analyses based upon the mean proportion of each class in the wolverine grid SECR mask area (Table 1). In general, the Northern Land Cover classes were not that precise. For example, class 26 in Table 1 indicated that a pixel could be “Lichen-shrubs-herb bare soil or rock outcrop”, which indicates a wide range of potential habitat attributes.

Table 1. Northern Land Cover classes and the spatially explicit capture-recapture (SECR) pooled classes and their occurrence on the wolverine grid and 30 km buffer zone. The proportion class is the overall proportion that each class occurred on the study area as indicated in the SECR mask.

| Northern Land Cover class | SECR pooled class | Proportion class |
|---|---|---|
| 28-Low vegetation cover (bare soil rock outcrop) | bare | 7.9% |
| 39-Recent burns | burn | 4.3% |
| 1-Evergreen forest (>75% cover)—old | forest | 0.3% |
| 13-Mixed evergreen-deciduous open canopy (25–60% cover) | forest | 0.0% |
| 14-Mixed deciduous (25–50% coniferous trees; 25–60% cover) | forest | 0.0% |
| 3-Deciduous forest (>75% cover) | forest | 0.0% |
| 4-Mixed coniferous (50–75% coniferous)—old | forest | 0.0% |
| 6-Mixed deciduous (25–50% coniferous) | forest | 0.0% |
| 7-Evergreen open canopy (40–60% cover)—moss-shrub understory | forest | 0.2% |
| 8-Evergreen open canopy (40–60% cover)—lichen-shrub understory | forest | 0.0% |
| 9-Evergreen open canopy (25–40% cover)—shrub-moss understory | forest | 0.1% |
| 18-Herb-shrub-bare cover mostly after perturbations | herb | 0.0% |
| 23-Herb-shrub | herb | 7.2% |
| 41-Low vegetation cover | herb | 1.8% |
| 35-Lichen barren | lichen_barren | 38.5% |
| 26-Lichen-shrubs-herb bare soil or rock outcrop | lichen_shrub | 3.9% |
| 36-Lichen-shrub-herb-bare | lichen_shrub | 11.3% |
| 38-Rock outcrop low vegetation cover | rock | 1.6% |
| 15-Low regenerating to young mixed cover | shrub | 0.1% |
| 16-Deciduous shrub land (>75% cover) | shrub | 0.2% |
| 19-Shrubs-herb-lichen-bare | shrub | 0.0% |
| 21-Sparse coniferous (density 10–25%) shrub-herb-lichens cover | shrub | 0.2% |
| 22-Sparse coniferous (density 10–25%) herb-shrub cover | shrub | 1.3% |
| 24-Shrub-herb-lichen-bare | shrub | 0.1% |
| 25-Shrub-herb-lichen-water bodies | shrub | 0.9% |
| 37-Sparse coniferous (density 10–25%) lichens-shrub-herb cover | shrub | 1.2% |
| 20-Wetlands | water | 0.1% |
| 43-Water bodies | water | 18.5% |
| 45-Snow/ice | water | 0.0% |

The dominant pooled SECR landcover was lichen_barren (Fig. 3). During the surveys water bodies would be frozen and therefore represent a viable wolverine habitat type which was considered in the SECR analysis.

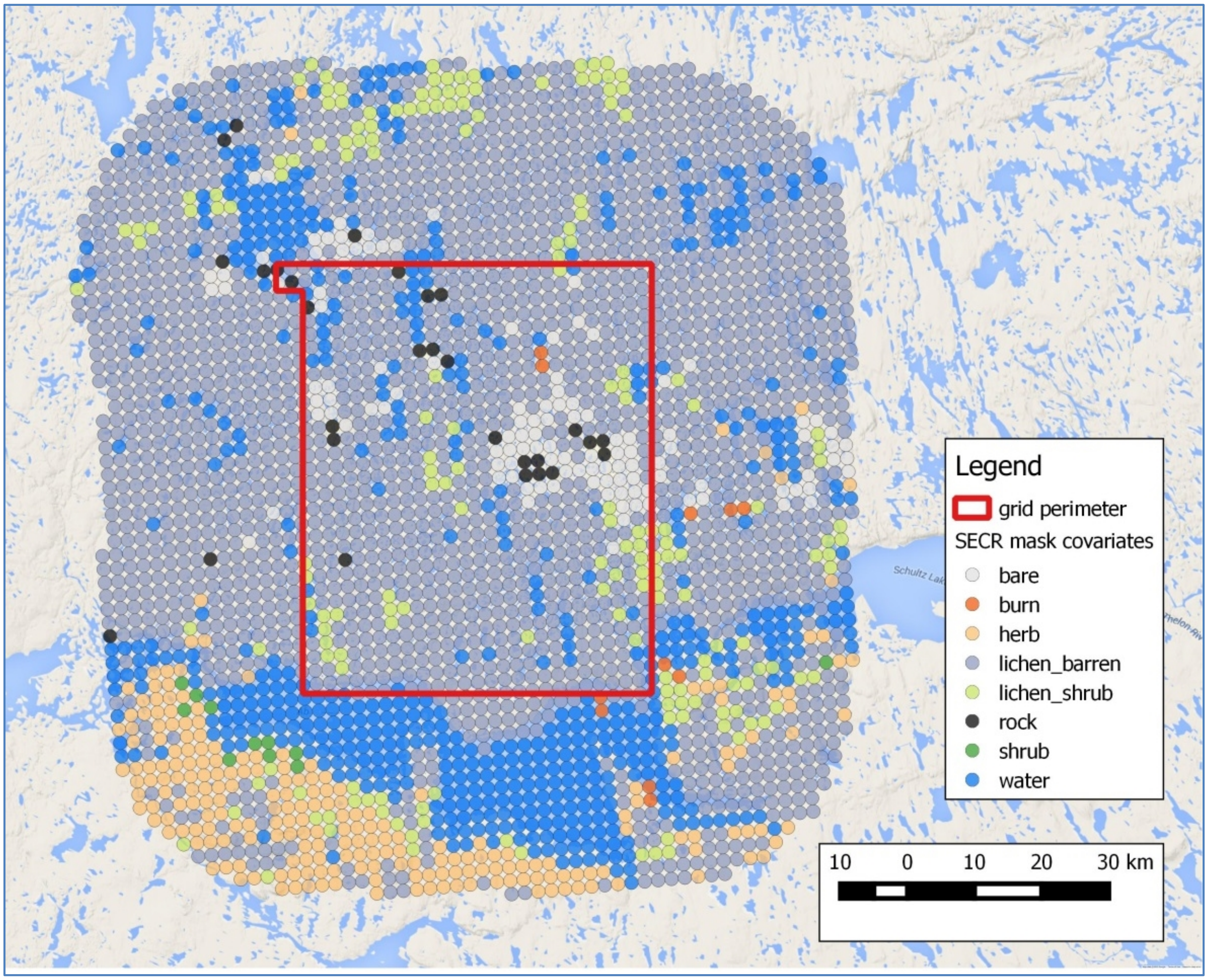


Figure 3. Dominant pooled Northern Land Cover habitat types classified on the SECR mask based on a 1 km buffer around each centroid point. Each mask point was classified by proportion of each habitat type and dominant habitat type (habitat type with the highest proportion).

The distribution of SECR classes as indicated by proportions of landcover in each 1 km buffer in figure 4. There was a range of coverage of each pooled landcover class with lichen_barren being the dominant class within the study area (Fig. 4).

Baker Lake hunters harvest wolverines in and around the study area, so an additional distance from Baker Lake covariate was added to the analysis to test whether proximity to Baker Lake affected wolverine density. The main rationale for this covariate was that harvest pressure might reduce wolverine density and harvest pressure was assumed to be higher in areas that were closer to Baker Lake.

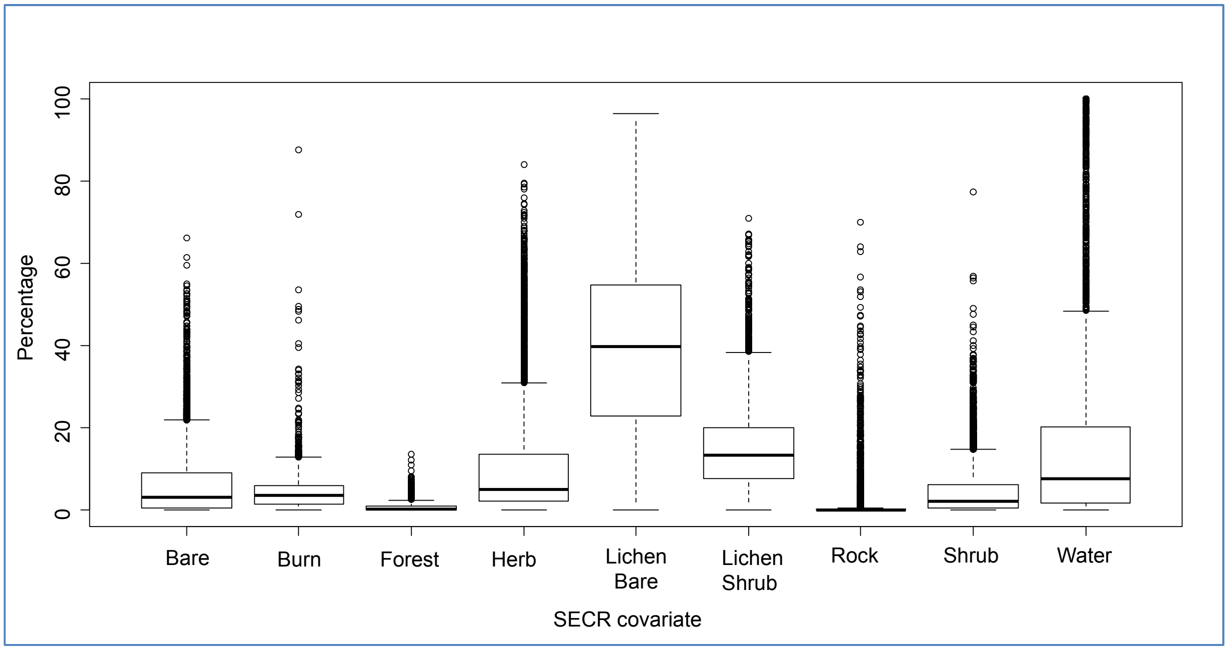


Figure 4. Distributions of the percentage of pooled landcover types in 1 km buffers around each SECR mask covariate. The bar in each box indicated the median proportion, box boundaries indicate the 25th and 75th percentiles. The limits indicate up to the 95th percentile. Points beyond the 95th percentile are indicated by individual points.

The SECR habitat covariates were added to the density term for each of the habitat classes. The support of these models was compared to a constant density model (which assumes homogenous density across the study area) to determine if any of the SECR habitat covariates was associated with wolverine density.

### 2.3.5 Pradel robust design open and closed model analysis

The Pradel model (Pradel 1996) robust design (Pollock and Otto 1983) in program MARK (White and Burnham 1999) was used to obtain estimates of local population size and trend from the mark-recapture data set. The Pradel model estimates apparent survival ($\phi$ - deaths and emigration), rates of addition (f - births and immigrants) and population rate of change ($\lambda$) from multiple year data sets. Population rate of change ($\lambda$) for the Pradel model is simply the population size in one year divided by the population size in the previous year. It is also equal to apparent survival ($\phi$) plus rates of addition (f) for a given year. The relative fit of models was evaluated using the Akaike Information Criterion (AIC) index of model fit. The model with the lowest AICc score was considered the most parsimonious, thus reducing estimate bias and optimizing precision (Burnham and Anderson 1998). In general, any models with a ΔAICc score of less than 2 are considered equal.

### 2.3.6 Simulation study of alternative grid sizes

One of the potential issues identified in 2013 was the low numbers of wolverines encountered in the grid area. This was likely due to the relatively small size of the study grid combined with lower densities of wolverines in the region. Such outcome likely reduced estimate precision and therefore our ability to monitor wolverine trends. One of the dominant questions was whether it would be possible to increase grid size to increase the population of wolverines susceptible to sampling while retaining sufficiently high capture probabilities. Grid size might be increased by increasing post spacing while reducing the number of posts sampled to therefore keep the amount of sampling effort at a feasible level.

To explore these options, a set of simulations was conducted using the 2013 data where grid size was increased by increasing post spacing from 4 km to 8 km while reducing the total number of posts. Simulations were then conducted to assess the relative bias and precision of density estimates. Simulations were conducted using the *secrdesign* (Efford 2015) package in the R statistical analysis program.

# 3.0 RESULTS

## 3.1 Summary of data

In 2013, 321 hair samples were successfully analyzed which belonged to 18 individual wolverines (8F:10M). In 2014, 207 hair samples were successfully analyzed, with 11 (3F:8M) individual wolverines identified, including eight identified during 2013 sampling. The number of new individuals detected was relatively similar for first two sessions in both years but detection of new individuals was lowest in the third session in 2014 (Table 2). The third session in 2014 only had 96 active posts, which may have reduced detections, however, inactivity of posts was accounted for in the SECR modelling process. The hair sample success rate dropped accordingly, from a weighted mean of 75% for 2013 to 70% for 2014. This drop was largely explained by the poor performance of 2014 third session samples, which had a 56% hair sample success rate, likely due to early thaw, which left flat posts on bare ground with fewer hairs. No individual from this study area matched to any individual from other Arctic datasets or study areas (D. Paetkau, WGI, unpubl. data).

In both years, about half of the wolverines (n = 12) were detected in more than one session. The number of detectors visited was quite high within each session suggesting that wolverines visited multiple posts within sessions.

Table 2. Summary statistics for 2013 and 2014 DNA mark-recapture sampling efforts at Aberdeen Lake, Nunavut.

| Statistic (Year) | Session | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Total |
| 2013 | | | | |
| Individual detected (session) | 9 | 8 | 15 | 32 |
| New individuals (session) | 9 | 2 | 7 | 18 |
| Cumulative detected (session) | 9 | 11 | 18 | 18 |
| Frequencies of detection (individual) | 9 | 4 | 5 | 18 |
| Detectors visited (session) | 56 | 64 | 97 | 217 |
| Detectors available (session) | 209 | 209 | 209 | 627 |
| 2014 | | | | |
| Individual detected (session) | 8 | 7 | 8 | 23 |
| New individuals (session) | 8 | 2 | 1 | 11 |
| Cumulative detected (session) | 8 | 10 | 11 | 11 |
| Frequencies of detection (individual) | 4 | 2 | 5 | 11 |
| Detectors visited (session) | 51 | 58 | 28 | 137 |
| Detectors available (session) | 208 | 208 | 96 | 512 |

On the DNA sampling grid, nine females and 12 males were detected in 2013 and 2014. The majority of wolverines were detected in 2013 with an additional one female and two male wolverines detected in 2014. Most wolverines were detected multiple times with some wolverines being detected at up to 58 different post X session combinations over the three sampling sessions in 2013 (Table 3).

Table 3. Summary of the number of unique detections (combinations of unique posts where a wolverine was detected for each sampling session) by year and sex of wolverine.

| Females | Detections (year) | | Males | Detections (year) | |
|---|---|---|---|---|---|
| Individual | 2013 | 2014 | Individual | 2013 | 2014 |
| 1-A08-B3 | 52 | 28 | 1-C06-A3 | 14 | 2 |
| 1-D12-A7 | 6 | 0 | 1-F01-A6 | 12 | 0 |
| 1-E09-A8 | 30 | 12 | 1-F07-D6 | 58 | 43 |
| 1-Y15-A5 | 2 | 0 | 1-G03-C6 | 0 | 3 |
| 2-E13-A7 | 0 | 1 | 1-G08-BO | 0 | 1 |
| 2-G09-GR | 12 | 0 | 1-I07-C5 | 1 | 0 |
| 2-K16-C2 | 2 | 0 | 2-G02-C4 | 29 | 23 |
| 3-L01-C3 | 1 | 0 | 3-A08-D4 | 2 | 2 |
| 3-Y03-B5 | 2 | 0 | 3-A13-D2 | 1 | 22 |
| | | | 3-B06-GR | 7 | 0 |
| | | | 3-K14-D5 | 2 | 7 |
| | | | 3-Y01-A4 | 1 | 0 |

Many of the wolverines traversed a substantial portion of the sampling grid, with both male and female wolverines traversing similar distances (Fig. 5). Eight individuals (2F: 6M) were detected on the grid in both years (Table 3), apparently these were resident wolverines, and nine individuals (4F: 5M) in both years were detected only in one session, likely transient wolverines or individuals whose home range overlapped only the periphery of the grid (Fig. 6). The wolverines detected on the periphery of the grid were seldom detected, likely because their home range centers occurred off the sampling grid. In 2014, approximately every third column of posts was sampled in session three. This most likely did not have a large effect on estimates given that most wolverines were detected across at least 3–4 rows or columns of posts. Program SECR accounted for this difference by only considering the active sites for session three in 2014.

In 2013, approximate mean distances moved per session for females and males were 11.1 km (±0.86, n = 99) and 13.9 km (±0.91, n = 117), respectively. In 2014, approximate mean distances moved for females and males were 9.9 km (±0.99, n = 38) and 14.3 km (±1.09, n = 95), respectively. Estimated distances should be interpreted cautiously for a few reasons. First, the actual order of wolverine detections at posts within a given session is unknown and therefore the actual distance between detections will be approximate or minimum. Second, distances between detections could potentially be influenced by behavioural response to posts. Wolverines may change their movements after initial detection due to attraction to posts ("trap happiness"). Both of these factors are accounted for by the fitting of spatially explicit models. The metric that best describes movement is the SECR scale parameter (σ) and the associated detection function, all of which are estimated and described later in this report.

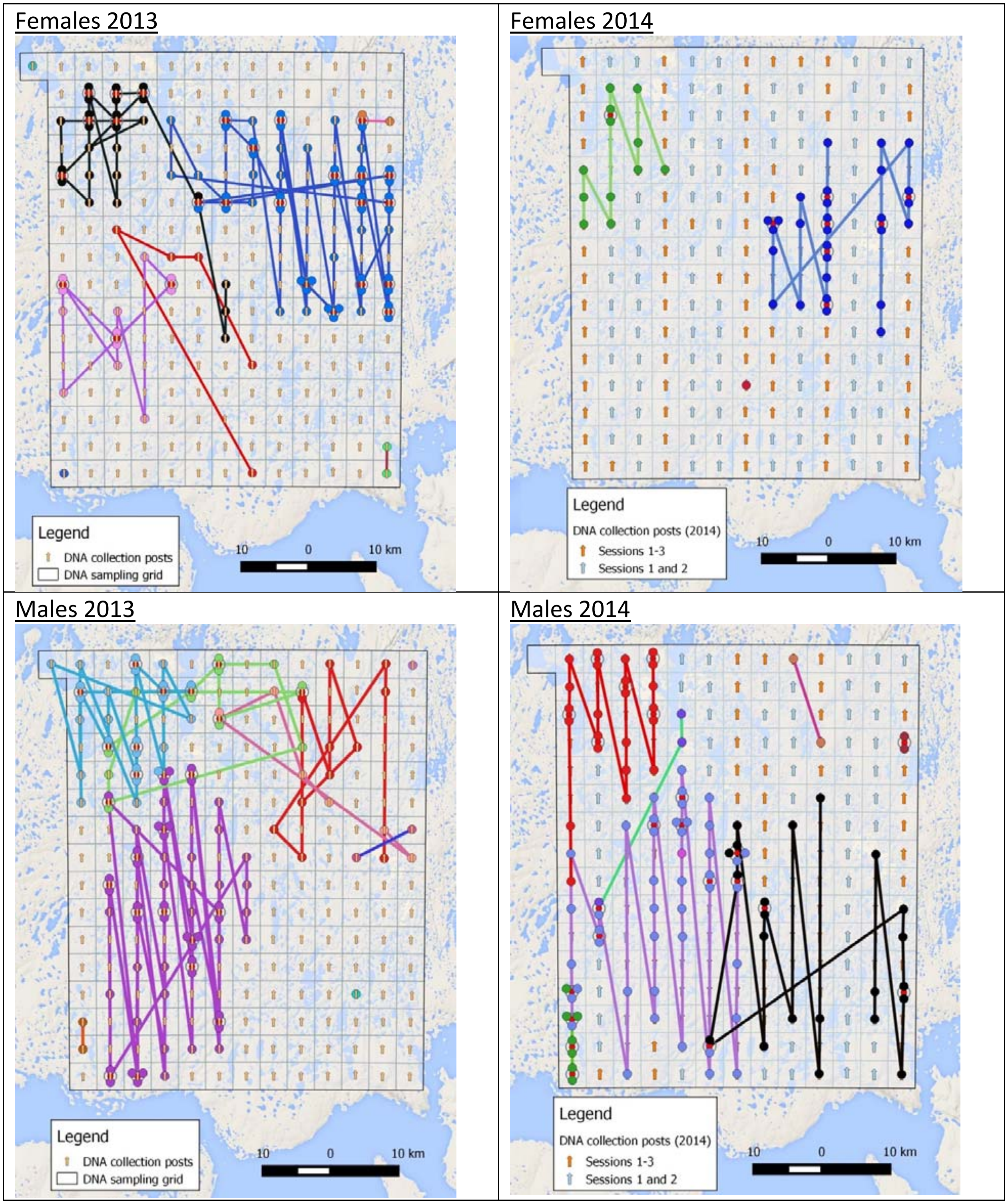


Figure 5. Detection location and approximate paths of wolverines using detections at unique posts across all sessions by sex and year. The paths for wolverines *are approximate* given that the order of detections within sessions is unknown. Multiple detections at single posts are staggered for easier interpretation. All posts were sampled for 3 sessions in 2013. Posts were sampled as noted in legend for 2014.

Plotting of mean detection location of wolverines by year (Fig. 6) suggests that despite the large areas traversed, wolverines displayed reasonable home range fidelity with relatively short distances between mean detection locations from each year. These mean detection locations do not necessarily indicate the home range center of wolverines given that they could only be sampled within the DNA grid.

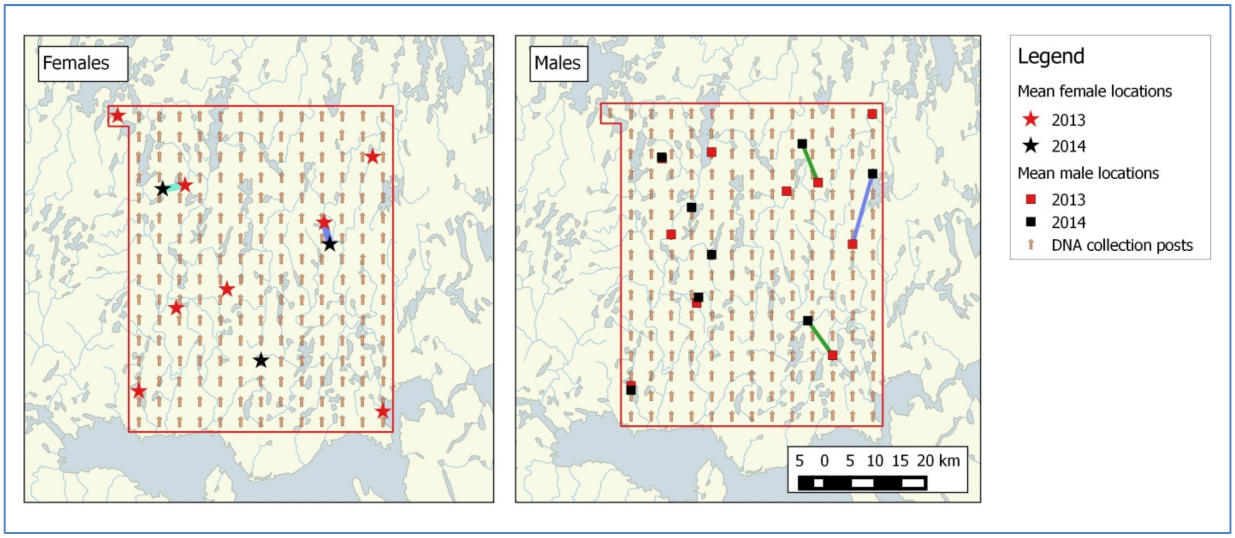


Figure 6. Mean detection locations of wolverines by sex and year. Multiple mean detection locations at the same post are staggered to facilitate interpretation. Mean locations of wolverines detected both years are connected by a colored line. In the case of males, all mean locations which overlap are from the same individual (detected in both 2013 and 2014).

## 3.2 SECR analysis

SECR model selection initially focused on determining the best model to describe sex and year-specific variation in detection probabilities and movements. The full combination of covariates was considered with only 4 models being more supported than a constant model (that assumed detection and scale of movement were similar for both sexes and years). Of the 4 models, a model that assumed constant detection across sexes and years but sex-specific scale of movement was most supported (Table 4, Model 1).

Table 4. SECR model selection for the Aberdeen Lake wolverine project. $AIC_c$ = sample size adjusted Akaike Information Criterion, $\Delta AIC_c$ = the difference in $AIC_c$ between the model and the most supported model, $AIC_c$ weight = $w_i$, K, the number of model parameters and log-likelihood (*LL*) are given. Baseline constant models are shaded for reference with covariate models.

| No | Detection ($g_0$) | Scale ($\sigma$) | $AIC_c$ | $\Delta AIC_c$ | $w_i$ | K | LL |
|---|---|---|---|---|---|---|---|
| 1 | constant | sex | 2472.2 | 0.00 | 0.63 | 4 | -1231.3 |
| 2 | year | sex | 2475.4 | 3.19 | 0.13 | 5 | -1231.4 |
| 3 | sex | sex | 2477.4 | 5.23 | 0.05 | 5 | -1232.4 |
| 4 | constant | year | 2477.5 | 5.33 | 0.04 | 4 | -1233.9 |
| 5 | constant | constant | 2477.7 | 5.52 | 0.04 | 3 | -1235.4 |
| 6 | session | constant | 2478.9 | 6.69 | 0.02 | 4 | -1234.6 |
| 7 | constant | sex*year | 2479.4 | 7.20 | 0.02 | 6 | -1231.8 |
| 8 | year | year | 2479.4 | 7.23 | 0.02 | 5 | -1233.4 |
| 9 | sex | year | 2480.1 | 7.96 | 0.01 | 5 | -1233.8 |
| 10 | sex | sex*year | 2480.2 | 7.98 | 0.01 | 7 | -1230.4 |
| 11 | year | sex*year | 2480.2 | 8.00 | 0.01 | 7 | -1230.4 |
| 12 | sex | constant | 2480.5 | 8.36 | 0.01 | 4 | -1235.4 |
| 13 | sex*year | sex | 2482.1 | 9.93 | 0.00 | 7 | -1231.4 |
| 14 | sex*year | constant | 2485.3 | 13.16 | 0.00 | 6 | -1234.8 |
| 15 | sex*year | sex*year | 2485.9 | 13.73 | 0.00 | 9 | -1229.2 |
| 16 | sex*year | year | 2486.9 | 14.68 | 0.00 | 7 | -1233.8 |

Additional analyses were conducted to explore potential behavioural response of wolverines to sampling using the baseline non-behavioural response models in Table 4. Results from previous studies (Boulanger and Mulders 2013ab) suggest that wolverines display a "trap happiness" response to sampling. This is the case here with the large number of repeated detections (Table 3). Behavioural response models considered individual responses to sampling in which a wolverine changed detection probability ($g_0$) or movement ($\sigma$) after initial detection for the duration of sampling (symbolized as b) or for just the session after detection (symbolized as B). In addition, site-level behavioural response models were considered in which the detection of a site changed after the session it detected a wolverine for the duration of sampling (symbolized as k) or for just a single session after it first detected a wolverine (symbolized as K). Finally, models that considered individual and trap specific detection were considered (symbolized as bk or Bk). In this case, trap response would be specific to individual wolverines that had been detected at that site rather than all wolverines.

Model selection suggested the importance of the scale of movement changes for individuals detected at specific sites (Table 5, model 1). Basically, this model suggests that wolverines will change (increase movement) for sites that they have previously visited. This response occurs for specific wolverine/site combinations rather than for all sites. For example, a site that had not detected a wolverine would not have an increase in movement relative to its location.

Table 5. SECR model selection for the Aberdeen Lake wolverine project for behavioural response models. $AIC_c$ = sample size adjusted Akaike Information Criterion, $\Delta AIC_c$ = the difference in $AIC_c$ between the model and the most supported model, $AIC_c$ weight = $w_i$, K, the number of model parameters and log-likelihood (*LL*) are given. Baseline non-behavioural models are shaded for reference with covariate models.

| No | Detection (g0) | Scale (σ) | AICc | ΔAICc | $w_i$ | K | LL |
|---|---|---|---|---|---|---|---|
| 1 | constant | sex+ animal/site (*bk*) | 2431.53 | 0.00 | 1.00 | 5 | -1209.5 |
| 2 | site(*k*) | sex | 2451.56 | 20.03 | 0.00 | 5 | -1219.5 |
| 3 | constant | sex+site(*k*) | 2452.29 | 20.76 | 0.00 | 5 | -1219.8 |
| 4 | site transient(*K*) | sex | 2460.41 | 28.89 | 0.00 | 5 | -1223.9 |
| 5 | animal/site (*bk*) | sex | 2460.83 | 29.30 | 0.00 | 5 | -1224.1 |
| 6 | constant | sex+site transient(*K*) | 2461.34 | 29.81 | 0.00 | 5 | -1224.4 |
| 7 | animal (*b*) | sex | 2468.52 | 37.00 | 0.00 | 5 | -1228.0 |
| 8 | animal transient(*B*) | sex | 2472.79 | 41.26 | 0.00 | 5 | -1230.1 |
| 9 | constant | sex | 2472.2 | 40.65 | 0.00 | 4 | -1231.3 |
| 10 | constant | sex+animal(*b*) | 2478.26 | 46.74 | 0.00 | 5 | -1232.8 |
| 11 | constant | sex+animal transient(*B*) | 2483.19 | 51.66 | 0.00 | 5 | -1235.3 |

Plots of detection functions for the behavioural response model (Table 5, model 1) indicates an increase in movements after initial encounter of posts by individual wolverines (Fig. 7). The actual change in overall movement would depend in this case on how many posts a wolverine had encountered given that post-specific encounters was modelled. The scale of the detection function relative to post spacing (approximately 4 km) suggests that the current post spacing is more than adequate to ensure detection of the majority wolverines on the sampling grid (as discussed later).

If a circular home range shape is assumed, it is possible to approximate home range size using estimates of σ based on initial detection. This home range size is equivalent to the 95% utilization distribution with home range radius (r) estimated as 2.45σ and home range area estimated as $\pi r^2$. Using this formula, estimates for home range size (based on Model 1 in Table 5) were 1,724 $km^2$ (CI=1,419-2,094) and 2,669 $km^2$ (CI=2,211-3,222) for females and males, respectively. Using these estimates, the home ranges of wolverines were relatively large compared to the overall size of the DNA sampling grid (3,344 $km^2$).

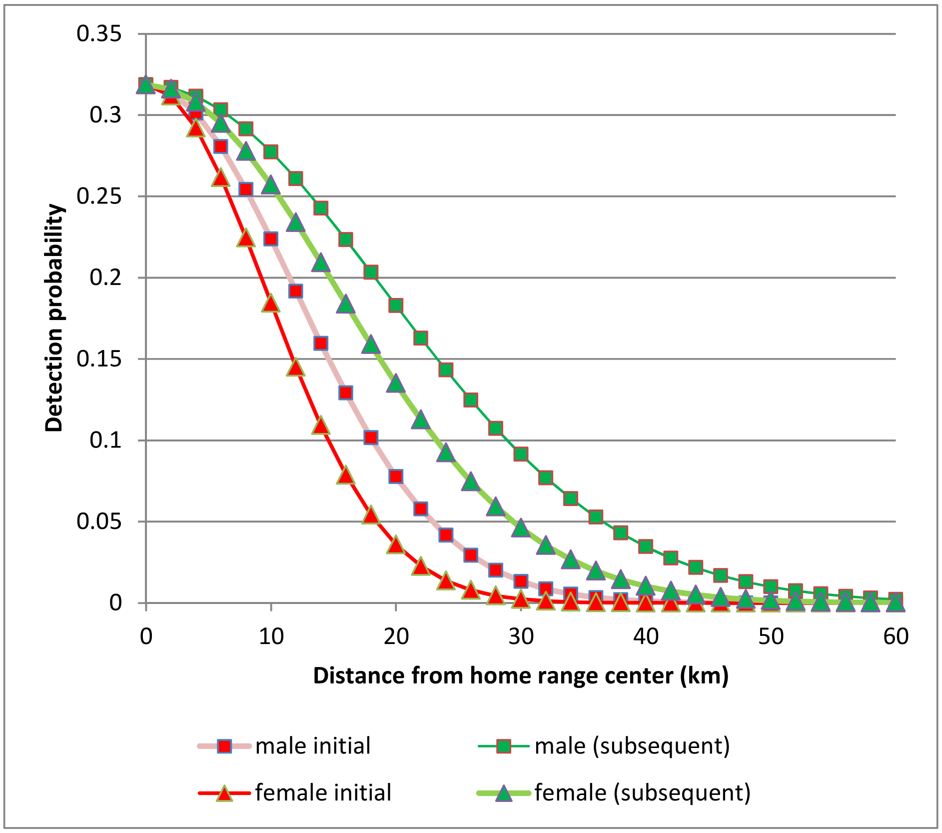


Figure 7. Detection functions for the most supported model for estimating wolverine densities in the sampling grid at Aberdeen Lake, Nunavut. This model assumes similar detection at the home range center but sex-specific scale of movement ( $\sigma$ ) as well as a post and animal specific behavioural response in $\sigma$ after the initial encounter of posts.

## 3.3 Estimates of population size and density

Estimates of the average number of wolverines on the sampling grid at a single capture time were derived from the most supported detection model for year and sex of wolverine (Table 5). In terms of SECR, the expected local population size for the DNA grid area is essentially an estimate of the number of home range centers occurring on the sampling grid (Efford and Fewster 2013). Estimates were 7.85 and 5.53 wolverines for 2013 and 2014, respectively (Table 6), which were less than the 18 and 11 individual wolverines detected on the grids in 2013 and 2014, respectively (Table 2). This suggests that many of the wolverines detected on the grid had home range centers off the grid, which is not surprising given the large home range sizes and the paths and locations of mean detection on the DNA grid (Figs. 5 and 6).

Interestingly, inclusion of the behavioural (bk) term on σ did not appreciably change estimates. For example, estimates based on a model without the bk term were 7.38 and 5.35 wolverines for 2013 and 2014, respectively.

Estimates were marginally precise for females but had acceptable precision for males and pooled sex estimates (as denoted by coefficients of variation of less than 20%). Density was obtained by dividing the average population size by grid area.

Table 6. Estimates of average population size (N) and density (wolverines per 1,000 $km^2$), average number of wolverines on the DNA grid, Aberdeen Lake, Nunavut, 2013-2014.

| Sex/year | Estimate | SE | Confidence Limit | | CV |
|---|---|---|---|---|---|
| Average N | | | | | |
| 2013 | | | | | |
| females | 4.51 | 0.99 | 2.95 | 6.89 | 21.9% |
| males | 3.34 | 0.53 | 2.46 | 4.55 | 15.8% |
| total | 7.85 | 1.12 | 6.97 | 11.10 | 14.3% |
| 2014 | | | | | |
| females | 3.36 | 0.93 | 1.97 | 5.73 | 27.8% |
| males | 2.17 | 0.23 | 1.76 | 2.67 | 10.7% |
| total | 5.53 | 0.96 | 6.97 | 11.10 | 17.4% |
| Density | | | | | |
| 2013 | | | | | |
| females | 1.35 | 0.30 | 0.89 | 2.07 | 21.9% |
| males | 1.00 | 0.16 | 0.74 | 1.37 | 15.8% |
| total | 2.36 | 0.34 | 2.09 | 3.33 | 14.3% |
| 2014 | | | | | |
| females | 1.01 | 0.28 | 0.59 | 1.72 | 27.8% |
| males | 0.65 | 0.07 | 0.53 | 0.80 | 10.7% |
| total | 1.66 | 0.29 | 2.09 | 3.33 | 17.4% |

The population size of wolverines on the grid and surrounding area that was vulnerable to sampling was calculated by estimating the "effective sampling area" of the grid with SECR methods (Table 7). For closed models, this area is termed the "superpopulation" and is less well defined (Efford and Fewster 2013). Estimates of wolverines were close to or slightly above the number of unique wolverines detected on the sampling grid for each year. This suggests sampling was highly effective in detecting all the wolverines on the grid as well as the immediate surrounding area.

Table 7. Estimates of wolverines in the grid and surrounding area (the effective sampling area of the grid) using closed models and SECR models (sexes pooled) for 2013 and 2014, Aberdeen Lake, Nunavut.

| Method | Estimate | SE | Confidence Limit | | CV |
|---|---|---|---|---|---|
| 2013 | | | | | |
| SECR | 21.20 | 2.07 | 17.50 | 25.70 | 9.8% |
| Closed N | 18.52 | 1.29 | 18.03 | 26.16 | 7.0% |
| 2014 | | | | | |
| SECR | 14.20 | 2.19 | 10.54 | 19.20 | 15.4% |
| Closed N | 11.00 | 0.62 | 11.00 | 11.23 | 5.6% |

## 3.4 Spatially explicit analysis of temporal trends and spatial variation in density

Spatial and temporal trends were investigated using SECR methods as well as the Pradel robust design method. SECR models were introduced into the analysis that considered temporal and spatial trends in the wolverine data set. Temporal trend models included year-specific and sex and year-specific variation in density. Of the models considered, a model with constant density was most supported (Table 8).

The most supported constant density model was then used as a base model for the spatial/density surface modelling analysis, which used the Northern Land Cover covariates (Table 1 and Figs. 3 and 4) to describe density variation on the sampling grid (Table 8). None of the density covariate models were more supported than the baseline constant density model. Distance from Baker Lake also was not supported as a distance covariate model.

Table 8. SECR model selection results for exploration of temporal and spatial trends in wolverine density in the sampling grid of Aberdeen Lake, Nunavut, 2013-2014. The most supported detection model (Table 4: g0(.) σ(sex+bk)) was used for all the density models. $AIC_c$ = sample size adjusted Akaike Information Criterion, $\Delta AIC_c$ = the difference in $AIC_c$ between the model and the most supported model, $AIC_c$ weight = $w_i$, K, the number of model parameters and log-likelihood (*LL*) are given.

| No | Density | AICc | ΔAICc | wi | K | LL |
|---|---|---|---|---|---|---|
| Temporal trends | | | | | | |
| 1 | constant | 2432.1 | 0.00 | 0.67 | 5 | -1209.7 |
| 2 | year | 2436.7 | 4.55 | 0.07 | 6 | -1210.4 |
| 3 | sex | 2451.1 | 18.99 | 0.00 | 6 | -1217.6 |
| 4 | sex*trend | 2457.9 | 25.78 | 0.00 | 8 | -1217.3 |
| 5 | sex*year | 2460.4 | 28.34 | 0.00 | 8 | -1218.6 |
| Spatial variation | | | | | | |
| 1 | shrub | 2434.4 | 2.32 | 0.21 | 6 | -1209.3 |
| 2 | bare | 2439.4 | 7.30 | 0.02 | 6 | -1211.8 |
| 3 | rock | 2439.5 | 7.40 | 0.02 | 6 | -1211.8 |
| 4 | forest | 2440.2 | 8.10 | 0.01 | 6 | -1212.2 |
| 5 | water | 2461.2 | 29.09 | 0.00 | 6 | -1222.7 |
| 6 | burn | 2462.2 | 30.09 | 0.00 | 6 | -1223.2 |
| 7 | dom. Habitat | 2470.1 | 38.03 | 0.00 | 12 | -1213.3 |
| 8 | lichen_shrub | 2474.1 | 42.01 | 0.00 | 6 | -1229.2 |
| 9 | herb | 2474.6 | 42.50 | 0.00 | 6 | -1229.4 |
| 10 | Sex*distance Baker Lake | 2475.4 | 43.26 | 0.00 | 8 | -1226.1 |
| 10 | lichen_bare | 2480.0 | 47.88 | 0.00 | 6 | -1232.1 |

## 3.5 Pradel model analysis of demography

Model building for the Pradel model first focused on testing of a baseline detection model. Our models allowed full variation in several parameters: capture and recapture rate variation (Table 9: model 8), year and sex variation in detection and redetection (model 7), year and sex variation in detection probabilities (model 6), sex specific variation in detection rate (model 5) and no variation in detection rate (model 4). The model with no variation in detection rate was most supported (model 4). Using this model, sex-specific variation in apparent survival and additions was explored. Of the models considered, a model with sex-specific variation in apparent survival but constant additions was most supported (model 1).

Table 9. Pradel model analysis of 2013 and 2014 Aberdeen wolverine mark-recapture data. $AIC_c$ = sample size adjusted Akaike Information Criterion, $\Delta AIC_c$ = the difference in $AIC_c$ between the model and the most supported model, $AIC_c$ weight = $w_i$, K, the number of model parameters and deviance are given. Baseline constant models are shaded for reference with covariate models. A (.) indicates the parameter was held constant. Otherwise, the covariate varied is indicated. Parameters are apparent survival (ϕ), rates of addition (f), capture probability (p) and recapture probability (c).

| No | Model | AICc | $\Delta AIC_c$ | wi | K | Deviance |
|---|---|---|---|---|---|---|
| 1 | Φ (sex) f(.) p(.) | 159.37 | 0.00 | 0.36 | 4 | 68.01 |
| 2 | Φ (.) f(.) p(.) | 159.39 | 0.02 | 0.36 | 3 | 70.36 |
| 3 | Φ (.) f(sex) p(.) | 161.58 | 2.22 | 0.12 | 4 | 70.23 |
| 4 | Φ (sex) f(sex) p(.) | 161.73 | 2.37 | 0.11 | 5 | 67.96 |
| 5 | Φ (sex) f(sex) p(sex) | 163.90 | 4.54 | 0.04 | 6 | 67.60 |
| 6 | Φ (sex) f(sex) p(sex*year) | 167.64 | 8.28 | 0.01 | 8 | 65.96 |
| 7 | Φ (sex) f(sex) p(sex*year) c(year*sex) | 171.24 | 11.87 | 0.00 | 11 | 60.55 |
| 8 | Φ (sex) f(sex) p(sex*year*t) c(year*sex) | 178.72 | 19.35 | 0.00 | 16 | 49.85 |

Model averaged estimates of apparent survival and additions were added to obtain estimates of overall change for males and females (Fig. 8), which further suggested a declining population. The primary drivers for this change was low apparent survival for both males and females. Low apparent survival could be due to high mortality or emigration from the study area (or both). In both cases estimates of overall change did not overlap suggesting that this decline was statistically significant.

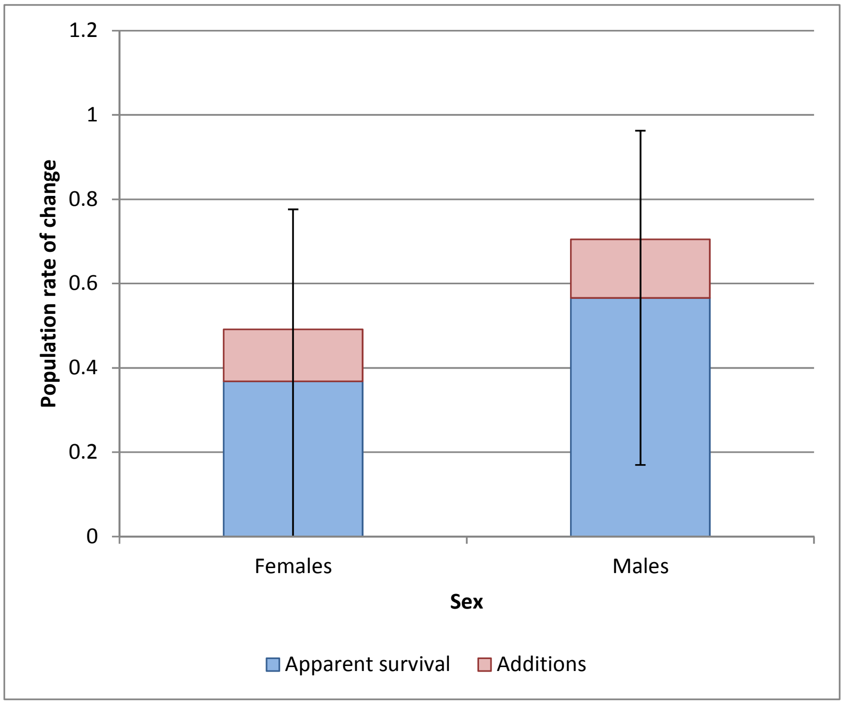


Figure 8. Model averaged estimates of apparent survival, rates of addition and population rate of change (apparent survival + rates of addition = population rate of change) for the 2013 and 2014 Aberdeen Lake wolverine study, Nunavut.

## 3.6 Simulation study of alternative grid sizes

Simulations in SECR design focused on single-year estimates of density, average population size, and population on the grid and surrounding area. The grid configuration was assumed to be expansions of the existing grid (4 km post spacing with 208 posts) by reducing the number of posts, while increasing post spacing up to 8 km (Fig. 9). The range of spacing of posts was based partially on rules of thumb for trap spacing for SECR studies based upon estimates of σ. In general, post spacing should be from 1.5σ to 2.5σ (Efford and Fewster 2013, Royle et al. 2014). Estimates of σ from this study were 9,563 m (CI = 8,676–10,054) and 11,900 m (CI = 10,831–13,074) for females and males, respectively, based on initial encounter of posts. In this case, conservative post spacing could be at least the value of σ for females (9.5 km). Given logistical constraints on field efforts, a post spacing of 5 to 8 km was considered for simulations.

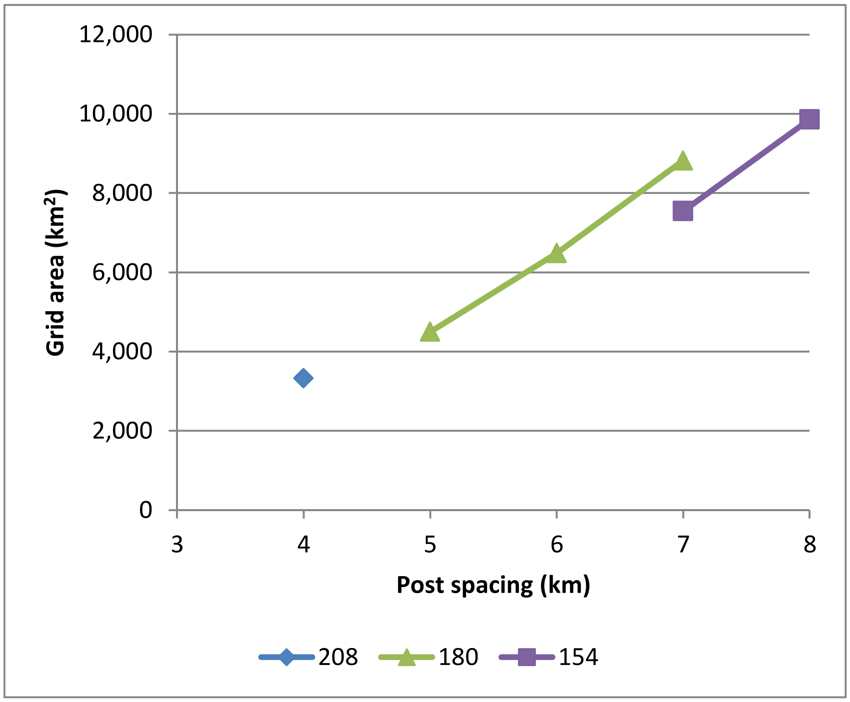


Figure 9. Grid areas (km$^2$) simulated as a function of the number of posts employed and post spacing. The existing study used 4 km post spacing with 209 posts.

Indicators of a successful design were a population size of wolverines on the grid and surrounding area of greater than 20 (based on 2014 densities) as well as an increase in relative precision compared to the present 4 km 209 post design. Using estimates of density and effective sampling area from 2014, estimates of the average number of wolverines on the grid and the grid and surrounding area were estimated. It can be seen that it would require at least a 6x6 km design with 180 posts to ensure that 20 wolverines were on the grid and surrounding area (Fig. 10).

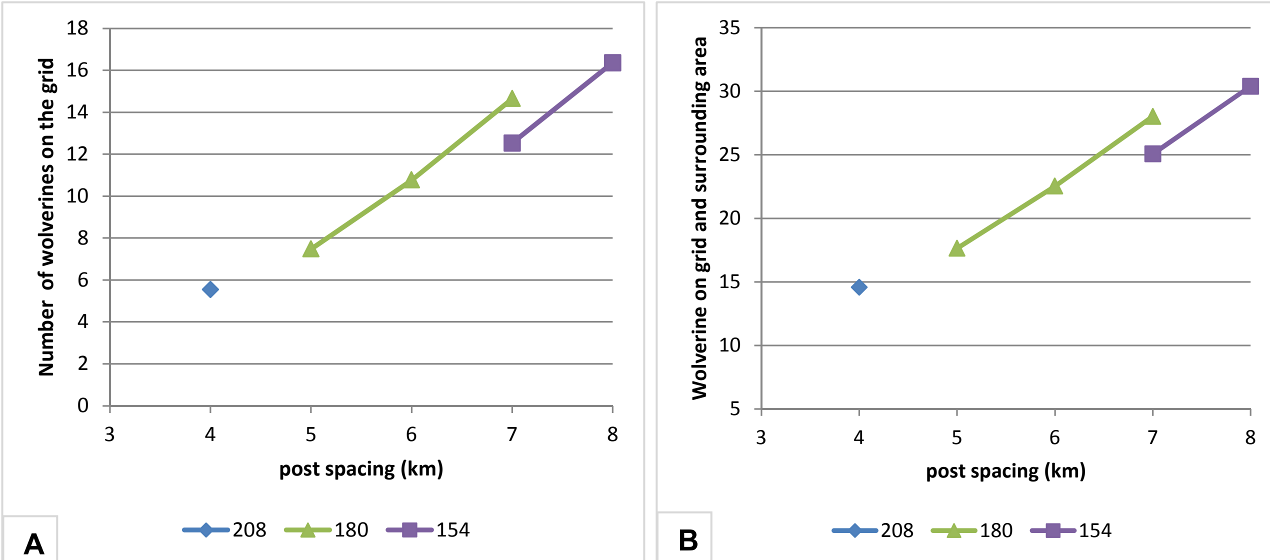


Figure 10. The estimated number of wolverines on the grid (A) and the number of wolverines on the grid and surrounding area (B) based upon estimates of density in 2014.

Results from the *secrdesign* simulations suggest that the precision of density estimates increased with grid size. This suggests that the main limiting factor for precision with this study is the number of wolverines likely to be sampled rather than the spacing of posts (Fig. 11). Increasing post spacing to increase grid size will increase estimate precision even if the number of posts sampled is reduced.

The actual estimates of precision pertain to a single year study and are therefore lower than from the current analysis that combined data from 2013 and 2014. For example, the estimate of coefficient of variation for the 2014 density estimates was 16.6% whereas simulated estimated precision was 32.0%. Therefore, simulation results should be interpreted in a relative manner. The main point of the simulations is that precision with larger post spacing increases relative to the present (4 km spacing) design.

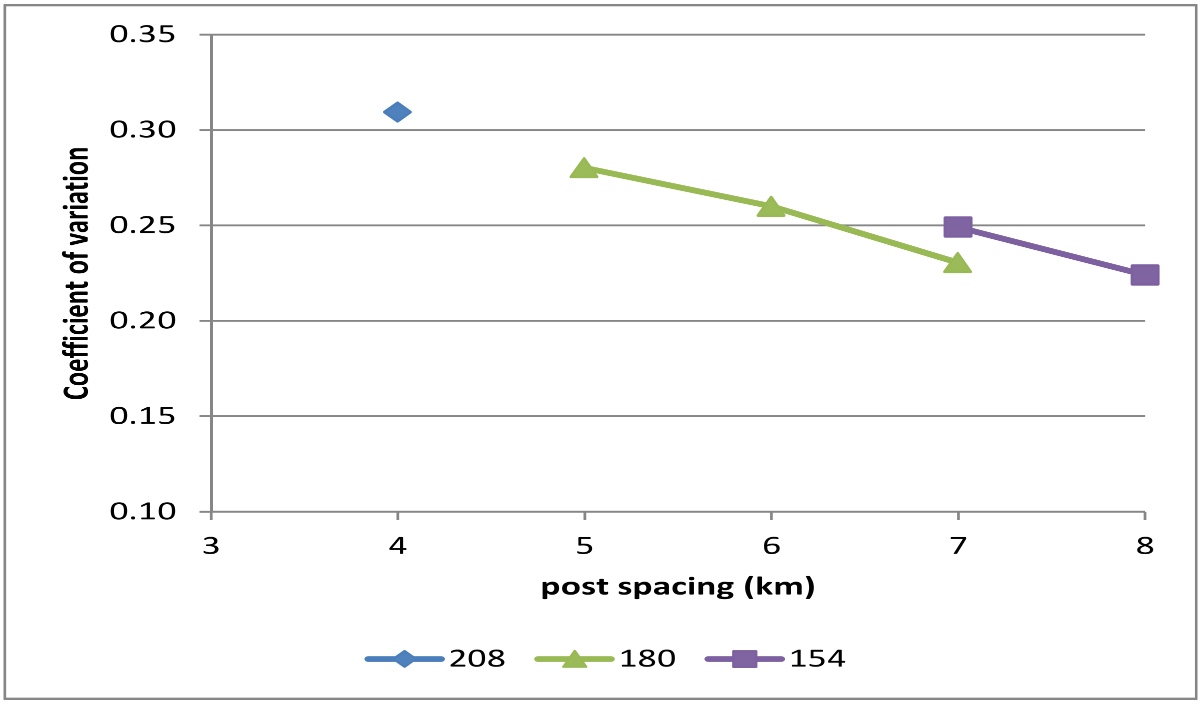


Figure 11. Estimated relative precision of density estimates from a single year study as a function of post spacing and the number of posts employed.

Camera data shows that wolverine visits to the bait post occurred on average 6 days (SD = 3, n = 49) after deployment. Based on the trigger cameras, while visiting the baited post wolverine spent on average 710 seconds (11.8 minutes) around the post (SD = 1125, n = 44). The wolverine visits to bait posts showed a clear pattern, with wolverines visiting posts often during night (42%, n = 48) or early morning hours (33%) with the least visits during the day (19%). Such nocturnal behaviour is also reported by Arnesen (2015) in Sweden, who observed significantly more visits during the night hours (68.9%) in comparison to day hours.

Ground-based survey is cost-effective way of study wolverines and it vigorously involved the local HTO and community. The land skills required for this type of field work were achieved by hiring five experienced hunters and HTO members (3 for the whole duration of the study and 2 as and when needed). They were very knowledgeable, actively participated in the field work and learned standardized wildlife survey techniques (sampling protocol, hair collection and data recording) and could potentially run this program in future years with minimal supervision and technical help. These trained HTO members are able to work as wildlife monitors at exploration/mining camps or participate in wildlife monitoring surveys. This seasonal employment to local hunters helps combat the high cost of living in the north and expensive maintenance of their hunting equipment to carry out subsistence harvesting activities. The study generated about 400 person-days of employment to local hunters and elders, the project helped to build a monitoring capacity in the HTO, and the baseline information collected within the socio-cultural framework will be used for future monitoring and for wolverine management. HTO board members reviewed and discussed the proposal and field methods in detail, provided guidance and obtained more awareness about the species status at the national and international level. The involvement of hunters and HTO in the study enhanced their interaction with the government and may be a mechanism to increase local involvement in wildlife management. The government staff learned land skills and more about how HTO/community members want to be involved in scientific studies and conservation in Nunavut. While working on the project, as hunters with immense experience, they act as stewards of the land on a daily basis and provided guidance to government staff and safely accomplished the field work. Some logistical and social gaps were identified during the field work that will be shared with other department researchers and will be addressed in future studies.

# 4.0 DISCUSSION

This study produced the first density estimates of wolverine in the Kivalliq region, Nunavut using a robust survey sample design and logistics facilitated by local hunters. Our average density estimate of 2.36/1,000 km$^2$ was low compared to other known values reported throughout the central Arctic. Despite low sample sizes, the precision of estimates from the combined 2013 and 2014 data sets were acceptable for the combined sex estimates (Table 6), most likely due to the large number of detections and redetection of wolverines. The estimated average number of wolverines on the grid was lower than the total of detections. This indicates that all resident wolverines were probably detected in DNA sampling, and also suggests that the grid is capturing wolverines using an area beyond the grid boundaries (as far as 30 km). The scale of movement by wolverines (based on repeated detections on the grid [Fig. 5] and the detection functions; [Fig. 7]) is relatively large compared to overall grid size.

The detection of site and wolverine-specific response in analyses is biologically intuitive. These models assume that a wolverine will change its scale of movement at a post that it has been detected at previously. This type of behavioural response model is much more exact in that it considers post and wolverine combinations based on previous encounter.

Within the 3,344 km$^2$ grid area, 2 females and 6 males were present on the grid for both years (Table 3) and this generated a density of 2.3 resident wolverines per 1000 km$^2$. Most of the individuals (n=9) were detected in one session only. It is likely that these were transient animals and this is consistent with COSEWIC (2014) that a sizeable proportion of the wolverine populations, normally sub-adults, are transient at any given time. This is also evident from the Baker Lake reported wolverine harvest (2010-2012) with high proportion of sub-adults (67%) and males (73%) in the harvest (M. Awan, DOE, unpubl. data). In 2015, Awan and Boulanger (in prep.) used the same methodology with 5x5 km cells and estimated 4.32 wolverines per 1000 km$^2$ in a study about 300 km south of the Aberdeen Lake study area. In the West Kitikmeot, higher densities were estimated (6.85/1,000 km$^2$ at High Lake in 2008 and 4.80/1,000 km$^2$ at

Izok Lake in 2012) by Poole unpubl. data (2013). However, both of these study areas were in the central Arctic characterized by generally higher productivity, and with no or occasional limited wolverine harvest. Krebs et al. (2004) reported substantially higher survival rates in non-harvested populations than harvested populations and significant differences in survival among habitats. Further, Gervasi et al. (2015) described that population properties, such as density or survival rates, often vary due to uneven spatial distribution of resources and mortality risks. Like grizzly bears, it has been generally assumed that wolverine densities are higher in the West Kitikmeot and lower to the north and east, and that population density is driven by productivity and seasonality (McLoughlin 2001). Inman et al. (2012) described that wolverine density estimates can vary among latitude and habitat type and comparison of wolverine density among studies must be made with caution because estimates may vary with study design and season. In North America, wolverine densities vary across ecological areas and habitat quality, to a maximum of about 5-10 wolverines/1,000 $km^2$ (COSEWIC 2014; Species at Risk Committee 2014). However, we expected wolverine density in the Aberdeen Lake area to be lower compared to central and western Arctic tundra habitat (western Kitikmeot and NWT) and taiga and mountain areas because of lower productivity on the eastern tundra (McLoughlin 2001; Rescan 2014).

Both SECR (Table 6) and Pradel model (Fig. 8) analyses resulted in lower estimates of abundance and density for 2014 compared to 2013. Consequently, the number of wolverines on the grid at any given time also declined between years as well as the superpopulation of wolverines on the grid and surrounding area. The difference between the two year estimates has a number of possible explanations. The Pradel model results suggest that low apparent survival rates are potentially driving the decline of wolverines in the area. In general, wolverines that were detected in both years (n = 8) showed reasonable fidelity to mean capture areas (Fig. 6) so we speculate that lower apparent survival is due to either low true survival or emigration of younger and breeding female wolverines to other areas. Like other mammals, high male-biased dispersal (Pusey 1987) and intersexual home range overlap is reported in wolverine populations (Vangen et al. 2001; Dalerum et al. 2007; Bischof et al.

2016). Others have reported long dispersal movements in yearlings from their natal area (due to competition of resources) before reaching sexual maturity (Copeland 1996; Mulders 2000; Vangen et al. 2001; Inman et al. 2012) and migration of wolverines from the areas with lower mortality to those with higher mortality (Gervasi et al. 2015, 2016). The average annual reported wolverine harvest for Baker Lake from 2010-2012 was 14 (range 11-18). It is likely that the Aberdeen Lake population is part of a source and sink dynamic, with emigration from the northwestern portion of the grid and adjacent areas replenish harvested animals closer to Baker Lake community. So this low apparent survival may likely be due, in part, to dispersing transient wolverines that spend only a portion of time on the grid, as also described by Mulders et al. (2007) in the central Arctic.

Various studies describe wolverine selection of deep snow for reproduction and den sites in rocky scree slopes, along eskers, within hard packed snowdrifts or under snow-covered boulders (Lee and Niptanatiak 1993; Magoun and Copeland 1998; Landa et al. 1998) and suggest that denning females were restricted to the areas having dense snow cover (≥1 m), distributed uniformly or accumulated in drifted areas, during the February to May denning period (Magoun and Copeland 1998; Copeland et al. 2010). McKelvey et al. (2011) hypothesized that snow depth may have a greater influence on wolverine denning than spring snow cover; thus, it is likely that less snow in the area in 2014 (Fig. 2) likely reduced the availability of reproductive den sites and altered the wolverine distribution in the area. This interpretation is supported by the detection of only three females in 2014 compared to eight females in 2013. Wolverine spatial patterns and variation with season and year on tundra is poorly understood, but denning philopatry has been reported in tundra breeding females (Lee and Niptanatiak 1996).

Observed decline and or inter-annual variability in abundance should be interpreted with caution. Indeed, the lower number of wolverine recorded in the 2014 (specifically in the third session) may be caused by the low snow quantity in the hilly areas (likely area of high density), which reduced sampling effort and detection, or emigration.

Moreover, due to less snow and early melting, 65% bait posts were lying down and with fewer hairs rather than large clumps of hairs trapped in barbwire, which caused a reduced DNA extraction rate for the third session (56%) due to insufficient DNA material for extraction.

Prey availability between years may contribute to changes in wolverine numbers, because the ungulate literature suggests that snow depth influences spatial and temporal distribution and use of habitat (Maher et al. 2012; Richard et al. 2014; Tablado et al. 2014), which affects distribution of predators (Hojnowski et al. 2012; Carricondo-Sanchez et al. 2016). The reasons for the apparent population decline/change from 2013 to 2014 are unclear, plausible explanations are weak and we have only one comparison (2013to 2014). This requires additional investigation to determine whether less snowfall and lower sampling coverage in 2014 may have contributed to this apparent decrease. While sampling effort was reduced, sampling was still reasonably systemic in 2014 with every third row being sampled in session three. However, if wolverine shifted their movements to areas that were not sampled by posts then it is possible that estimates were reduced due to shift in distribution of wolverines relative to posts on the sampling grid. This baseline result is a snapshot of wolverine status in early spring over two years. The apparent annual variation in density estimates highlights the need for continued monitoring to better determine spatial and temporal drivers of local abundance and how wild populations change over time (Harris et al. 2005; Mulders et al. 2007). Three study areas in the central Arctic in the NWT exhibited a decline in wolverine density of 35% to 61% between 2004–2005 and 2011 (COSEWIC 2014). Boulanger and Mulders (2013ab) believe that these declines were concurrent with declines in the Bathurst caribou herd and not related to mining activities.

Given the low wolverine density in the sampling grid area, the main challenge to future survey efforts will be detecting sufficient wolverines to allow estimates of trends. Previous simulation studies suggest that at least 20 (preferably 50) wolverines are needed on a sampling grid for adequate power to detect trends (Boulanger and

Mulders 2013b). The current 4 km post spacing oversamples the population as indicated by the large number of recaptures of resident wolverines.

Other studies in the Arctic tundra utilized 3x3 km (Mulders et al. 2007), or 5x5 km cell size (Boulanger 2012; Dumond et al. 2012). Considering the low density in the Kivalliq region and logistics this study used 4x4 km grid cell to examine whether sample size of wolverines on the grid, grid cell size spacing and other study design features were adequate to monitor wolverine trend in the region. Simulations of sampling designs (post spacing, grid size) suggest that increasing post spacing up to 7x7 km while reducing the number of posts sampled can increase sample size and estimate precision. Studies in West Kitikmeot have obtained precise estimates of wolverine population size with 5 km post spacing (Boulanger 2012). Increasing post spacing and overall grid size increases the distance between posts and therefore the overall amount of field effort. The main way to reduce field time would be to reduce the number of overall posts (from 208 to 154) concurrent with expanding cell size.

A future goal of this DNA sampling effort is to describe wolverine density across the contiguous portion of the Kivalliq region. In order to achieve this goal sampling should be spread widely across the region. From this study we obtained a precise wolverine density estimate for the grid area which may not be an adequate representation of wolverine densities in other parts of the region. To generate a second estimate of population size within the broader region a DNA grid around Henik Lake, about 300 km south of the Aberdeen Lake study area, was sampled in 2015-16, which estimated a higher density of wolverines (Awan and Boulanger in prep). For Kivalliq regional population estimates we will use combined data from these 2 study grids similar to the sub-grids approach proposed for the Kivalliq grizzly bear study (Boulanger et al. 2013). This type of simulation could be considered with discussion of likely sub-grid areas and overall field logistical constraints. The main advantage of the sub-grid approach is that it could contribute to an estimate of the overall regional population of wolverines rather than an estimate of wolverines on a single sampling grid.

The density surface modelling exercise did not detect associations of wolverine density with Northern Land Cover covariates or distance from Baker Lake. We suspect this was caused by the lack of resolution in the Northern Land Cover classification as well as the relatively small scale of the sampling grid. The large scale of movement of wolverines and subsequent larger scale of habitat selection may also be at play. Johnson et al. (2005) used wolverine locations from a radio telemetry study by Mulders (2000) in the Southern Arctic ecozone on the central barrens in the NWT. This work indicated a strong relationship between wolverine occurrence and sedge habitat, while wolverines were avoiding areas dominated by heath rock, heath tundra, and lichen veneer. We suspect that selection and distributions of densities of wolverines occur on a relatively large scale compared to the grid area. Non-invasive DNA sampling and SERC analyses have detected associations between barren-ground grizzly bear and habitat in the Tuktuyaktuk-Inuvik regions of the NWT (Boulanger et al. 2014) as well as with other wildlife species (Royle et al. 2013; Efford 2014a).

In summary, results from this study contribute to baseline data for wolverine ecology in the Arctic tundra and will be used to generate regional population estimates for future monitoring. This allows us to evaluate current harvest in the territory and will provide a quantitative basis to establish future sustainable harvest limits. A database containing “DNA fingerprints” of individual wolverine has been established which will be used for population delineation. This study data set will be used to further refine and optimize DNA sampling methods for future wolverine studies on the tundra. Wolverines in the region exist at low densities and are being exposed to increasing levels of human activity, with existing or proposed mining activity (Meadowbank Gold Mine, Areva). Wolverine is a culturally and economically important furbearer for Inuit. Like other wildlife species, the local wolverine harvest pattern shows that the bulk of wolverine harvest occurs northwest of Baker Lake (Awan and Szor 2014) and harvest of wildlife increased along the Meadowbank mine all weather access road (Agnico Eagle Mines 2014). We suggest genotyping of wolverine harvest samples from Baker Lake to include mortality data for future demographic analysis. There is currently no wolverine monitoring program executed at the Meadowbank mine, so potential effects of the mine and the all weather road are unknown. Based on the low density of wolverines in the area, we recommend multiple years DNA sampling to accurately determine population trend by involving the mine through NIRB and the Baker Lake HTO.

## 5.0 FIELD TEAM

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## 8.0 **APPENDIX 1:** Wolverine hair snagging posts.

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information**: **X** **Decision**:

**Issue:** The effect of predation on the calving grounds of the Qamanirjuaq and Beverly Barren-ground caribou herds.

## Background:

- Evidence from traditional and scientific sources indicates that caribou herds cycle naturally, periodically increasing and decreasing at relatively regular intervals.

- Two main factors influencing reproductive output and survival in ungulates are nutrition and predation. Calf mortality is identified as an important factor in the population dynamics of some caribou herds on barren lands.

- Predation is recognized as a vital ecological regulatory mechanism for prey populations. It is believed that predators are essential to maintain healthy prey populations by removing weak and sick individuals from the population.

- The Department of Environment (DOE) investigated the extent of predation within the calving areas of Qamanirjuaq (2010 and 2012) and Beverly (2011 and 2013) herds. This initiative was undertaken in response to: (1) widespread population declines of Barren-ground caribou herds across the Canadian North and (2) local hunter reports of increasing barren-ground grizzly bear and wolf populations, and concerns regarding the extent to which predators may be reducing caribou numbers.

- Cause of death among new-born caribou calves was investigated by searching randomly selected transects for dead calves using helicopter. Transects were selected over calving areas with high and medium densities of breeding females.

- Within the Qamanirjuaq herd core calving area, sixty-one dead new-born caribou calves were found and necropsied between the 11$^{th}$ and 14$^{th}$ of June 2010 and the 11$^{th}$ and 17$^{th}$ of June 2012. Sixty-nine dead new-born caribou calves were found and necropsied within the Beverly herd core calving area between the 13$^{th}$ and 17$^{th}$ of June 2011 and the 12$^{th}$ and 15$^{th}$ of June 2013. Calves with a combination of predation signs such as puncture marks through skin and tissues, blood around wounds, subcutaneous hemorrhage, crushed skull and/or lacerations on back or rump, were assumed to have died of predation.

## Current Status

- Predation was determined to be the cause of death for only 9.0% (2 out of 21) of calves with a known cause of death in the Qamanirjuaq herd in 2010 and 32% (13 out of 40) in 2012. This indicated that predation related calf mortality appeared relatively low in the Qamanirjuaq herd over both years' survey period.

- Non-predation mortalities were the most important cause of death in both years in the Qamanirjuaq calving area (Table 1). The majority of calf mortalities showed signs of either stillbirth or early neonatal abandonment.

- Predation was determined to be the cause of death for 52.0% (26 out of 50) of calves with a known cause of death in the Beverly herd in 2011 and 58% (11 out of 19) in 2013.

- Our necropsy results showed that a large proportion 67% (12 out of 18) of the calves killed by wolves on the Beverly calving grounds were weaker and would have died anyway (e.g., sick, lame, starving, birth defects). The "additional mortality" exclusively due to wolf predation represents only a small proportion of the total estimate of mortality attributed to predators.

- The total calf mortality in first week of life appears relatively low in both subpopulations with a two-year average of approximately 2.0% and 6.0% in the Qamanirjuaq and Beverly subpopulations respectively (Fig 1).

- Extensive wolf harvest has been occurring along the migratory route of the Qamanirjuaq caribou herd. Several Inuit communities (Arviat, Whale Cove, and Rankin Inlet) have close access to the Qamanirjuaq caribou spring migration corridor and as a result, harvest high numbers of wolves most springs. In comparison, the Beverly calving area is located much farther from Inuit communities and the harvest of wolves along their migration route is therefore much lower.

## Recommendation

- Our results suggest that a certain portion of the mortality attributed to wolf predation could be considered "compensatory mortality" (killing the sick and weak or otherwise inferior calves) since some of those calves were most likely to die due to disease. The mortality on healthy caribou calves is therefore lower than the percentage of total calf mortality due to wolves presented above/in Table 1.

- Predation related calf mortality appeared relatively low on the calving grounds

- The current declines in the Qamanirjuaq and Beverly caribou herds are likely attributed to nutritional stress due to range depletion/disturbance, including winter range. A Predator control program will likely have little effect on caribou population growth due to the fact that wolf related calf mortality is relatively low at the calving grounds.

Table 1: Percent frequency of occurrence of causes of death in newborn calves (≤ 7 days old) found in the core area of the Qamanirjuaq and Beverly caribou herd calving grounds, in June 2010 - 13 (unknown mortality causes excluded).

| **Cause of death** | **Beverly herd** | | | **Qamanirjuaq herd** | | |
|---|---|---|---|---|---|---|
| | 2011 (n=50) | 2013 (n=19) | **Total (n=69)** | 2010 (n=21) | 2012 (n=40) | **Total (n=61)** |
| **Non-predation death**[†] | 48.0% | 42.0% | **46.0%** | 91.0% | 68.0% | **75.0%** |
| **Predation death** | 52.0% | 58.0% | **54%** | 9.0% | 32.0% | **25.0%** |
| *Wolf predation* | *40.0%* | *53.0%* | ***44.0%*** | *0.0%* | *10.0%* | ***7.0%*** |
| *Grizzly bear predation* | *2.0%* | *0.0%* | ***1.0%*** | *0.0%* | *0.0%* | ***0.0%*** |
| *Eagle predation* | *0.0%* | *0.0%* | ***0.0%*** | *0.0%* | *5.0%* | ***3.0%*** |
| *Predator unknown* | *10.0%* | *5.0%* | ***9.0%*** | *9.0%* | *17.0%* | ***15.0%*** |

*†Includes atelectases, pathophysiological disorders, separation, malnutrition and pneumonia.*

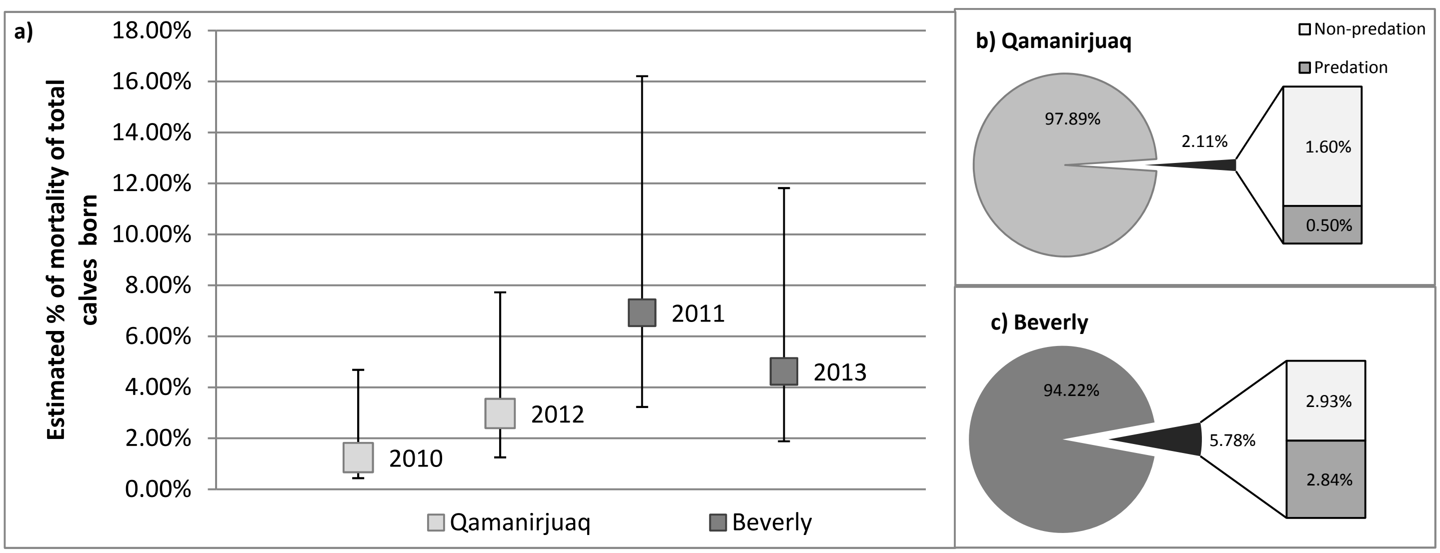


Fig 1: Summary of estimated calf mortality on core area of calving grounds of Beverly and Qamanirjuaq caribou herds during their first week of life. a) Estimated annual calf mortality with 95% confidence interval; b) Two-year average calf mortality (black pie slice) and relative proportion of non-predation vs predation mortalities in Qamanirjuaq caribou subpopulation. c) Two-year average calf mortality (black pie slice) and relative proportion of non-predation vs predation mortalities in Beverly caribou herd.

# The effect of predation on the Qamanirjuaq and Beverly subpopulations of Barren-Ground Caribou ( *Rangifer tarandus groenlandicus*)

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**Summary**

Recent surveys of barren-ground caribou herds across the Canadian North have indicated wide spread population declines. Several hunters from communities on and/or adjacent to caribou range believe barren-ground grizzly bear and wolf populations are increasing, and are concerned about the extent to which predators may be reducing caribou numbers.

To understand the predator-prey interactions, our main objective was to investigate extent and causes of neonatal mortality among caribou calves. Cause of death among new-born caribou calves was investigated within the calving areas of Qamanirjuaq (2010 and 2012) and Beverly (2011 and 2013) subpopulations by searching randomly selected transects for dead calves using helicopter. Transects were selected over calving areas with high and medium densities of breeding females. Calves with a combination of signs such as puncture marks through skin and tissues, blood around wounds, subcutaneous hemorrhage, crushed skull and/or lacerations on back or rump, were assumed to have died of predation.

Within the Qamanirjuaq subpopulation core calving area, sixty-one dead new-born caribou calves were found and necropsied between the 11th and 14th of June 2010 and the 11th and 17th of June 2012. Predation was determined to be the cause of death for only 9.0% (2 out of 21) of calves with a known cause of death in the Qamanirjuaq herd in 2010 and 32% (13 out of 40) in 2012.

Sixty-nine dead new-born caribou calves were found and necropsied within the Beverly subpopulation core calving area between the 13th and 17th of June 2011 and the 12th and 15th of June 2013. Predation was determined to be the cause of death for 52.0% (26 out of 50) of calves with a known cause of death in the Beverly herd in 2011 and 58% (11 out of 19) in 2013.

Predation related calf mortality appeared relatively low in the Qamanirjuaq herd over both years survey period. While a large proportion (67%, 12/18) of the calves predated by wolves on the Beverly calving grounds were already predisposed to death due to physiological or pathological disorders and were probably already weakened by their physiological condition. Our results suggest that certain portion of the mortality attributed to wolf predation could be considered “compensatory mortality” since some of those calves were already predisposed to death. The “additional” mortality on healthy caribou calves solely due to wolf predation is therefore probably lower than the percentages presented above.

Key words: Barren-ground caribou, *Rangifer tarandus groenlandicus*, calving ground, grizzly bear, mortality, predator, Qamanirjuaq herd, Beverly herd, Nunavut, wolf.

## Table of Contents

# 1.0 Introduction

A growing body of evidence from traditional and scientific sources indicates that caribou herd periodically increase and decrease at relatively regular intervals. Two main factors influencing reproductive output and survival in ungulates are nutrition (Skogland 1986; Gunn 1992) and predation (Miller and Broughton 1970; Parker 1972; Miller et al. 1985; Miller et al. 1988; Adams et al. 1995; Young and McCabe 1997; McLoughlin 2001). The relative role of these two factors is spatially and temporally regulated by stochastic environmental conditions (Gunn 1992; Post and Stenseth 1999) and local abundance of predators. In Nunavut, barren-ground caribou (*Rangifer tarandus groenlandicus*) are preyed upon by a suite of predators, including barren ground grizzly bears (*Ursus arctos*) and wolves (*Canis lupus*).

*Qamanirjuaq caribou subpopulation*

The mainland migratory barren-ground caribou of the Kivalliq, referred to as the Qamanirjuaq Caribou subpopulation (QCS) represent one of the largest caribou herds in Nunavut occupying an estimated 300,000 km$^2$ range. The estimated annual value to all aboriginal communities utilizing Qamanirjuaq caribou for subsistence is $21 million (BQCMB financial report, 2008). Aerial and photographic surveys to estimate the number of breeding females have been conducted on the Qamanirjuaq subpopulation annual concentrated calving area (ACCA) since the 1970s. The estimates are then extrapolated to estimate subpopulation size. The QCS has shown an increase from 44,000 animals in 1977 to 260,000 ± 60,000 in 1987, highest number of animals (496,000 ± 105,400) being estimated was in 1994 (Heard 1981; Gates 1983; Russell 1990; Thomas 1996). Spring classifications of cow: calf ratios have indicated that recruitment to the population is declining since the mid-1990s (Fig 1). Campbell (2008) described a decline in cow: calf ratios from 60:100 in 1992 to 47:100 in 1996 to 30:100 in 1999, 26:100 in May 2003 and finally 16:100 in 2006. This recent decline in recruitment is of great concern to wildlife managers because recruitment replaces the loss of adults from predators, harvest and other factors and an imbalance between recruitment and mortality leads to decreases in population size. Efforts to evaluate the status of the range and the condition of the herd were undertaken in recent years (Campbell 2008).

Predation, on the other hand, has received limited attention (Miller and Broughton 1974) so far in Nunavut

*Beverly caribou subpopulation*

In 1994, a photographic survey of the Beverly caribou subpopulation (BCS) within its southern Beverly to Garry Lakes (BGLS) annual concentrated calving area (ACCA) estimated 120,000 ± 43,100 (SE) breeding females from which a total subpopulation estimate of 276,000 ± 106,600 (SE) adults and yearling caribou was extrapolated based upon fall composition study results. From 1994 to 2002, little research and monitoring of the Beverly subpopulation occurred. In response to concerns from communities and government representatives over the paucity of information on the status of the Beverly subpopulation during that period, the Northwest Territories (NWT) Government coordinated a reconnaissance survey of the BCS within its BGLS annual concentrated calving area in June 2002. The reconnaissance survey made a number of findings: 1) the calving area was the smallest recorded since 1979 and approximately 500 km$^2$ smaller than observed in June 1994; 2) the relative densities of adult caribou on the calving ground were lower than most other survey years up to and including the 1994 survey year with the exception of the 1987 and 1988 survey years (Johnson and Mulders, 2002). The NWT Government observed even fewer animals during reconnaissance surveys flown over the same study area in June 2007, 2008, 2009 and 2010 (90 - 100 caribou observed on transect in June 2010; relative density of 0.20 caribou/km2) (unpublished GNWT data). At the time, these findings suggested a severe decline in the Beverly subpopulation. This conclusion, however, was not consistent with communities' knowledge of caribou in that area. Nagy et al. (2011) provided an alternative explanation for the number of caribou observed on the BGLS ACCA. Their analysis demonstrated that the Beverly subpopulation now occupied the western extents of the Queen Maud Gulf Lowlands (QMGL) area. The results of this study, coupled with local knowledge within the communities on the northern extents of the range (Baker Lake, Gjoa Haven, and Kugaaruk, HTO meetings and pers. comm.), strongly supported a distributional shift in the Beverly calving ground. This shift occurred to the QMGL geographical area some 200 to 250 km north of their previous BGLS ACCA. The Beverly subpopulation likely responded to various demographic and geographic influences such as predation, anthropogenic disturbance, low habitat productivity, insect harassment or other factors. It is also likely that the subpopulation had experienced a concurrent population size decline of unknown magnitude (Gunn et al, 2010). The events leading to the observed shift likely occurred over a period of many years (Nagy et al., 2011) but gaps in current knowledge make it difficult to conclude which mechanisms were responsible for the major changes observed on the BGLS ACCA.

Calf mortality is identified as an important factor in the population dynamics of many caribou herds on barren lands (Miller and Broughton 1974; Miller et al. 1983). Multiple studies have revealed that wolves (Miller and Broughton, 1974; Miller et al. 1985; Miller et al. 1988, Williams, 1995, Boertje and Gardner, 2000) and barren-ground grizzly bears (Adams et al, 1995; Young and McCabe, 1997; McLoughlin, 2001; Gau et al., 2002) are effective predators on caribou and are often identified as a major cause of calf mortality. According to local knowledge from Kivalliq communities, barren-ground grizzly bear and wolf populations might be increasing in the Kivalliq, and are concerns about the extent to which predators may be reducing caribou numbers have been expressed. The objective of this project was to investigate the extent of predation within the Qamanirjuaq and Beverly subpopulations ACCA, during the calving period to better understand the impact of predation on the dynamic of both caribou subpopulations.

## 2.0 Study area

This study was conducted on both the Qamanirjuaq and Beverly subpopulations annual concentrated calving areas (ACCA) as defined by Nagy and Campbell (2012). Both ACCA were delineated using a kernel analysis on location data collected from satellite and Global Positioning System (GPS) collars fitted on female caribou. Location data obtained between 1995 and 2010 and between 2006 and 2010 were used to delineate the Qamanirjuaq and Beverly subpopulation ACCA respectively (Figure 1). While both a northern and southern concentrated calving area are recognized for the Beverly caribou subpopulation, only the northern area was covered in this study as the southern area has been essentially abandoned over the last decade (Campbell et al., 2014).

The Beverly northern ACCA is located within the Queen Maud Gulf Lowland ecoregion. The Ecological Stratification Working group (1995) described this ecoregion as extending eastward along the arctic slope from Bathurst Inlet to near Chantrey Inlet with association to the lowlands south of Queen Maud

Gulf. The mean annual temperature is approximately -11°C with a summer mean of 5.5°C and a winter mean of -27°C. The mean annual precipitation ranges from 125 mm to 200 mm in the southern edge of the ecoregion. The Queen Maud Gulf Ecoregion is classified as having a low arctic ecoclimate. It is characterized by a cover of shrub tundra vegetation, consisting of dwarf birch (*Betula glandulosa*), willow (*Salix spp*.), northern Labrador tea (*Ledum groenlandicum*), mountain avens (*Dryas spp).*, and *Vaccinium* spp. Tall dwarf birch, willow, and alder (*Alnus crispa*) occur on warm sites; wet sites are dominated by sphagnum moss (*Sphagnum spp.*) and sedge (*Carex spp.*) tussocks. Geologically the region is composed of massive Archean rocks that form broad, sloping uplands that reach about 300 m above sea level (ASL) in elevation in the south, and subdued undulating plains near the coast. The coastal areas are mantled by silts and clay of postglacial marine overlap. Bare bedrock is common, and Turbic and Static Cryosols developed on discontinuous, thin, sandy moraine, level alluvial, and marine deposits are the dominant soils. Permafrost is continuous and deep with low ice content. The Queen Maud Gulf Bird Sanctuary covers most of the ecoregion. The sanctuary is an important migratory bird (duck, goose and shorebird) habitat (Ecological Stratification Working Group, 1995).

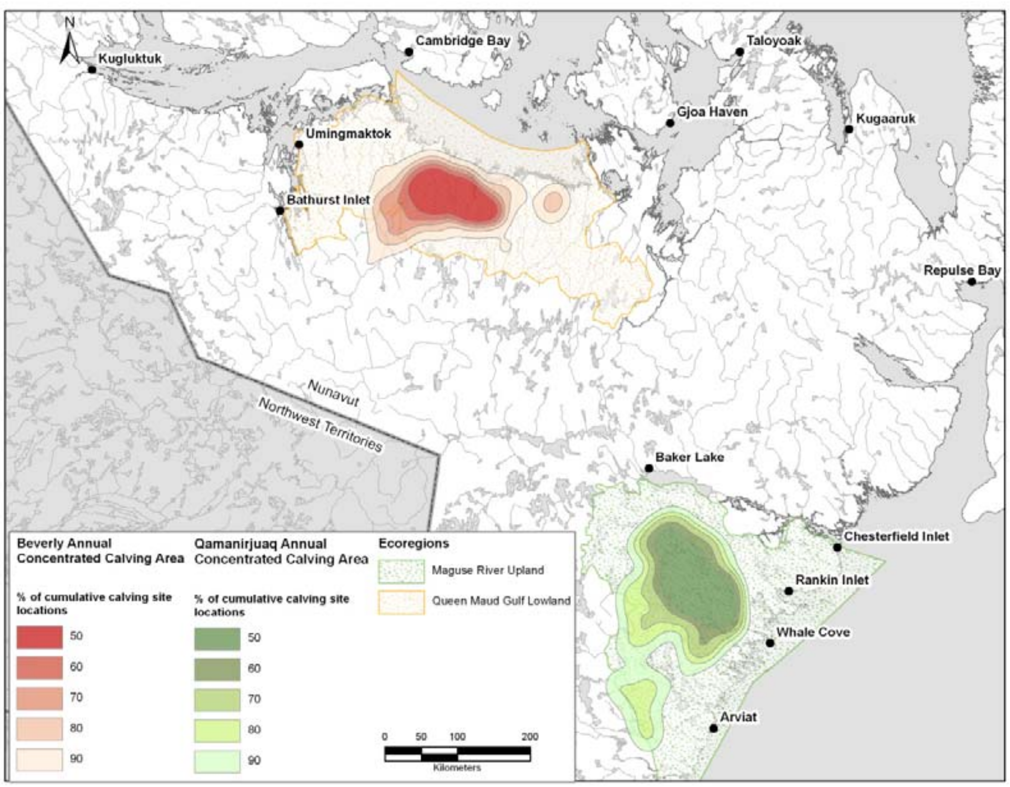


Figure 1: Location of Qamanirjuaq and Beverly caribou subpopulation Annual Concentrated Calving Areas (ACCA) as defined by Nagy and Campbell (2012).

The Qamanirjuaq ACCA is almost entirely located within the Maguse River Upland ecoregion. This ecoregion is characterized by mean annual temperatures ranging from $-8^{0}$C in the south to $-11^{0}$C in the north. A mean summer temperature of $6^{0}$C and a winter mean of $-24^{0}$C occur across the region. Mean annual precipitation varies from 250-400mm. The coastal climate is moderated by the open waters of the Hudson Bay during late summer and early fall. The ecoregion is classified as having a low arctic ecoclimate. It is characterized as having a cover of shrub tundra vegetation. *Betula glandulosa*, *Salix* spp and *Alnus crispa* occur on warm dry sites while poorly drained sites are dominated by *Salix* spp, *Sphagnum* spp (Sphagnum moss) and *Carex* spp. The region is associated with areas of continuous permafrost with medium ice content. Hummocky bedrock outcrops covered with discontinuous, acidic, sandy, granitic tills are dominant. Prominent fluvialglacial ridges (eskers) and beach ridges occur. Wetlands make up 25% to 50% of the land area and are characterized by low and high centered polygon fens (Ecological Stratification Working Group, 1995).

## 3.0 METHODS

This project was conducted over 4 years, in the months of June 2010, 2011, 2012 and 2013 alternating between the Qamanirjuaq and Beverly annual concentrated calving areas (ACCA). Surveys were conducted on the Qamanirjuaq herd in 2010 and 2012 and on the Beverly herd in 2011 and 2013. We compared all four surveys using similar methodology. The surveys were structured into three main components: 1) Systematic reconnaissance survey, 2) Systematic caribou calf mortality survey and 3) Calf carcasses necropsy. The systematic reconnaissance survey was designed to determine the timing and distribution of caribou calving as well as to stratify effort based on observed relative densities of caribou. The systematic caribou mortality survey was conducted in the identified core calving areas only and aimed at determining the extent of calf mortality on the calving grounds. During both of these surveys, all predator observations (mainly grizzly bears and wolves) were recorded to identify the extent of predator presence on calving grounds. The third component consisted ot the necropsying of caribou calf carcasses collected during the mortality survey to determine the most probable cause of death.

## 3.1. Systematic reconnaissance survey

The systematic reconnaissance survey was designed to estimate relative densities and delineate aggregations of breeding females (hard antlered cows or cow/calf pairs) and allowed for the stratification of the ACCA for the subsequent caribou mortality survey. Potential reconnaissance survey transects were distributed systematically over both study areas, encompassing the known extent of the annual concentrated calving area for each herd (Nagy et al., 2011). Transects were based on a pre-defined UTM grid and were oriented north to south (across spring migratory gradients) and spaced 10 kilometers apart. Each transect had associated "transect station points" that were located at 10 kilometres intervals along the lines, separating the whole transects into 10 km long "transects segments" (Fig 2). These pre-determined "transect segments" were used to regroup caribou observations for the purposes of calculating relative density within the segment. A rigid set of criteria based on the presence/absence of hard antlered cows and/or the presence of calves governed which transect segments were flown and when the survey stopped at a specific transect to move to the next adjacent transect (Campbell et al., 2010).

Fixed-wing aircraft (Cessna Grand Caravan or de Havilland Turbo Otter) were used for the systematic reconnaissance surveys. Strip widths were established using streamers attached to the wing struts. The strip width was 400 m out each side of the aircraft, for a total transect width of 800 m. During the reconnaissance survey, altitude was maintained as close as possible to 122 m (400 ft) above ground level (agl) using a radar altimeter. Ground speed was maintained at approximately 160 kph (100 mph) but ranged between 140 (90 mph) and 180 kph (110 mph). All observations of caribou were recorded and whenever possible, distinction was made between cows with and without hard antlers. Adult bulls and yearlings were generally obvious and separated out from the other observations. Newborn calves were recorded whenever observed. All grizzly bears and wolves observed were also recorded.

The initiation of the reconnaissance survey was based on average peak calving derived through the analysis of location data and movement rates of collared caribou cows within both the Beverly and

Qamanirjuaq subpopulations. These collars were equipped with a UHF (Ultra High Frequency) beacon to allow for satellite relay of daily locations of each collared animal once every four days. The locations of these GPS radio-collared caribou cows were also used to insure that the reconnaissance survey was covering the full extent of the current year's calving area.

## 3.2. Systematic caribou calf mortality survey

Following the reconnaissance survey, and before starting the calf mortality survey, all caribou observations recorded were entered into ESRI ArcGIS® ArcMap™ 10.0 software (ESRI, 2011). We used the counts of hard antlered caribou to stratify the entire reconnaissance area into three density classes (low, medium and high) of breeding cows. All the observations recorded during the reconnaissance survey along a "transect segment" were summed and divided by the total area of the transect segment (10km x 0,8km = 8km$^2$) to determine the density of hard antlered caribou within each transect segment. This value was then assigned to the center point of that transect segment. This created a systematic distribution of density data points throughout the whole reconnaissance area. We used the Kriging tool, in the Spatial Analyst 10.1 extension in ArcMap™ (ESRI, 2011), to interpolate the densities of hard antlered caribous in between each data point. The same process was also used with total adult caribou observations to map the whole density distribution of caribou throughout the study area. Since caribou densities and distributions varied significantly between herds and survey years, the limits of each density class varied between surveys. The objective of the stratification was to concentrate most of the systematic caribou mortality survey within the core of the ACCA and to distribute our effort within the different density classes similarly in both years of the survey for each herd.

Once the density stratification was completed, the assigned high and medium density antlered caribou strata were divided into a series of potential north-south transects, 10 kilometers long and one kilometer apart. These tighter transects would then be used to search for caribou calf carcasses by helicopter. Because of the fast rate of decomposition and scavenging on calf carcasses, we tried to complete our calf mortality survey within 5 days following the onset of the reconnaissance survey. Time and logistic constraint dictated the transects to be flown. A subset of transects were selected within the complete set of available transects to cover as much as possible the whole extent of the high density stratum and to have a minimum of 10% coverage of that stratum. We also tried to cover approximately 5% of the medium density stratum[1].

We used a Bell 206B (Jet Ranger) helicopter to fly over the selected transects at an average altitude of 30-60m above ground level and a speed of 90km/h (range from 80 to 120km/h). Two designated observers, one in the front seat and one in the back seat on the opposite side, were continuously searching for calves covering approximately 100 meters on each side of the helicopter. For each carcass found, the exact GPS location was recorded and perpendicular distance to the transect line was measured *a posteriori*. All grizzly bear and wolf observations were also recorded.

## 3.3. Calf carcass necropsy

When observers located a carcass, we landed, searched the immediate area for predator signs and took pictures of the carcass and surroundings. The carcass was then numbered, picked-up and brought back to camp to conduct a necropsy and determine the most probable cause of death. Each carcass was skinned and the necropsies consisted of an external and internal examination of the body and visceral organs. We recorded the following data:

(1) date;
(2) location (latitude/longitude);
(3) sex (by examination of genitalia. Carcasses were classified as unknown sex when genitalia were absent);
(4) approximate age (<1, 1-3, 4-7 or >7 days according to body weight, condition of pelage and umbilical cord, and degree of hoof wear using the same set of criteria as Miller et al. (1988));
(5) body weight (to 0.1 kg, as "whole" or "partial");
(6) approximate % of carcass missing and parts absent (thoracic viscera, abdominal viscera, muscle tissue, head);
(7) number and species of animals nearby;
(8) presence/absence of scat, hairs and tracks around the carcass (hairs and scat samples were collected when present);

[1] Our method differed slightly in the first year of the study (2010). For each of the reconnaissance survey transects flown inside the high and medium strata, two new transects were established on each side of that original transect, spaced 200m apart, and calf carcasses were searched along those new transects.

(9) wounds and predation signs (puncture wounds and their location, presence of blood around wounds, subcutaneous hemorrhages, disarticulation of limbs, hide being inverted, skull crushed, claw marks on hide);
(10) stomach content (empty, milk curds only, milk curds and trace of vegetation, milk curds well mixed with vegetation, vegetation only);
(11) Condition of the left and right lung (each being classified as “purplish and small”, “generally pink with some purplish areas”, “normal condition”);
(12) Other comments.

A “field cause of death” was then established according to our findings during the necropsy and each carcass was classified as either: (1) Non-predation death, (2) suspected wolf predation, (3) suspected grizzly bear predation, (4) suspected eagle predation, (5) predation by unknown predator, (6) unknown cause of death.

In 2010 and 2011, we collected lung, liver, kidney and spleen samples from each carcass. Samples were kept in a cooler on ice and sent to the Canadian Cooperative Wildlife Health Center (Guelph, Ontario) for histopathology analysis. The laboratory analysis consisted in 1) histological examination of tissues to detect any abnormal development of organs (eg. fetal ateclectasis) or lesions; 2) examination for bacterial infection of tissues and 3) toxicological screening for heavy metal levels in kidneys. In 2012 and 2013, samples were collected around punctures marks found on calves by rubbing a rayon swab around the wounds to try to pick up predator DNA. These samples were sent to Wildlife Genetic International (Nelson, British Columbia) for species identification. DNA was extracted from the swab using QIAGEN DNeasy Blood and Tissue kits (Qiagen, Valencia, California). Species testing used a sequence-based analysis of the mitochondrial 16S rRNA gene. Different sets of primers were used which were designed to amplify Carnivora DNA preferentially as well as most potential mammals and bird species. The final banding pattern was then compared to reference data from several mammalian and avian species, including wolf, grizzly bear, wolverine, arctic fox and golden eagle. Using the results from both of these post-field analyses, as well as our previously determined “field cause of death”, we established a “final cause of death” for each carcass using the same 6 categories.

## 3.4. Estimating the extent of calf mortality in core calving grounds

To determine what the calf mortality observed represents for the subpopulation, we used the data obtained from the surveys and necropsies to estimate the total percentage of calves born in the core area of the calving ground that died from either predation or non-predation causes. This was done in three steps: 1) Estimating the total number of adult caribou inside the high and medium density strata, 2) Estimating the percentage of breeding females within both strata to estimate the total number of calves born and 3) Estimating the total number of calf carcasses present in each density strata.

*i) Estimating total number of adult caribou*

To estimate the total number of adult caribou within the high and medium density strata, we used the observations recorded during the systematic reconnaissance survey. The original reconnaissance transects were truncated according to the boundaries of each density stratum and we used Jolly's Method 2 for unequal transect length to estimate the total number of adult caribou present in each stratum. Since a full population estimate was conducted on the Beverly herd in 2011, we used the transects (3.4km and 5.5km apart, in the high and medium density stratum respectively) and observation data from this survey to estimate more accurately the total abundance of adult caribou within both density strata.

*ii) Estimating the total number of breeding females/calves born*

To determine the total number of calves born in each density stratum, we used the best information available each year to estimate the proportion of breeding females within all adult caribou observed. All breeding females were assumed to have produced a single calf. In 2010, we used the number of hard antlered cows (assumed to be breeding cows) observed during the reconnaissance survey within each density stratum to estimate the total number of breeding females using Jolly's Method 2. In 2011, a composition survey was conducted as part of the full population estimate and caribou were classified from the air using a Bell 206-B Jet Ranger helicopter as breeding females (with calf and/or udder), non-breeding female (no antlers no udder, no calf), yearling or bull (Campbell et al., 2014). We used the composition survey observations within each density stratum to determine the percentage of breeding females inside both density strata. In 2012 and 2013, we used two different techniques to maximize the accuracy of our breeding female estimates. First, we used the counts of antlered cows during the reconnaissance survey and estimated the total number of breeding cows using Jolly's Method 2. However, considering that we observed multiple females with calves and without hard antlers (most pronounced on the Beverly ACCA), we decided to also take multiple photographs of caribou groups throughout our study area to be able to count cow:calf ratios and correct our breeding female estimate if necessary.

*iii) Estimating the total number of dead calves*

To be able to obtain our final estimate of the percentage of all caribou calves that died in the core area of the calving ground, we used a distance sampling approach. While conducting our systematic caribou calf survey, our flight track was recorded on a GPS (one point recorded every 100 to 500 meters) and the exact coordinates of each calf carcass found was recorded. This allowed us to measure the perpendicular distance between our flight line and each carcass found. We used the boundaries of each density stratum to truncate our flight line and determine the length of each transect flown within a given density class stratum as well as to determine in which density class each carcass was found. We used DISTANCE 6.0 (Thomas et al., 2009) software to estimate the total number of dead calves in each density stratum.

The distance sampling method assumes that the probability of detection is at its maximum on the track line and decreases with increasing distance from the aircraft. However, in aerial visual surveys such as this one, the probability of maximum detection actually occurs at some distance from the track line due to a blind area under the aircraft. This was corrected by left truncation of the data as recommended by Thomas et al. (2009). We identified the width of the "blind spot" under the helicopter by plotting a histogram of the distribution of perpendicular distances recorded each year and identifying the distance under which no or very few observations were recorded (ranged between 20-30 meters). We assumed maximum detection probability at the left truncation distance, and therefore, left truncation was applied by subtracting the left truncation distance to the perpendicular distance before further analyses. We also right truncated the distribution if any extreme outliers were recorded to allow for a better fit of the detection function to the distribution. We used the multiple covariate distance sampling (MCDS) engine to test several models to estimate the detection function using the "half-normal" and "hazard rate" key functions, with the "cosine" and "polynomial" series expansion. Model selection was firstly based on the Akaike's Information Criterion (AIC). Since multiple models had a similar AIC value, further selection was based on the Goodness of fit statistic and the detection function with the best fit, especially near the zero distance, was selected. Because our sample size was relatively small within any given survey year , we first tested a model using the four years of data on the two subpopulations with a single detection function using all observations. Since the same surveying method and date were used in all years, there was no reason to expect different detection functions per year, herd or density class. The MCDS engine then allowed us to test for effects of the covariate “year” and “subpopulation” on the estimation of the detection function. The year covariate had 4 levels (2010, 2011, 2012 and 2013) and the subpopulation covariate had 2 levels (Beverly and Qamanirjuaq) (Appendix-1). The density of dead calves was calculated separately for each density stratum. Finally, results obtained from the calf necropsies allowed us to determine the percentage of calves that died from either predation or non-predation causes within each density stratum. This proportion was applied to the total number of dead calves estimated within each density stratum to obtain a final estimate of the extent of calf mortality within each subpopulation due to predation versus non-predation causes.

# 4.0 RESULTS AND DISCUSSION

## 4.1 Qamanirjuaq caribou subpopulation

Studies of the Qamanirjuaq caribou subpopulation were initiated in June 2010 and completed June 2012. Systematic reconnaissance surveys were flown between June 7$^{th}$ and 13$^{th}$ in 2010 and between June 7$^{th}$ and 10$^{th}$ in 2012. The distribution of caribou differed between both years but the core calving area location was similar. In 2010, the high density stratum (50-133 antlered caribou/km$^2$) covered 482 km$^2$ and the medium density stratum (10-50 antlered caribou/km$^2$) covered 938 km$^2$. In 2012, the high density stratum (23-45 antlered caribou/km$^2$) covered 419 km$^2$ and the medium density stratum (10-23 antlered caribou/km$^2$) covered 1,262 km$^2$. The estimated number of adult caribou and breeding females in each density class are listed in Table 1.

The caribou calf mortality surveys were flown immediately following fixed wing reconnaissance surveys. For the Qamanirjuaq subpopulation, mortality surveys were flown from June 11$^{th}$ to 14$^{th}$ in 2010 and from June 11$^{th}$ to 17$^{th}$ in 2012. We covered 116 and 106 ten kilometer long transects in 2010 and 2012 respectively. Approximately 5.0% and 15.3% of the high density stratum and 2.5% and 7.7% of the medium density stratum was covered in 2010 and 2012 respectively (Fig 2).

During the June 2010 calf mortality survey, we found a total of one adult and 40 calf carcasses. No necropsy was performed on the adult. Six of the calf carcasses were found on lakes and were inaccessible, yielding a total of 34 carcasses examined for cause of death. Out of the 40 calf carcasses found in 2010, only 31 were located on transect, in the high (15) and medium (16) density strata, and were used in our calculations to estimate the extent of calf mortality in the core calving area. Proportions of calf mortality causes were similar in both stratum with 89% and 88% of dead calves resulting from non-predation causes, and 11% and 12% of calf mortality resulting from predation in the high and medium density stratum respectively. Overall, we estimated that in 2010, approximately 1.10% of all calves born in the core calving area of the Qamanirjuaq subpopulation died from non-predation related causes in their first week of life. An additional 0.15% of all calves died from predation for a total of 1.24% of all calves dying within their first week of life within the core calving area (Table 1).

During the June 2012 Qamanirjuaq calf mortality survey, a total of five adult and 57 calf carcasses were observed. No necropsy was performed on the adults. Out of the 57 calf carcasses found, 51 were located on transect in the high (30) and medium (21) density strata. These observations were subsequently used in our calculations to estimate the extent of calf mortality in the Qamanirjuaq core calving area. Seventy-seven percent (77%) and 62% of calf mortalities were the result of non-predation causes, while 23% and 38% of dead calves found were due to predation within each of the high and medium density stratum respectively. Overall, we estimated that in 2012, approximately 2.11% of all calves born in the Qamanirjuaq core calving area died from non-predation related causes in their first week of life. An additional 0.86% of all calves died from predation over the same period for a total of 2.97% of all calves dying within their first week of life in the core calving area (Table 1).

a)

b)

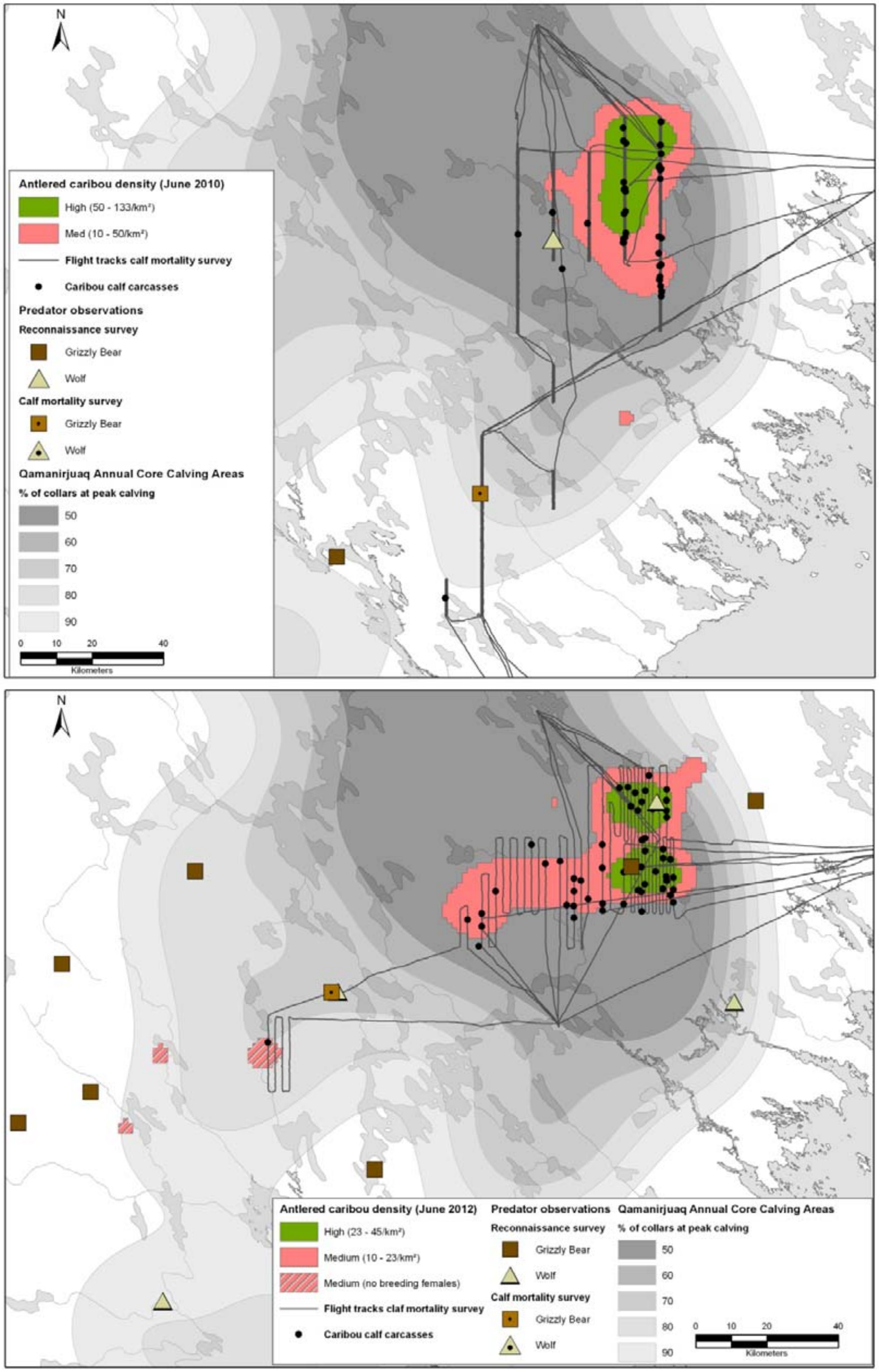


Figure 2: Densities of antlered caribou calculated from observations recorded during the systematic reconnaissance survey conducted on the Qamanirjuaq ACCA in a) 2010 and b) 2012. Flight tracks from the systematic calf mortality surveys, location of caribou calf carcasses found and predator observations are also included. The Qamanirjuaq ACCA as defined by Nagy and Campbell (2012) is shown for spatial reference.

**Table 1**: Estimate of total adult caribou, total breeding cows and total calf mortality due to predation and non-predation causes in the core area of Qamanirjuaq caribou herd's calving grounds in a) 2010 and b) 2012.

a)

| Density strata of antlered caribou | Area (km²) | Total caribou estimate [95% CI] | CV | % of breeding females | Total breeding cows estimate [95% CI] | Dead calves density (/km²) | Total dead calves estimate [95% CI] | CV | Estimate of total calf mortality | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Predation | Non-predator | Total |
| **High density (50-133/km²)** | 482 | 95,831 [47,796-143,866] | 0.19 | 49.33% | 47,273 [23,577-70,969] | 0.56 | 261 [126-541] | 0.37 | 0.06% | 0.49% | 0.55% |
| **Medium density (10-50/km²)** | 938 | 34,062 [18,883-49,242] | 0.21 | 40.99% | 13,962 [7,740-20,184] | 0.38 | 501 [271-927] | 0.32 | 0.45% | 3.14% | 3.59% |
| **TOTAL** | **1,420** | **129,893 [66,679-193,107]** | | | **61,235 [31,318-91,153]** | | **762 [397-1,468]** | | **0.15%** | **1.10%** | **1.24%** |

b)

| Density strata of antlered caribou | Area (km²) | Total caribou estimate [95% CI] | CV | % of breeding females | Total breeding cows estimate [95% CI] | Dead calves density (/km²) | Total dead calves estimate [95% CI] | CV | Estimate of total calf mortality | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Predation | Non-predator | Total |
| **High density (23-45/km²)** | 419 | 17,403 [11,547-23,348] | 0.14 | 94.01% | 16,361 [10,855-21949] | 1.00 | 422 [231-770] | 0.31 | 0.59% | 1.99% | 2.58% |
| **Medium density (10-23/km²)** | 1,262 | 24,030 [18,091-29,970] | 0.12 | 77.70% | 18,671 [14,057-23,287] | 0.49 | 620 [335-1,149] | 0.32 | 1.26% | 2.06% | 3.32% |
| **TOTAL** | **1,682** | **41,433 [29,548-53,318]** | | | **35,032 [24,912-45,236]** | | **1,042 [566-1,919]** | | **0.86%** | **2.11%** | **2.97%** |

### 4.1.1. Predation mortalities

In June 2010, two grizzly bears and one wolf were observed during the reconnaissance survey in the vicinity of the Qamanirjuaq core calving area. One grizzly bear was also observed in the low density area of breeding females during the calf mortality survey. In June 2012, nine grizzly bears and seven wolves (five singles, one pair) were observed during the reconnaissance survey. One bear and one wolf were observed directly inside the core calving area while the remaining were in the lower density strata within 150 kilometers of the core calving area .Two grizzly bears (mother and yearling) were also observed during the 2012 calf mortality survey, in the low density area of breeding females.

Predation related calf mortality appeared relatively low in the Qamanirjuaq herd over both the June 2010 and 2012 survey periods. Calves with a combination of signs such as puncture marks through skin and tissues, blood around wounds, subcutaneous hemorrhage, crushed skull and/or lacerations on back or rump, were assumed to have died of predation. Out of all calf carcasses for which a cause of death could be established, 9.5% (2/21) were attributed to predation in 2010 and 32.5% (13/40) in 2012. The higher abundance of predators observed in the vicinity of the calving grounds in 2012 coincides with also a higher proportion of predated calves.

Due to the small body size of the calves, predators likely spent very little time at the carcasses complicating predator species identification as very little sign was typically found around the carcasses. In 2010, both predation events were classified as “unknown predator”. In 2012, four out of 13 predated calves (30.8%) were attributed to wolves based on bite mark patterns. The genetic samples collected around puncture marks allowed us to confirm the presence of wolf DNA on one carcass. However, most of the other genetic samples collected were of too poor quality to be able to draw a solid conclusion. Grizzly bear hairs were found next to one calf carcass and one golden eagle (*Aquila chrysaetos*) was found feeding on a freshly killed calf allowing us to identify the most probable predator in those two cases. The remaining calves (7) were classified as “unknown predator”.

Out of the 15 predated calves found within the Qamanirjuaq core calving area, 40% had not been consumed while the majority had more than 50% of the carcass eaten. Typically all the viscera and various portions of muscle tissue were missing. Fifty percent (50%) of the kills attributed to wolf (2/4) had not been consumed. Considering our small sample size, it is difficult to draw conclusions from this observation but these percentages are similar to those observed by Miller and Broughton (1974) within the Qamanirjuaq subpopulations calving grounds. Miller et al, (1985) suggested that under conditions of overabundance of vulnerable preys such as newborn calves on calving grounds, wolves can and do kill in surplus of their short-term needs. This “surplus” or “excessive” killing then result in many carcasses either untouched or selectively consumed (often milk curd and viscera only).

Out of 8 predated calves that still had their viscera available for examination, 62.5% appeared to be healthy calves, having their stomach filled with milk curd and both of their lungs in good condition. The remaining 37.5% showed signs of pulmonary atelectasis and had empty stomach (probable abandonment) and were probably already predisposed to an early death (compensatory mortality).

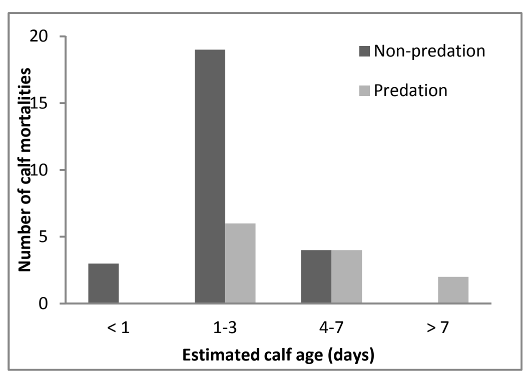


Figure 3: Frequency of predation and non-predation related mortalities in Qamanirjuaq neonate caribou calves according to estimated age.

The age distribution of predated and non-predated calves suggests that non-predator death predominantly occurred by 3 days of age while older calves appeared more prone to predation ($\chi^2$ = 7.639, df=3, p = 0.054; Fig 3). When considering only calves that had less than 5% of their body missing, predated calves were also heavier on average than calves that died from non-predation causes ($\xi$ = 5.3kg vs 4.2kg, df=28, p=0.04).

### 4.1.2. Non-predation mortalities

Field necropsies and histophysiological examination performed by the Canadian Cooperative Wildlife Health Centre (CCWH) allowed us to conclude that at least 19 carcasses found in 2010 were non-predation related deaths. In 2012, 27 carcasses were classified as non-predator death. When considering only carcasses for which a cause of death could be determined, 90.5% (19/21) and 67.5% (27/40) of those carcasses were the result of non-predator causes in 2010 and 2012 respectively. Non-predation mortalities were the most important cause of death in both years on the Qamanirjuaq core calving area.

The majority of calves categorized as non-predator death in both years showed signs of either stillbirth or early neonatal abandonment (78.9% and 88.9% in 2010 and 2012 respectively). Calves with completely empty stomach and no trace of milk curd (26/46) were most likely stillborn or had been abandoned by their mother shortly after their birth (Miller et al., 1988). Pulmonary problems were frequent among those calves as 84.6% (22/26) showed signs of either pulmonary atelectasis, bronchopneumonia or aspiration of foreign material into their lungs (meconium or amniotic fluid/squames). Birth defects/malformations were also present in 19.2% (5/26) of these calves. In 11.5% (3/26) of calves with an emply stomach, no obvious cause of death could be identified though the absence of any physical trauma and hoof wear, as well as their small body weight led us to conclude that these were also neonatal death. Calves that had their stomach filled with vegetation only, were also probably separated or abandoned by their mother. Abandonment can be due to various causes such as predator harassment, physical or physiological disorder of the calf or young primiparous cows being in poor physical condition (Miller et al., 1988). In 92.3% (12/13) of those likely separated/abandoned calves, we found signs of neonatal atelectasis. One or more lobes of their lungs had patches of fetal atelectic lung tissue (dark puplish blotches of various sizes) which would result in breathing difficulties and possible brain damage from cerebral hypoxia (Zachary and McGavin, 2012), increasing their disposition to separation/abandonment. Only one calf found with vegetation only in its stomach did not show any obvious signs of physiological disorder, but the absence of any milk curds and physical trauma led us to classify it as a non-predator death likely due to separation from its mother and milk supply ultimately causing starvation.

Of those non-predated calves that did not show signs of stillbirth or abandonment, and that had presence of milk in their stomach, 75% (3/4) had signs of pulmonary problems from either atelectasis, aspiration of foreign material into their lungs and/or pneumonia. The severity of their condition likely allowed them to survive a few days before death. The last calf (1/4) appeared to have drowned while crossing a small lake.

In both years, we could not determine the definitive cause of death for a number of calf carcasses. Nineteen (19) and 17 calves were classified as “unknown cause of death” in 2010 and 2012 respectively. Most of those calves (22/36) were too consumed and/or decomposed to be able to draw any conclusion; six calves were found in slushy mires on melting lakes and could not be picked up for necropsy. These calves probably drowned or died of fatigue, stress, or thermal shock while trying to cross the lakes but this could not be confirmed; three calves had a combination of possible predation and non-predation signs making it difficult to draw a conclusion while five calves had no sign of predation and appeared to be relatively healthy so no cause of death could be concluded.

## 4.2. Beverly caribou subpopulation

In 2011 and 2013, we carried out an identical predation study on the Beverly caribou subpopulation annual concentrated calving area. The systematic reconnaissance survey was flown between June 9$^{th}$ and 11$^{th}$ in 2011 and between June 10$^{th}$ and 12$^{th}$ in 2013. The distribution of caribou differed between both years with the core calving area having moved slightly eastward in June 2013. While most breeding females appeared to be concentrated in more or less the same core area in 2011, this was not the case in 2013 where hard antlered females appeared to be spread throughout a wider area. Considering that the number of hard antlered females was so low and so wide spread in 2013, the study area stratification was made according to total number of adult caribou for that specific year. Since there is a segregation between breeding females and bulls/yearlings during the calving period, the aggregations of adult caribou observed in the core calving area were usually mostly breeding females. To avoid including in our analysis areas that were not aggregations of breeding females, we excluded any medium or high density area where bulls and/or yearlings were observed. In 2011, the high density stratum (3-11 antlered caribou/km²) covered 1,528 km² and the medium density stratum (1-3 antlered caribou/km²) covered 3,574 km². In 2013, the high density stratum (9-34 adult caribou/km²) covered 1,334 km² and the medium density stratum (3-9 adult caribou/km²) covered 3,861 km². The estimated number of adult caribou and breeding females in each density class is indicated in Table 2.

Caribou calf mortality surveys within the Beverly subpopulation core calving area were flown from June 13th to 17th in 2011 and from June 12th to 15th in 2013. The surveys covered 119 and 148 ten kilometer long transects in 2011 and 2013 respectively. Approximately 11.7% and 9.9% of the high density stratum was covered and 2.4% and 3.7% of the medium density stratum was covered in 2011 and 2013 respectively (Fig 4).

During the June 2011 Beverly subpopulation calf mortality survey, we found a total of 2 adult and 61 calf carcasses. No necropsy was performed on the adults. One calf carcass was found on a lake and could not be picked-up for necropsy yielding 60 carcasses that were examined for cause of death. Sixty of the 61 calf carcasses found in 2011 were located on transect and were used in our calculations to estimate the extent of calf mortality in the core calving area. Forty-seven percent (47%) and 67% of dead calves found were the result of non-predation causes, and 53% and 33% of dead calves found were due to predation, in the high and medium density stratum respectively. In June 2011 an estimated 3.33% of all calves born in the Beverly core calving area died from non-predation related causes in their first week of life while an additional 3.60% of all calves died from predation. In total 6.93% of all calves born in 2011 in the Beverly subpopulation core calving area died within their first week of life (Table 2).

During the second calf mortality survey flown within the Beverly annual core calving area in June 2013, we found a total of 37 calf carcasses. Thirty-four (34) of the 37 calf carcasses were located on transect and were used in our calculations to estimate the extent of calf mortality in the core calving area. Forty percent (40%) and 43% of dead calves found were the result of non-predation causes, while 60% and 57% of dead calves found were due to predation, in the high and medium density stratum respectively. Overall, we estimated that in 2013, approximately 2.54% of all calves born in the Beverly core calving area died from non-predation related causes in their first week of life. An additional 2.08% of all calves died from predation for a total of 4.62% of all calves dying within their first week of life in the core area of the Beverly calving grounds in June 2013 (Table 2).

a)

b)

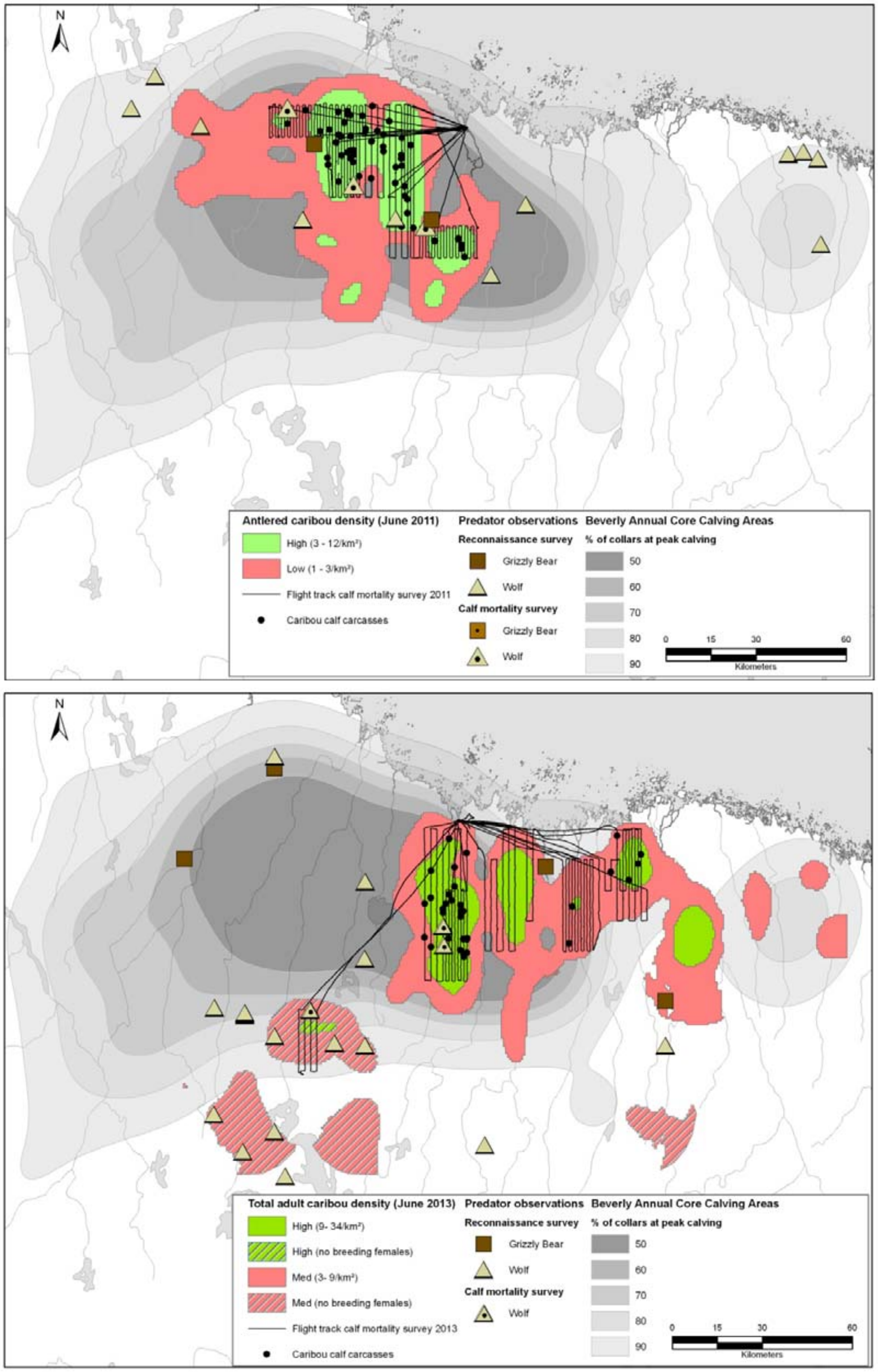


Figure 4: Densities of antlered caribou calculated from observations recorded during the systematic reconnaissance survey conducted on the Beverly ACCA in a) 2011 and b) 2013. Flight tracks from the systematic calf mortality surveys, location of caribou calf carcasses found and predator observations are also included. The Beverly ACCA as defined by Nagy and Campbell (2012) is shown for spatial reference.

**Table 2**: Estimate of total adult caribou, total breeding cows and total calf mortality due to predation and non-predation causes in the core area of Beverly caribou herd's calving grounds in a) 2011 and b) 2013.

a)

| Density strata of antlered caribou | Area (km²) | Total caribou estimate [95% CI] | CV | % of breeding females | Total breeding cows estimate [95% CI] | Dead calves density (/km²) | Total dead calves estimate [95% CI] | CV | Estimate of total calf mortality | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Predation | Non-predator | Total |
| **High density (3-12/km²)** | 1,528 | 15,415 [13,368-17,463] | 0.07 | 95.10% | 14,660 [12,712-16,607] | 0.75 | 1,151 [693-1,911] | 0.26 | 4.16% | 3.69% | **7.85%** |
| **Medium density (1-3/km²)** | 3,574 | 10,330 [8,249-12,410] | 0.10 | 68.68% | 7,094 [5,665-8,523] | 0.10 | 356 [119-1,068] | 0.59 | 1.66% | 3.36% | **5.02%** |
| **TOTAL** | **5,102** | **25,745 [21,617-29,873]** | | | **21,754 [18,378-25,131]** | | **1,507 [812-2,979]** | | **3.60%** | **3.33%** | **6.93%** |

b)

| Density strata of total adult caribou | Area (km²) | Total caribou estimate [95% CI] | CV | % of breeding females | Total breeding cows estimate [95% CI] | Dead calves density (/km²) | Total dead calves estimate [95% CI] | CV | Estimate of total calf mortality | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Predation | Non-predator | Total |
| **High density (9-34/km²)** | 1,334 | 21,251 [17,110-25,392] | 0.09 | 69.46% | 14,761 [11,885-17,637] | 0.40 | 540 [277-1,052] | 0.34 | 1.57% | 2.09% | **3.66%** |
| **Medium density (3-9/km²)** | 3,861 | 18,958 [15,357-22,559] | 0.09 | 53.89% | 10,216 [8,276-12,157] | 0.16 | 615 [284-1,331] | 0.40 | 3.01% | 3.01% | **6.02%** |
| **TOTAL** | **5,194** | **40,209 [32,467-47,951]** | | | **24,977 [20,160-29,794]** | | **1,155 [561-2,383]** | | **2.08%** | **2.54%** | **4.62%** |

### 4.2.1. Predation mortalities

In 2011, three grizzly bears (one single, one pair) and nine wolves (five singles, two pairs) were observed during the Beverly subpopulation reconnaissance survey. All grizzly bears as well as five of the nine wolves were observed within the medium and high density strata of antlered females. Three additional grizzly bears (one mother + two juveniles) and four wolves were also observed during the calf mortality survey within the high and medium density strata. In 2013, five grizzly bears (three singles, one pair) and 19 wolves (12 singles, two pairs, one group of three) were observed during the Beverly subpopulation reconnaissance survey in the vicinity of the core calving grounds (< 75 km from the boundary of the medium density strata). Three of those bears were observed within the medium caribou density stratum. Five wolves (one pair, one group of three) were also observed during the calf mortality survey, within the high caribou density stratum.

Out of all Beverly calf carcasses for which a cause of death could be established, 52.0% were attributed to predation in 2011 and 57.9% in 2013. When combining both survey years of each subpopulations, the proportion of dead calves attributed to predation was higher in the Beverly ACCA than in the Qamanirjuaq ACCA ($p_{Beverly} = 0.536$, $p_{Qamanirjuaq} = 0.246$, $Z = 3.446$, $p = 0.001$) (Table-3).

In both years, wolves appeared to be the dominant predator. In 2011, 76.9% (20/26) of predated calves were attributed to wolves and 91.0% (10/11) of 2013 predation mortalities were believed to be wolf kills. Swab samples collected around puncture marks in 2013 allowed us to confirm the presence of wolf DNA on 6 of these 10 calves. During both years, only one calf was suspected to have been killed by a grizzly bear and the remaining were classified as “unknown predator species” due to the lack of evidence.

Table 3 : Percent frequency of occurence of causes of death in newborn calves (≤ 7 days old) found in the core area of the Qamanirjuaq and Beverly caribou subpopulation calving grounds, in June 2010, 2011, 2012 and 2013 (unknown mortality causes excluded).

| Cause of death | **Beverly herd** | | | **Qamanirjuaq herd** | | |
|---|---|---|---|---|---|---|
| | 2011 (n=50) | 2013 (n=19) | Total (n=69) | 2010 (n=21) | 2012 (n=40) | Total (n=61) |
| Non-predation death | 48.0% | 42.1% | 46.4% | 90.5% | 67.5% | 75.4% |
| Predation death | 52.0% | 57.9% | 53.6% | 9.5% | 32.5% | 24.6% |
| *Wolf predation* | *40.0%* | *52.6%* | *43.5%* | *0.0%* | *10.0%* | *6.6%* |
| *Grizzly bear predation* | *2.0%* | *0.0%* | *1.4%* | *0.0%* | *0.0%* | *0.0%* |
| *Eagle predation* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *5.0%* | *3.3%* |
| *Predator species unclear* | *10.0%* | *5.3%* | *8.7%* | *9.5%* | *17.5%* | *14.8%* |

Out of the 37 predated calves found in the Beverly calving grounds during both years, 29.7% (11/37) had not been fed upon, 40.5% (15/37) had only their viscera gone, and the remaining (11/37) had at least some of the muscle tissues consumed in addition to the viscera. When considering wolf predated calves only, 32.2% (10/31) of the carcasses had not been fed upon. These results are similar as those from the Qamanirjuaq calving grounds in 2010/12 and also seems to point towards a behaviour of “surplus” or “excessive” killing by wolves when face with high density of vulnerable preys.

Of 18 calf carcasses that were attributed to wolf predation and that were still in good enough condition to examine their viscera for possible histophysiological disorders, 55.6% (10/18) were found to have some degree of pulmonary atelectasis and were probably already weakened by their physiological condition, 11.1% (2/18) had their stomach filled with vegetation only and had probably been abandoned/separated from their mother already and 33.3% (6/18) appeared to be healthy and still nursed by their mother at the time of predation. Hence, it is important to consider that at least some portion of the mortality attributed to wolf predation could be considered “compensatory mortality” since some of those calves were already predisposed to death. The “additional” mortality on healthy caribou calves solely due to wolf predation is therefore probably lower than the percentages presented above.

The age distribution of predated and non-predated calves suggests that non-predator death mostly occurred within 3 days of age on the Beverly ACCA while older calves appeared more prone to predation ($\chi^2$ = 4.702, df=2, p = 0.095; Fig 5). When considering only calves that had less than 5% of their body missing, predated calves were heavier on average than non-predated calves ($\xi$ = 5.4kg vs 4.0kg, df=27, p<0.01).

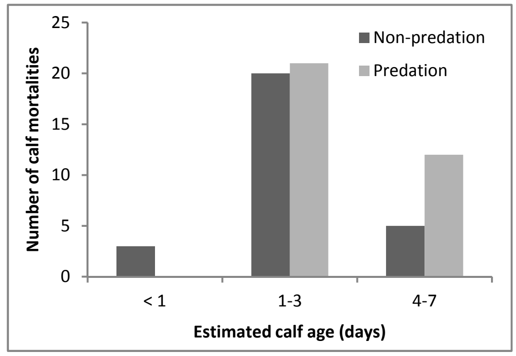


Figure 5: Frequency of predation and non-predation related mortalities in Beverly neonate caribou calves according to estimated age.

### 4.2.2. Non-predation mortalities

The field necropsies and histophysiological examination performed by the Canadian Cooperative Wildlife Health Centre (CCWH) allowed us to conclude that 24 of the Beverly calf carcasses found in 2011 were non-predation related deaths. In 2013, 8 calf carcasses found were classified as non-predator death. When considering only carcasses for which a cause of death could be determined, 48.0% (24/50) and 42.1% (8/19) of those carcasses were the result of non-predator causes in 2011 and 2013 respectively.

Pulmonary pathophysiological disorders were also common in the Beverly subpopulation. Out of all non-predated calves found in 2011 and 2013, 59.4% (19/32) showed signs of major respiratory problems such as pulmonary atelectasis or aspiration of foreign material (meconium or amniotic fluid/squames) into their lungs. The majority (13/19) of those calves did not have any milk curd present in their stomach probably as a result of stillbirth or early neonatal abandonment due to their condition. One calf was found with a congenital skull malformation. The remaining calves categorized as non-predator deaths (12/32) were all lacking any signs of physical trauma and thus predator did not appear to be involved in their death. Six of those calves still had most of their viscera still available for examination; four had no trace of milk curd in their stomach and had probably been abandoned/separated from their mother and might have died from starvation while the two other calves seem to have been nursing before they died and the actual cause of death could not be confirmed.

Eleven (11) and 18 calves were classified as “unknown cause of death” in 2011 and 2013 respectively. Most of those calves (22/29) were too consumed and/or decomposed to determine a conclusive cause of death. The warm temperatures encountered in June 2013 (Daily average temperature in Cambridge Bay = 7.1°C in 2013 compared to 1.6°C in 2011, between start and end dates of survey) (Environment Canada, 2014) likely accelerated the proliferation of *Diptera* larvae in the carcasses resulting in many highly decomposed carcasses during that year. Six calf carcasses had a combination of possible predation and non-predation signs making it too difficult to draw a conclusion. One calf was found on a lake but could not be picked up to perform a necropsy. Fatigue and drowning were likely the cause of death of that last calf but this could not be confirmed.

## 4.3. Extent of calf mortality in core calving grounds

The main objective of this study was to compare the relative impact of predators on these two distinct barren-ground migratory caribou subpopulations. The results highlight the differences in the predator-prey dynamic between the two geographically separated subpopulations. The systematic approach of the present work allowed us to estimate the total number of caribou calves that died each year in the core calving area of the Beverly and Qamanirjuaq subpopulations during the newborn calves’ first week of life. Despite the known variability in annual distributions of breeding cows within the ACCA, we have confidence that the results of this study provide a statistical precision sufficient to evaluate the relative level of predation on caribou calves within both ACCA. In addition we believe the method is well adapted to monitor trends in predation between multiple years based on the differences observed between the two geographically separated subpopulations.

The total calf crop mortality appears relatively low in both subpopulations with a two-year average of approximately 2.11% and 5.78% in the Qamanirjuaq and Beverly subpopulation respectively. This is lower than the neonatal mortality estimated by Williams (1995) on the Beverly herd in 1993 (11.4%) and 1994 (7.2%) and by Miller et al. (1988) in 1981-1983 (approx. 10%). It is also lower than the calf crop mortality estimated by Whitten et al. (1984, 1985 and 1986 in Williams, 1995) on the porcupine herd (6.6%-15.4%). Differences in methodology might explain the observed discrepancy with results from this study. Despite the relative precision of the results obtained during this program we must caution that financial and logistic constraints did not allow for the coverage of the entire ACCAs and results presented in this report only apply to the core area of the calving grounds. While we can expect similar mortality rates throughout the whole ACCA, this predation survey was not conducted in the areas where breeding females were present in low density.

The two-year average estimated total calf crop mortality due to predation within the core area of the Beverly ACCA was 2.84% compared to 0.5% for the Qamanirjuaq subpopulation (Fig 6). Wolves were the most common species responsible for predation mortalities in both caribou herds. Visual observations of wolves were however much higher in the vicinity of the Beverly ACCA than in the Qamanirjuaq ACCA. A total of 37 wolf observations were recorded during the 2011 and 2013 Beverly surveys compared with 8 observations recorded during the 2010 and 2012 Qamanirjuaq surveys. A possible explanation for this large difference might be the extensive wolf harvest happening along the migratory route of the Qamanirjuaq caribou herd. Several Inuit communities (Arviat, Whale Cove, Rankin Inlet) have close access to the Qamanirjuaq caribou spring migration corridor and as a result harvest high numbers of wolves most springs, likely reducing the number of wolves accessing the Qamanirjuaq ACCA. In comparison, the Beverly ACCA is located much farther from Inuit communities and the predator harvest along their migration route is therefore much lower (Campbell et al., 2014).

Miller et al (1988) had suggested from their observations on the Beverly traditional calving ground that probably 5-7% of the calf crop was killed by wolves during their first week of life. This is approximately twice the amount that we estimated during our study on the current Beverly ACCA. Even though methodology differs between both studies, this could suggest that the predation pressure on the Beverly caribou subpopulation has decreased in recent years. This decrease could be the net result of the documented shift in ACCA from the vicinity on Beverly/Garry Lakes area to the western Queen Maud Gulf (Nagy et al., 2011; Nagy and Campbell, 2012; Campbell et al., 2014). In fact, Bergerud et al. (2008) further suggests that distributional shifts of migratory caribou populations in response to predators shouldn't be surprising, and that many of the major shifts in ACCAs documented over the years have produced evidence supporting the same.

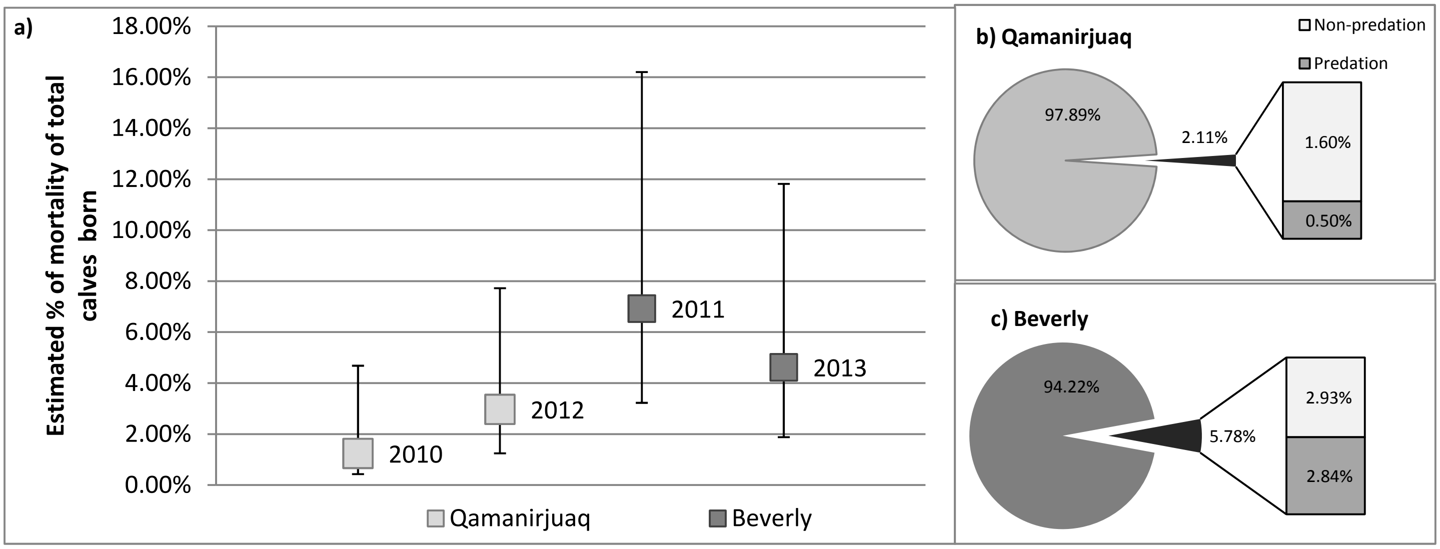


Fig 6: Summary of estimated calf mortality on core area of calving grounds of Beverly and Qamanirjuaq caribou subpopulations during their first week of life. a) Estimated annual calf mortality with 95% confidence interval; b) Two-year average calf mortality (black pie slice) and relative proportion of non-predation vs predation mortalities in Qamanirjuaq caribou subpopulation. c) Two-year average calf mortality (black pie slice) and relative proportion of non-predation vs predation mortalities in Beverly caribou subpopulation.

While the percentage of calves dying from predation in the Beverly herd was estimated to be approximately 5.7 times higher than in the Qamanirjuaq herd, the ecological significance of this level of predation needs to be evaluated. Predation is recognized as a regulatory mechanism for prey populations. It is believed that predators are essential to maintain healthy prey populations by removing weak and sick individuals from the population. Our necropsy results showed that a large proportion of the calves predated by wolves on the Beverly calving grounds were probably already predisposed to death due to physiological or pathological disorders. Hence, the “additional mortality” solely due to wolf predation represents only a small proportion of the total estimate of mortality attributed to predators. Similarly, the very low predation rate observed in the Qamanirjuaq subpopulation might even be detrimental to the herd health and might increase the occurrence of diseases such as the infectious pododermatitis (foot rot) epidemic observed in 2011.

While several grizzly bears where observed both in the Beverly and Qamanirjuaq calving grounds, very few calf carcasses found were attributed to grizzly bear predation. Grizzly bears are known to feed on caribou calves (Young and McCabe, 1997; Gau et al., 2002). The fact that we found so few calves that had been killed by grizzly bear might be due to the fact that the consumption of new born calf carcasses by grizzly bears is so complete that the remains often go undetected. Calf predation by grizzly bear is therefore probably underestimated in this study.

This predation study represents a first step in investigating the effect of predation on barren-ground caribou in Nunavut. The information presented in this report provides an insight into the predator-prey dynamic of the ecosystem but only covers the calving period and the first week of like of newborn caribou calves.  We recommend that additional studies should also been conducted to evaluate calf survival during the post-calving period as well as in the wintering grounds to better understand the full impact of predation on calf survival throughout their first year of life. Telemetry and dietary studies of wolves and grizzly bears are also suggested as a complementary means of estimating the impact of predators on caribou calf survival. Video camera collars could also effectively document the predation rate of wolves and grizzly bears on caribou calves throughout the calving and post-calving period.

We also suggest some improvement of the methodology used during this study to increase the accuracy of the estimates of the total calf crop mortality on the annual concentrated calving areas. More extensive ground counts of cows with and without distended udders would allow a better estimate of the proportion of breeding females and total calf production rather than the presence/absence of hard antlers which appears to be misleading at least in some years or some subpopulations. Increasing the coverage of the systematic calf mortality survey in both caribou density strata to approximately 15-20% in the high density stratum and 10% in the medium density stratum would also increase the accuracy of the total calf mortality estimate. Very little literature exists on typical predation signs and patterns from specific predator species on small carcasses such as caribou calves. The identification of wolf DNA on some calf carcasses allowed us to identify particular patterns and signs that are typical of wolf predation. Video footage from camera collars and additional DNA analysis on future calf carcasses could provide additional information on signs and characteristics typical of grizzly bear predation on such small preys, and would be helpful to distinguish grizzly bear's kills from other species to better evaluate the impact various predators on caribou calf survival.

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## Appendix 1 : Distance sampling analysis

Table X1: Summary of detection function model fits for estimating total number of calf carcasses found during calf mortality surveys. K = total number of parameters in model, AIC = Akaike Information Criterion, and $\hat{P}_a$= estimated proportion of carcasses detected along the transects.

| Model Key function, expansion serie | Covariates | K | AIC | ΔAIC | $P_a$ |
|---|---|---|---|---|---|
| Hazard rate, cosinus | None | 2 | 562.10 | 0.00 | 0.356 |
| Half-normal, cosinus | None | 2 | 563.82 | 1.72 | 0.391 |
| Hazard rate, cosinus | Year | 5 | 563.65 | 1.56 | 0.329 |
| Hazard rate, cosinus | Herd | 3 | 564.12 | 2.03 | 0.346 |

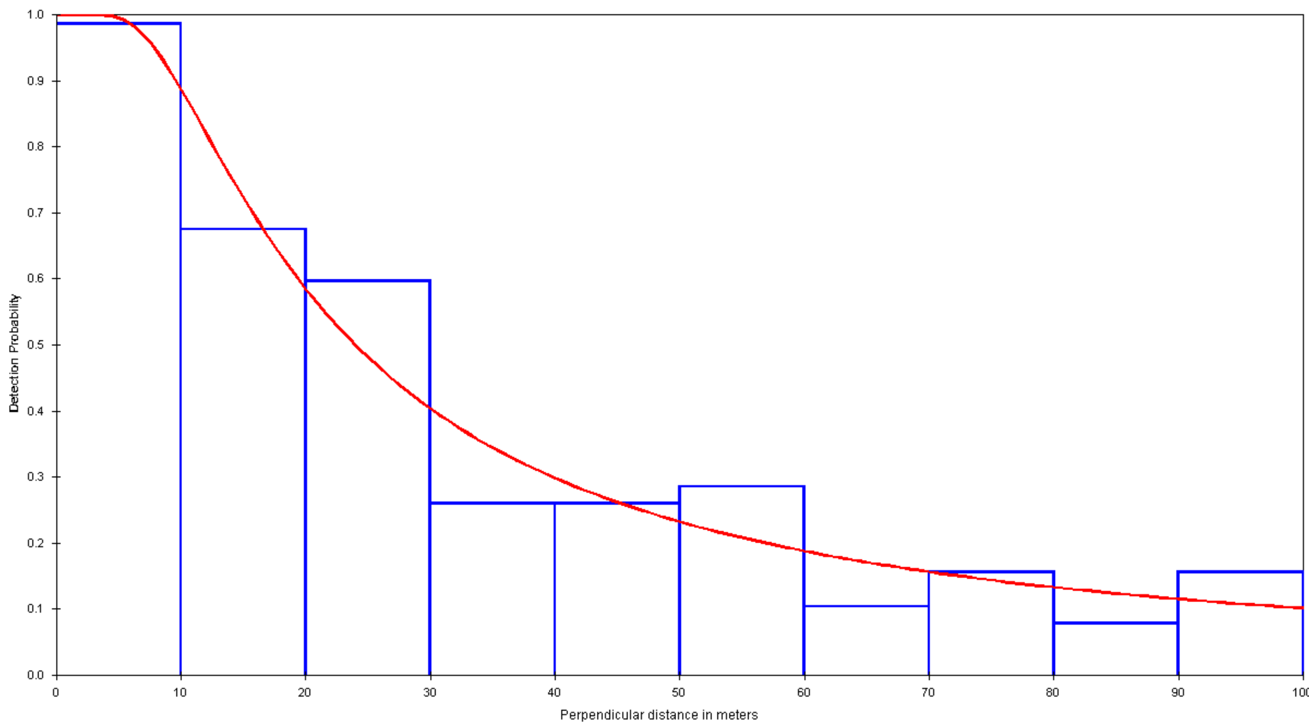


Figure X1: Detection probability curve

```
Effort        :    3991.722
 # samples     :   412
 Width         :    100.0000
 Left          :       0.0000000
 # observations:   137

 Model
    Hazard Rate key, k(y) = 1 - Exp(-(y/A(1))**-A(2))


              Point         Standard    Percent Coef.        95 Percent
  Parameter   Estimate       Error      of Variation     Confidence Interval
  ---------  -----------  -----------  --------------  ----------------------
    A( 1)      18.14         6.127
    A( 2)      1.311        0.2761
    f(0)     0.28118E-01  0.47775E-02       16.99      0.20141E-01  0.39253E-01
    p        0.35565      0.60428E-01       16.99      0.25476      0.49650
    ESW       35.565       6.0428           16.99       25.476       49.650
  ---------  -----------  -----------  --------------  ----------------------
```

## Appendix 2 : necopsy sheet

**Carcass ID :** CAR - 2011 -

Date :
Observer:
Waypoint # :
Latitude :
Longitude :
Photo taken : Y N
Carcass in natural resting position: Y N

Sex :
Age category : Calf Yearling Adult

Condition of pelage : In placental sac / Pelage soaked / Pelage dry

Umbilical cord: Fleshy & wet / Drying, still soft / Dried

Hoof wear : Yellowish / Blackish, no wear / Blackish with scratches / Black and worn

Stomach content : Empty / Milk curd only / Milk curd + trace vegetation / Milk curd + vegetation / Vegetation only

Lungs condition : Purplish, small (fetal) L R / Pink + purplish areas L R / Normal condition L R

Approximate age (days) : < 1 / 1-3 / 4-7 / > 7

Foamy fluid in trachea: Y N
Weight (kg) :
Body length (cm) :
Neck circ. (mm) :
Chest girth (mm) :
% of carcass missing :
Carcass consumed by predator : Y N

**Description of kill site :**

Topography : Flat / Hill side / Hill top
Vegetation : Moist meadow / Mesic tundra / Shrub

**Description of carcass:**

Main entry hole to body cavity : Thorax / Abdomen

Puncture wounds : Y N
Location of wounds : Skull / Neck / Thorax / Abdomen
Blood around wounds : Y N
Subcutaneous hemorrhage : Y N
Limbs disarticulated : Y N
Hide inverted : Y N
Skull crushed : Y N
Claw marks on hide : Y N
Organs removed : Eyes ☐ Ears ☐ Tongue ☐

Estimated time of death : < 24h / 1-7 days / > 7 days

**Predator signs:**

Predator nearby ?
Carcass burried/covered? Y N

Scats near carcass? Y N
Species : Wolf / Grizzly bear / Wolverine
Number of scats:
Scar sample ID:

Tracks near carcass? Y N
Species : Wolf / Grizzly bear / Wolverine

Hairs near carcass? Y N
Species : Wolf / Grizzly bear / Wolverine
Hair sample ID:

**Samples collected** (CAR-________ to ________)

Liver: ☐ Lungs: ☐ Kidney: ☐ Spleen: ☐ Muscle: ☐ Tooth: ☐ ___________: ☐ ___________: ☐

Comments :

**Cause of death**

Wolf ☐ Suspected Wolf ☐ Grizzly Bear ☐ Suspected Grizzly Bear ☐ Non-predator ☐ Unknown ☐

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information:** **Decision: X**

**Issue: The Nunavut Grizzly Bear Co-Management Plan**

## Background

- There is no formal TAH on grizzly bears. Currently, Inuit harvest bears for domestic use and in defense of life and property with no restrictions.
- There is no mandatory harvest reporting, and no regulations protecting family groups (females with cubs) or bears in dens
- Although there is no immediate conservation concern with current harvest levels, a defensible management system to ensure the harvest is sustainable will require adequate harvest monitoring and reporting
- A better defined management framework is needed to ensure the persistence of grizzly bear populations and facilitate the full economic benefit of this renewable resource (e.g. sale of hide, sport hunts, wildlife viewing, etc.)

## Current Status

- The Department of Environment (DOE) worked cooperatively with relevant Hunters and Trappers Organizations (HTOs), Regional Wildlife Organizations (RWOs), communities and other stakeholders (e.g. Nunavut Wildlife Management Board, Parks Canada, Environment and Climate Change Canada and Nunavut Tunngavik Inc.), seeking their input to develop a draft Nunavut Grizzly Bear Co-Management Plan over the last five years.
- Initial consultations with HTOs focused on identifying management priorities and goals.
- The draft plan was developed based on input received in initial consultations and then taken back to communities and HTOs for final review and input
- This draft management plan submission and its recommendations have the support of HTOs and provide a voluntary co-management framework for, harvest reporting, protection of family groups and bears in dens and help address human-bear conflicts.
- The DOE will submit recommendations on Sport Hunting allocations to the NWMB for decision and RWO distribution.

## Consultations

A full consultation summary has been provided in a separate document.

Preliminary Consultations

- Kivalliq Wildlife Board (KWB) and all Kivalliq HTOs in 2011-12
- Kugluktuk, Cambridge Bay and Gjoa Haven HTOs in February 2014

Second Consultations

- Kitikmeot and Kivalliq Regional Wildlife Boards (RWOs), October 2015
- All Kitikmeot Region HTOs and communities, October/November 2015
- All Kivalliq Region HTOs and communities, January/February 2016
- Environment Canada, NWMB staff, GNWT and internal DOE review in summer of 2015 and early 2016

## Recommendation

DOE requests the NWMB approve the Nunavut Grizzly Bear Co-Management Plan

Attachments

Draft Nunavut Grizzly Bear Co-Management Plan

Nunavut Grizzly Bear Co-Management Plan Consultation Summary

# Nunavut Grizzly Bear Co-Management Plan

June 2017

Department of Environment in Consultation with:

Nunavut Communities
Hunters and Trappers Organizations
Kitikmeot Regional Wildlife Board
Kivalliq Wildlife Board

# Nunavut Grizzly Bear Co-Management Plan

## PREFACE

Management of grizzly bears in Canada is conducted at the provincial and territorial level. In Nunavut, the management of all wildlife is ultimately governed by the Nunavut Land Claims Agreement (NLCA). Within the direction of the NLCA, management must invite public participation and promote public confidence, particularly amongst Inuit.

The Minister of the Environment and the Nunavut Wildlife Management Board (NWMB) hold the ultimate responsibility and primary responsibility for wildlife management respectively under the NLCA. The NWMB has the responsibility of approving management plans (Article 5 section 5.2.34 d(i)). This plan has been prepared with the cooperation of the Government of Nunavut Department of Environment (DOE), Regional Wildlife Organizations (RWOs), Hunters and Trappers Organizations (HTOs), NWMB, and Environment and Climate Change Canada (ECCC), with input from the Government of the Northwest Territories, and the participation of Inuit.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints.

## EXECUTIVE SUMMARY

This management plan has been developed cooperatively by co-management partners with the intent to provide guidance and direction to the co-management partners to help them with their decision-making and to identify goals and objectives for the management of the grizzly bear population. Ongoing communications between co-management partners, Inuit participation and cooperation will be fundamental to the plan's success.

Although current harvest does not pose an immediate conservation concern, close monitoring and additional management actions are required to ensure long term sustainability. The main actions of this plan, which are supported by the users voluntarily, include protection of family groups, bears in dens, harvest monitoring, and reducing human-bear conflict.

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# 1. INTRODUCTION

Based on Inuit observations and Inuit Traditional Knowledge, there is strong evidence that grizzly bears have increased in number in Nunavut as well as expanded their range, both in the eastern and northern portion of the territory. The scientific community generally agrees with this although studies in support are sparse. This apparent increase is at odds with southern grizzly bear populations where loss of habitat has reduced their range to only a fraction of what it was historically.

Although territory wide surveys have not been conducted, it is estimated that there are in the order of 1,500 to 2,000 grizzly bears in Nunavut (COSEWIC 2012). The information available on grizzly bears in Nunavut is uneven across the territory, with most of it being from the western part of the Kitikmeot region. This management plan will serve as a guide for long term sustainable use and management of the species.

In the past, grizzly bears were mainly present in the Kitikmeot and western portions of the Kivalliq. Inuit occasionally hunted grizzly bears for hides, fat, meat, and other traditional uses. With the recent range expansion, more bears are being hunted for subsistence and economic reasons. Under NLCA grizzly bear is listed both as a big game (Schedule 5.1) and furbearer (Schedule 5.2).

Human-caused death is the main cause of sub-adult and adult bear mortality in Nunavut. Across their entire range, loss of habitat and harvest are the main threats to grizzly bears. Grizzly bears generally exist at low densities, breed late in their life, and have small litter sizes and long birth intervals. In addition, grizzly bears need large areas of undisturbed land. The barren ground grizzly bear has the largest home range size documented with an annual range for males of 7245 $km^2$ and for females 2100 $km^2$. There is concern that the cumulative effects of various human-caused mortalities and increasing development on the land may cause the grizzly bear population to decline in Nunavut.

Grizzly bears can come into conflict with people when they are attracted to food and garbage in communities, at camps and cabins, or at industrial sites. Human-bear conflict often results in the death of the bear. There are programs to prevent bears from becoming problems by limiting attractants and/or reacting appropriately when bears are encountered. Human activities, particularly development, tourism activities, and private camps must be managed appropriately to minimize impacts on grizzly bears and their habitats.

The grizzly bear has been assessed as a species of Special Concern in Canada and is currently under consideration for listing under the *Species at Risk Act* (SARA). Trade in grizzly bear parts is regulated domestically by the *Wild Animal and Plant Protection and Regulation of International and Inter-provincial Trade Act* (WAPPRIITA), and internationally under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Nunavut's grizzly bear population is shared with the Northwest Territories (NWT). The NWT already has management systems in place and has encouraged Nunavut to also implement a harvest management system.

## 2. GUIDING PRINCIPLES

Sustainable grizzly bear management depends on active participation and support from all co-management partners. The following principles will guide conservation and management decisions, within the framework of the NLCA:

- To integrate Inuit societal values and Inuit traditional knowledge, collectively called *Inuit Qaujimajatuqangit* (IQ), in grizzly bear management;
- IQ and scientific knowledge will be considered jointly in decision-making,
- To consider public safety in management actions;
- To consider the ongoing social, cultural, and economic value of the grizzly bear in decision-making;
- To consider how grizzly bears interact with the ecosystem when considering management actions;
- Where there are threats of serious or irreparable damage to the grizzly bear population, lack of certainty will not be a reason for postponing reasonable or precautionary conservation measures, while considering that harvesting practice is essential part of Inuit culture.

## 3. GOAL OF THE GRIZZLY BEAR MANAGEMENT PLAN

To maintain a viable and healthy grizzly bear population for current and future generations, and to ensure that grizzly bears remain an integrated and functioning part of the ecosystem while allowing monitored and sustainable harvest.

## 4. BACKGROUND

In 1947, the NWT Game Regulations provided a closed season for harvesting grizzly bears. Historically, grizzly bears were only occasionally harvested as they were not a central species to Inuit life. Grizzly bears were generally harvested when encountered, but encounters were rare. In the late 1980s, there was a quota system put in place for grizzly bears by the government of NWT, in both the Kitikmeot and Kivalliq regions. Each region was allocated 10 tags each year for sport hunts or the sale of hides. More recently the GN has determined that the current regulations require a decision from the NWMB in order to allow sport hunting tags to be issued in those same regions.

Traditionally, Inuit have managed grizzly bears and human-bear conflict problems by processing and caching food safely, by having few or no permanent structures that attract bears, and by harvesting bears that ventured too close to human settlements.

Recent grizzly bear expansion eastward to the Hudson Bay coast, and north to Victoria Island has resulted in increased frequency of human-bear interactions and associated property damage to cabins and cached meat. Now there is concern for public safety within communities and on the land within the range of grizzly bear in Nunavut, particularly in areas where bears have recently increased in numbers.

In Nunavut, human safety and the right of Inuit to harvest grizzly bears remain high priorities. There is a need to monitor harvest and limit other human caused mortality to ensure that current and future harvest remains sustainable without posing a conservation concern.

## 5. GRIZZLY BEAR CO-MANAGEMENT IN NUNAVUT

The following co-management partners participate in grizzly bear management. Their roles are defined in full detail in Article 5 of the NLCA. A brief summary of each follows, however the NLCA is the guiding document.

### 5.1 Nunavut Wildlife Management Board

The role of the NWMB is defined in the NLCA sections 5.2.33 and 5.2.34, and consists of, but is not limited to, setting Total Allowable Harvest (TAH) and Non-quota limitations (NQLs). In addition, the NWMB approves management plans and is responsible for status designation of threatened species. The NWMB is the main instrument for wildlife management in Nunavut.

### 5.2 Regional Wildlife Organizations

RWOs role is defined in sections 5.7.6 of the NLCA. These roles include, but are not limited to, regulating the activities of HTOs including allocation of TAH among communities.

### 5.3 Hunters and Trappers Organizations

HTOs role is defined in sections 5.7.2 and 5.7.3 of the NLCA. These roles include, but are not limited to, regulating the harvesting activities of members. This includes allocation of TAH among members and setting of harvest seasons. As per the NLCA, an HTO may develop rules for non-quota limitations relevant to their members.

### 5.4 Department of Environment

The Minister of Environment retains the ultimate authority over wildlife management in

Nunavut as per the NLCA.  DOE staff conduct research, work to collect IQ, and make recommendations to the NWMB for decision. Conservation Officers enforce the *Wildlife Act* and regulations. Programs to reduce human-bear conflicts and to reduce and compensate for property damages caused by bears are being implemented.

### 5.5 Nunavut Tunngavik Inc.

Nunavut Tunngavik Incorporated represents all beneficiaries in the Nunavut Settlement Area by ensuring the land claim is properly adhered too. The NLCA is constitutionally protected under Canada's Constitution Act, 1982.

### 5.6 Government of Canada

If listed under the SARA, Environment and Climate Change Canada (ECCC) would be responsible for a national management plan for grizzly bears. Currently ECCC is responsible for managing grizzly bears and their habitat on federal lands under their jurisdiction (National Wildlife Areas and Migratory Bird Sanctuaries) as well as lands under the jurisdiction of the Parks Canada Agency (National Parks, National Park Reserves and National Historic Sites).

## 6. SPECIES DESCRIPTION

Inuktitut: Aklaq/Aklak (Inuktitut/Inuvialuit – Uummarmiut dialect);
Aghat, (Inuktitut - Inuinnaqtun);
Aklah (Inuktitut)
English name - Grizzly bear
French name - Ours grizzli, Ours brun
Latin name - *Ursus arctos* (Linneaus 1758)

### 6.1 Status

**SARA Canada**: No Status
**COSEWIC***:* Special Concern (2012)
**IUCN**: Least Concern (2008)
**Nunavut Wildlife Act**: Not Assessed

### 6.2 General Description

Grizzly bears in Nunavut are similar in size to those in southern populations but are smaller than grizzly bears inhabiting coastal Alaska, in part possibly as a result of the lower primary productivity of the barrens. Grizzlies have a prominent shoulder hump, long front claws and fur color ranging from blonde through shades of brown to nearly black. Genetic diversity is substantially lower for Nunavut grizzly bears compared to other populations in North America.

## 6.3 Distribution

The current range of grizzly bears in Nunavut encompasses most of the mainland, and some of the southern islands of the Arctic Archipelago (Figure 1). Victoria Island is now inhabited by grizzly bears. Observations of grizzly bears have been recorded several times in recent years on several other large islands close to mainland Nunavut, including King William Island, Melville Island and historically on Southampton Island.

## 6.4 Biology

Grizzly bears in Nunavut are long-lived, with maximum age of 28 years recorded for both sexes. A primary cause of natural mortality for adult females is predation by males. Adult males will also kill cubs and yearlings in late spring to mate with the females; however, the majority of cub deaths occur during denning or within the first month of leaving the den, with malnutrition likely being the primary cause of mortality in cubs.

The mean age at first reproduction for female grizzly bears in Nunavut is approximately 8 years of age, which is later than most other populations in North America. Males can start mating at 4-5 years of age but most mating is done by more mature males.

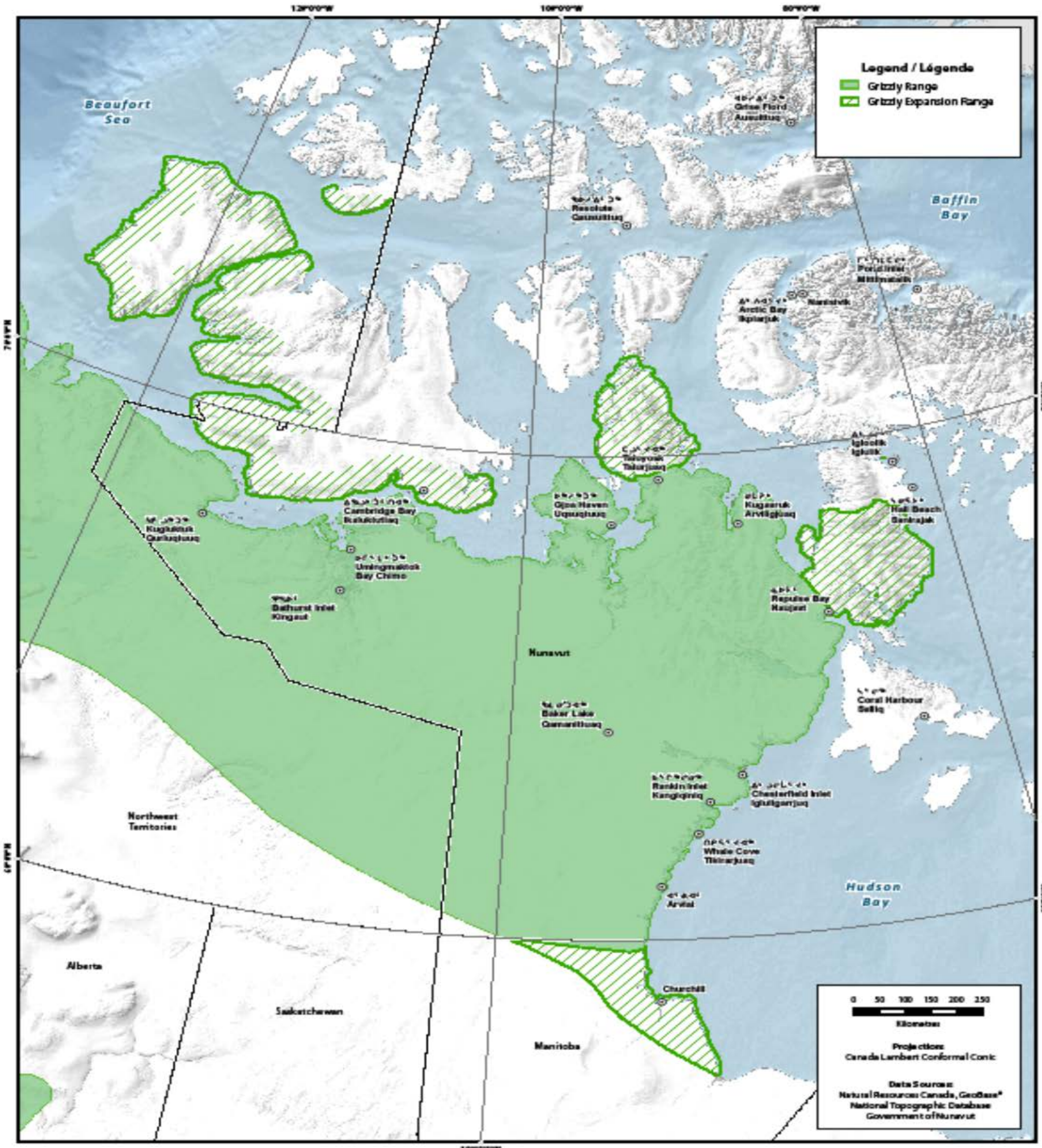


**Figure 1.** Range of grizzly bear in Nunavut.

Mating occurs from April to July and there is delayed implantation with gestation beginning in the fall. Litter size range from 1-4 with 2 being most common. Cubs are born in January and nurse in the den until the female emerges in early May. Males typically emerge from their dens in late April. Denning usually begins in the last two weeks of October (females prior to males). The cubs remain with their mother until about 2 years old, and the sow can mate again only after the cubs leave, or cubs are lost. The mean interval between litters is 2.8 years.

Grizzly bears are predators of caribou and muskox in Nunavut. Where available, Arctic ground squirrels are preyed upon by grizzly bears, and make up a significant component of their diet. Occasional prey items noted for grizzly bears also include red-back voles and several species of lemmings (*Dicrostonyx and Lemmus spp*), ptarmigan (*Lagopus spp*.), Arctic hare, nesting ducks and geese and their eggs, ringed seal, beached whales, and spawning fish. Sedges and berries are also important dietary components. IQ suggests that grizzly bears are very resilient and capable of adapting to various environments.

The common parasites of grizzly bears include worms of the genera *Diphyllobothrium* and *Baylisascaris*. Other diseases of note that have been observed in grizzly bear populations include *Clostridium* infections (i.e. botulism), toxoplasmosis, canine distemper, and rabies. *Trichinella spiralis* in grizzly bear populations is a concern for public health. It is likely that *Trichinella* infects grizzly bears throughout Nunavut. Grizzly bear meat should be properly cooked prior to consumption to prevent trichinosis in humans.

# 7. CONSERVATION THREATS AND CHALLENGES

Nunavut has an adaptive wildlife management system whereby threats of any kind, including those posed by industrial activity or change in distribution/abundance due to climate change, can be identified and responded to quickly through the NLCA process. The following are current and/or potential future threats facing grizzly bears in Nunavut.

## 7.1 Industrial Activity, Habitat, and Climate Change

Grizzly bears in Nunavut require a large area to sustain a healthy population, find adequate food and denning sites, and for social interactions.

Human resource development is generally considered detrimental to grizzly bears and their habitat. Particularly, grizzly bears in tundra habitats are more likely to be displaced by human activity due to lack of available security (forest) cover. Several active and proposed mines and other industrial pursuits in Nunavut may affect bears indirectly due to increased hunter access from road development leading to an increase in human-bear conflicts and harvest. Co-management partners should provide information and guidelines into process of environmental impact assessment on how to minimize impacts of development on grizzly bears and their habitat.

Climate change is affecting terrestrial and marine environments; however, impacts on grizzly bears are not clear. It is challenging to predict and mitigate the effects of climate change on habitat.

## 7.2 Harvest

Some demographic estimates, such as reproductive parameters for the Kitikmeot region, are from 1990s and little information is available for the Kivalliq. Ongoing studies to determine population status and trend will provide local estimates to extrapolate to territorial estimates. Despite the limited data, there is adequate information, both scientific and local knowledge, to advise decision-makers on appropriate management actions.

**Kitikmeot Region:**

During a grizzly bear collaring project from 1996 to 1999 in the west Kitikmeot/Slave Geological Province, grizzly bear population (3 years old or older) was approximated at a density of 3.5 bears /1,000 $km^2$. In 2008-2009, DOE estimated a density of 5 bears/1,000 $km^2$ in a 40,000 $km^2$ area around Kugluktuk using genetic mark-recapture hair snagging technique. In 2011, to the east of Kugluktuk, in the Doris North Gold project area, Rescan (2012) detected 6 bears/1,000 $km^2$ (39 grizzly bears in a 6,500 $km^2$ study area) using hair snagging technique. With the same technique, to the south, at the Sabina-Back River project area, Rescan (2013) reported a detection of 6–8 grizzly bears/1,000 $km^2$ (109 grizzly bears in ~18,000 $km^2$ study area).

From 1988 to 1995 and from 1996 to 1999, collaring programs on grizzly bears allowed an estimate of the population growth rate of the bear population in the west Kitikmeot. Annual population growth rates were estimated at 1.026 (2.6%) from 1988 to 1995 and 1.033 (3.3%) from 1996 to 1999. Given the west Kitikmeot area is estimated at approximately 150,000 $km^2$ of land, we can therefore estimate a grizzly bear population from 780 to 915 based on the high and low population growth rates above. This slightly increasing trend is consistent with Inuit observations of more grizzlies on the land.

Between 1995 and 2014, the annual harvest of grizzly bears in the Kitikmeot region has fluctuated from 4 to 22 bears/year, with an average of 13 bears/year. Based on an estimate of 780 to 915 bears and the indicators of a positive bear population growth rate, the current harvest rate (1.4 to 1.7%) and the average annual harvest of 13 bears is sustainable. DOE considers a maximum harvest rate of 2% for Nunavut grizzly bears as sustainable; therefore the west Kitikmeot could sustain a slight increase in the annual harvest provided that females are protected.

**Kivalliq Region:**

Grizzly bear densities in the Kivalliq are lower than in the west Kitikmeot; however, adequate scientific studies have not been conducted to estimate actual densities, with the exception of a pilot study on a small scale by Arviat HTO in the periphery of North Henik Lake in 2013. Where 7 individual grizzly bears (4M:3F) were identified with no extrapolation to a regional population estimate.

Local and scientific observations indicate an expansion of grizzly bear range eastward, resulting in an increase in local abundance. Grizzly bear harvest in the Kivalliq has increased substantially since 2008. From 1995 to 2007 the harvest averaged 5 bears annually. From 2008 to 2014, the average annual harvest increased to 18 bears. Based on the available scientific information (increasing proportion of females in the harvest and decreasing proportion of adults in the recent harvest) the current harvest level is probably not sustainable over the long run and may cause a population decline, highlighting the need for harvest monitoring and reporting.

**Nunavut Wide:**

Although there has not been a complete survey of the grizzly bear population in Nunavut, it is estimated that between 1500 and 2000 grizzly bears live in Nunavut (hair snagging studies and visual observations from caribou and muskox surveys). The maximum recommended harvest rate for grizzly bear in Nunavut is 2% of population estimate. With this estimate, the harvest should be around 30 to 40 bears/year. In the absence of better information, a conservative harvest of 30 bears/year seems reasonable (2% of the lowest estimate and 1.5% of the highest estimate).

The average Nunavut harvest from 1995 to 2014 was 22 bears/year. Currently, male grizzly bears represent 80% of the harvest between 1995 and 2014. However, the proportion of females in the harvest varies annually. The harvest of females, and especially females with cubs, is considered to have a greater negative impact on the population. Nevertheless, a highly male biased harvest can also be detrimental.

Considering science and IQ agree that bears have increased in number and range, the current territorial annual harvest average of 22 bears per year does not present an immediate conservation concern.

Sport hunting is an activity that provides economic benefits to communities; the DOE supports the continuation of sport hunting and use of commercial tags. The sport hunting limits or the allocation of resident non-beneficiary harvest limits will be subject to NWMB decision and RWO allocation.

Protection of family groups, bears in dens, and adequate harvest reporting is required to ensure harvest remains sustainable. This will also demonstrate that harvest rates are defensible to other jurisdictions and help maintain trade and sport hunts, which are identified as important by communities.

## 7.3 Grizzly Bears and People

Currently, in many areas of Nunavut, the number of bears encountered in communities and on the land has increased, thus increasing the potential for human-bear conflicts. This public safety issue requires appropriate management action by co-management partners. Although co-management partners in some communities have developed community human-bear conflict management plans, continued efforts at implementation, training and funding for these plans is needed to ensure success.

## 7.4 Working Together

Nunavut's grizzly bear population is shared with the Northwest Territories. Cooperative efforts between jurisdictions on research and monitoring, and consultation should be encouraged. Within Nunavut it is important for co-management partners to effectively participate in management and regulatory processes. An open dialogue with sharing of information and knowledge is crucial to successfully work together, yet this remains a challenge due to logistical constraints and the capacity of co-management partners.

# 8. MANAGEMENT OBJECTIVES AND ACTIONS

The following subsections describe general objectives to address the above threats and challenges, followed by more specific actions to help achieve the objectives.

## 8.1 Industrial Activity, Habitat, and Climate Change

Grizzly bears on the barrens have the largest recorded home ranges in North America. This means that they require significant space to sustain a healthy population, find enough food and denning habitat, and carry out social interactions.

The management of human activities and the environmental impact assessment process are key to ensuring sustainable development of the land, providing economic and social benefits to communities. The environmental impact assessment process should consider grizzly bear needs when assessing proposals of human activity within their range and there should be mitigation and safety measures undertaken to reduce human-bear conflicts.

The potential effects of climate change include changes to primary productivity, which may impact prey species (both plants and animals), as well as changes in denning periods. Understanding the potential impacts, both negative and positive, are key to long-term sustainability of grizzly bears.

Objectives:

- Minimize the impacts of land use activities on grizzly bear movements, habitat, vegetation and prey species
- Ensure co-management partners have the resources and information to effectively participate in management actions
- Examine potential impacts (individual and cumulative) of increasing resource development activities and focus research to better understand climate change impacts, both negative and positive, on ecological conditions that are important to grizzly bears

Actions:

- Provide input into environmental assessment process under (Nunavut Impact Review Board (NIRB) for development projects
- Continue to collect scientific and Inuit knowledge on grizzly bears for use in decision-making and regulatory reviews
- Develop a monitoring plan to provide information on:

i. potential subpopulations delineation
ii. population status and trend
iii. impacts of climate change and potential cumulative impacts of anthropogenic land use.

### 8.2 Harvest Management

Human-caused mortality is the main cause of death in adult and sub-adult grizzly bears; therefore, management of harvest is a key component of grizzly bear management. Harvest, other than defense kills, is conducted as part of traditional and subsistence activities or as part of commercial activities (sale of hides and sport hunts with HTO approval). Considering their relatively low density and long generation time, the grizzly bear population in Nunavut can only sustain a limited harvest.

The current harvest pattern appears to have allowed grizzly bears to increase; however, long term effects of various harvest scenarios require further investigation. Monitoring and obtaining reliable population estimates as well as ensuring harvest levels are sustainable will become increasingly important as the level of human activity increases. Protection of breeding females, family groups, and bears in dens will help mitigate the effects of harvest.

Objectives:

- Maintain a sustainable harvest of grizzly bears and monitor the harvest through reporting and sample collection
- Protect family groups and bears in dens
- Reduce defense kills to allow for increased subsistence harvest while reducing risk to the public in the communities and at camps

Actions:

- Develop a harvest reporting program to support decision making, with appropriate harvest samples and harvest information
- Hunters, on a voluntary basis, refrain from harvesting family groups and bears in dens
- Utilize bear awareness and damage prevention programs to reduce defense of life and property kills (DLPK) and Conduct community education and awareness program to reduce human-bear conflicts

### 8.3 People and Bears

Many problems with bears could be avoided and often result from poor site management or from avoidable encounter-related issues.

From 1980 to 2014, 172 grizzly bears were reported killed in defence of life and property (average of 5/year) representing 27.3% of total reported grizzly bear deaths. However, some problem bears that were shot were reported as subsistence kills, and therefore, the actual number of bears killed as a result of conflicts with people is higher than the reported number.

Inuit have encountered grizzly bears for generations, and have observed an increase in the number of grizzly bears as well as range expansion. Along with the observed increase in bears there have been increasing concerns of public safety, as well as increasing damage to property and food caches. Harvesting of grizzly bears for subsistence, and economic benefit is still very important. Ensuring defense kills are minimized and traditional harvest is maintained is important to communities.

Objectives:

- Continue to develop and improve methods for protection of people, property, and meat caches
- Improve community involvement in protections activities
- Ensure adequate support for community bear monitors (including training and equipment)

Actions:

- Reduce the number of defense of life and property kills (DLPK) by:
    i. Promoting public bear awareness and safety through education
    ii. Identifying factors leading to human-bear conflicts
    iii. Improve communication to the public about bear safety, deterrence, and available programs
    iv. Making deterrent tools available to land users
    v. Install and maintain electric fences in key areas (research camps, Outpost camps, mining and exploration camps, etc.)
    vi. Ensure the Wildlife Damage Compensation and Wildlife Damage Prevention programs are accessible to the public and adequately funded
- Develop and implement Community Bear Plans
- Provide education and training on the use and maintenance of electric fences and other deterrent tools

### 8.4 Working together

This plan was developed with the participation of co-management partners. This is a positive step towards improved cooperative management but more can be done both within Nunavut and with neighboring jurisdictions. Within Nunavut there is a need for improved communication and sharing of knowledge, as well as increased participation of Inuit in research projects.

Objectives:

- Increase involvement of Inuit in research programs

- Improve collection and archiving of IQ so that it is accessible for decision-making.

Actions:

- Develop collaborative research partnerships, particularly for IQ studies, to increase capacity
- Continue to work with HTOs on Inuit involvement in research.

At the inter-jurisdictional level, improved cooperation should be encouraged. This cooperation may include government-to-government and user-to-user agreements.

Objectives:

- Improve inter-jurisdictional coordination
- Build cooperative research programs in areas such as population monitoring and traditional knowledge studies.

Actions:

- Pursue inter-jurisdictional agreements for data sharing and joint research programs
- Develop a knowledge and information sharing framework for co-management partners
- Seek research partnerships with external researchers to increase capacity.

## 10. PLAN REVIEW

In order to be sure that the goal and objectives of this management plan are realized, it is essential to measure progress on the implementation of the plan. The review of objectives in this management plan will occur with co-management partners initially after 5 years, and then every 7 years.

The number of grizzly bears and the trend (population, reproduction, survival rates etc.), the conservation of habitat, incorporation of IQ, number and types of bear-people conflicts are all essential performance measures with which to measure the success of grizzly bear conservation in Nunavut.

## Appendix A - Proposed Research and Monitoring

**Recommended Harvest Monitoring Program**

- Date, location and type of kills and submission of samples
- Human – Bear conflict monitoring.

**Population Monitoring**

- Trend in abundance through hair snagging studies
- Changes in distribution
- Delineation of subpopulations
- Number of females with cubs / yearlings and number of cubs / yearlings by collaring females.

## Appendix B – Selected Relevant Literature


COSEWIC. 2012. COSEWIC assessment and status report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 84 pp. (www.registrelepsararegistry.gc.ca/default_e.cfm).

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Dumond, M., J. Boulanger, and D. Paetkau. 2015. The estimation of grizzly bear density through hair-snagging techniques above the tree line. Wildlife Society Bulletin 9999:1-13; DOI:1002/wsb.520.

Ferguson, S.H. and P. D. Mc Loughlin. 2000. Effect of energy availability, seasonality, and geographic range on brown bear life history. *Ecography* 23(2):193-200.

Hunters and Trappers Organizations, Kitikmeot/Kivalliq Regions. 2004-2015. Minutes of meetings.

McLoughlin, P. D., H. D. Cluff, and F. Messier. 2002. Denning ecology of barren-ground grizzly bears in the central arctic. *Journal of Mammalogy,* 83(1):188–198.

McLoughlin, P. D., M. K. Taylor, H. D. Cluff, R. J. Gau, R. Mulders, R. L. Case, S. Boutin, and F. Messier. 2003. Demography of barren-ground grizzly bears. *Can. J. Zool*. 81: 294–301.

McLoughlin, P. D., R. L. Case, R. J. Gau, H. D. Cluff, R. Mulders, and F. Messier. 2002. Hierarchical habitat selection by barren-ground grizzly bears in the central Canadian Arctic. *Oecologia* 132:102–108.

McLoughlin, P. D., H. D. Cluff, R. J. Gau, R. Mulders, R. L. Case, and F. Messier. 2002. Population delineation of barren-ground grizzly bears in the central Canadian Arctic. *Wildlife Society Bulletin* 30(3):1–10.

Rescan. 2012. Doris North Gold Mine Project: Final Grizzly Bear DNA Report, 2012. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.

Rescan. 2014. Back River Project: Grizzly Bear and Wolverine DNA Report, 2013. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM company.

# Consultations on the Nunavut Grizzly Bear Co-Management Plan

2011-12, 2014 and October 2015 to February 2016

Department of Environment, Government of Nunavut Iqaluit, Nunavut

## Executive Summary

Government of Nunavut, Department of Environment (DOE) representatives conducted consultations with the Hunters and Trappers Organizations (HTOs), Regional Wildlife Organizations (RWOs), and communities from 2011- 2016 in two separate phases. The purpose of the preliminary consultations was to provide co-management partners with an overview of the current lack of management system for grizzly bears, highlight the need for a system, and to gather input on potential management goals and priorities for management.

The draft plan was then developed based on the input from the preliminary consultations. This was followed by a second round of consultations focusing on the initial draft, and input from targeted questions, to help further refine the draft plan.

The focus of the plan is to ensure there is adequate monitoring and reporting of harvest, secure support for protection of family groups and bears in dens, improve efforts to reduce human-bear conflict, and define actions to implement these management efforts. Discussions focused on the increasing number of bears observed in most areas, concerns about public safety and property damage, the need to ensure that harvest is sustainable and defendable, and the need to protect family groups. Support for these management actions was received in the form of HTO's passing motions of support for the proposed management actions.

This report attempts to summarize the comments made by participants during the consultations.

## Preface

This report represents the Department of Environment's best efforts to accurately capture all of the information that was shared during consultation meetings with the Hunters and Trappers Organizations, Regional Wildlife Organizations and communities of the Kivalliq and Kitikmeot regions.

The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

## Table of Contents

## 1.0 Report Purpose and Structure

This report is intended to collate and summarize comments, questions, concerns and suggestions provided by the HTOs, RWOs, and communities to develop a grizzly bear co-management plan. Preliminary consultations were conducted with communities about grizzly bear management to identify the management goals and priorities of:

- Kivalliq Wildlife Board (KWB) and Kivalliq HTOs in 2011-12;
- Kugluktuk, Cambridge Bay and Gjoa Haven HTOs in February 2014.

After these preliminary consultations, a draft management plan was developed incorporating the priorities identified. Secondary consultations on the draft management plan were then conducted with:

- Kitikmeot and Kivalliq Regional Wildlife Boards (RWOs), October 2015;
- All Kitikmeot Region HTOs and communities, October/November 2015 and
- All Kivalliq Region HTOs and communities, January/February 2016.

The draft was revised based on input received and shared again with HTOs, RWOs, Environment and Climate Change Canada (ECCC), Nunavut Wildlife Management Board (NWMB) staff, and Nunavut Tunngavik Inc. (NTI) for a final review in April 2016. The draft has received direction and input from stakeholders from its inception to completion.

## 2.0 Purpose of Consultations

The purpose of the preliminary consultations was to discuss the current status of grizzly bear management in Nunavut, current harvest rates and to identify management goals and priorities for grizzly bears. After the preliminary consultations the draft management plan was prepared and presented at the KWB and the Kitikmeot Regional Wildlife Bard (KRWB) annual meetings and to all relevant HTOs and other co-management partners to obtain further input and direction.

### 2.1 Format of Meetings

For the second round of consultations the draft management plan was shared with co-management partners. In September 2015 a translated PowerPoint presentation, outlining the process, and a summary of the draft by each section and its intent, was submitted to HTOs and RWOs. The boards were requesting to review it and consider specific questions. Later, the HTO and public meetings in the communities were held in the evening or afternoon and ran between 1 to 3 hours depending on HTO/community engagement. Meetings were facilitated and lead by the DOE Carnivore Biologist, who was also the presenter. DOE Regional Wildlife Managers for Kitikmeot and Kivalliq participated where possible in their respective regions. Additionally the draft management plan and process was presented at the KWB and KRWB annual general meetings in October 2015. A translator was present for HTO and public meetings to ensure adequate access for all participants.

A short introduction explained the purpose of the consultation, need for a management plan, historical perspective, legislative uncertainty, and the current management system and harvest rates. Here are some specific questions DOE representatives asked of the HTOs and community members during the consultations;

- Do the guiding principles and goals of the plan reflect IQ?
- Reflection of Inuit knowledge and perspective in the document, are the statements made accurately reflecting current knowledge?
- What are the main issues and challenges from the communities' perspective in regards to grizzly bears? Increasing numbers? Public safety? Ability to have sport hunts? maximum harvest?
- What research do communities want to see, and what will they support?
- What specific actions would communities like to see to implement the management plan?

The participants were invited to ask questions, raise concerns, or provide recommendations throughout the meetings. After the presentation, questions/discussion continued until no further questions were raised. At the end of the meetings DOE requested that HTO boards pass a motion in support of the management plan.

## 3.0 Summary by Community

The objectives were made clear to the HTO members prior to and at the start of each meeting. There were many similar questions, concerns and suggestions raised by HTO Board members across the regions. The Inuit perspective, expressed during consultations, is that all species must be harvested based on need and/or purpose and must be preserved and managed accordingly. During the first phase of consultations, it was identified that Kitikmeot region HTOs want to keep defence kills to a minimum and use the resource for sport hunting, whereas, Kivalliq HTOs (except Arviat) consider grizzly bear as a nuisance and public safety issue and want to keep the population to a minimum. Both regions are in agreement to provide protection to family groups (mothers and cubs) to keep the reproductive potential intact, and to ensure that Nunavut's grizzly bear management system is defendable to other jurisdictions and able to maintain harvest.

When preliminary consultations started in the Kivalliq region, in 2011, Environment and Climate Change Canada officials were completing a CITES non-detriment finding (NDF) for the grizzly bears. During the KWB AGM in June 2011 the uncertainty around legislative management authority, current harvest numbers, and lack of formal harvest management system, along with the possible consequences of negative NDF, were specifically presented and discussed. The KWB passed motion #KWB-AGM-2011 -06-02-J supporting the development of a management plan and urges their members to adopt local hunting rules that include:

1. A buffer zone will be established around each Kivalliq community from which local harvesters will be allowed to harvest Grizzly Bears without further restrictions mentioned below. The area of the buffer zone or distance from the community is yet to be determined through consultation with the communities.
2. Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother and within the designated buffer zone.
3. Grizzly Bears in dens shall be protected and shall not be harassed or disturbed in any way.

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In late 2011 and early 2012 all Kivalliq HTOs supported the KWB motion and development of management plan. The idea of community buffer zones was dropped because most of the land in Kivalliq region is not accessible during the summer.

In early 2014, Kugluktuk, Cambridge Bay and Gjoa Haven HTOs showed support for the management plan and HTOs were interested in minimizing defence kills and using the resource for sport hunting. Kugluktuk and Cambridge Bay HTOs requested an increase in the sport hunt quota. Arviat and Baker Lake HTOs were also interested in the potential of starting sport hunts. The Kitikmeot region HTOs agreed to work with DOE to reduce people/bear conflicts to limit defense kills.

Several members from different HTOs stated that over the past few years that hunters in the Kivalliq and Kitikmeot regions reported seeing more grizzly bears. The number of bears encountered around communities and on the land has been increasing and Inuit families no longer feel safe in camps on land in summer. This presents a public safety issue which requires appropriate management actions by co-management partners. Some HTO members in the Kivalliq region, especially in Baker Lake, expressed their concern regarding the loss of meat caches due to grizzly bears. They are concerned that because of the loss of so much cached meat, it is beginning to change hunting practices and affect their culture. Less people are going to hunt and then cache because of the fear of loss to grizzly bears. Community members feel this could affect future practices and then the loss of these skills.

HTOs and communities in both regions understand the need for some conservation measures, such as protection of family groups and bears in dens, and having a management system in place, to defend the harvest at national and with other jurisdictions.

In the draft management plan we identify that the review of objectives in this management plan will occur with co-management partners after 7 years. However, during consultations a majority of HTOs said that first review should be after 3 years and then all co-management partners can agree review after every 5 or 7 years.

### 3.1 Cambridge Bay Consultation Summary

Community consultations were organized with Ekaluktutiak HTO in February 2014 to identify the management goals and priorities of the communities for the management plan. A second

HTO and public meeting was organized in October 2015 and the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice on the plan.

**Date**: February 26, 2014 and October 28, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

GN-DoE, Regional Wildlife Manager: Mathieu Dumond

Ekaluktutiak HTO Board

**Comments and questions:**

Community members and HTO members expressed that the number of bears encountered around the community and on Victoria Island has been increasing and Inuit families no longer feel safe in summer camping areas. They indicated that there would be support for a management plan as it would convey to other provinces that we are managing our harvest to be sustainable and we are working to reduce human-bear conflict. It was suggested to start a grizzly bear hair snagging research study on Victoria Island because of increasing human-bear conflict around Cambridge Bay in recent years, as well as reports of hybrid bears (with polar bears). The Board requested DOE help to prepare a proposal to get funding from the NWMB.

There is currently no sport hunting in Cambridge Bay but the HTO wants to initiate a sustainable sport hunting program. The community and HTO Board expressed interest in working more on camp cleaning and garbage management, especially in summer camping areas, to reduce the number of defense kills. They also emphasized the need to increase the collection of traditional knowledge.

Members asked for more detail pertaining to the Wildlife Damage and Compensation Program (WDCP), specifically regarding eligibility for the program and whether tent damage is covered under this program.

**Recommendation:**

The Ekaluktutiak HTO board supported the draft grizzly bear co-management plan and the board supported the local hunting practices (letter in Appendix A):

- Report all human related bear deaths/harvest, and provide harvest samples and harvest information for harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.2 Gjoa Haven Consultation Summary

Community consultations were organized with the Gjoa Haven HTO in February 2014 to identify the management goals and priorities of the community for the management plan. A second HTO and public meeting was organized in early November 2015 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Meeting Dates**: February 27, 2014 and November 01, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

GN-DoE, Regional Wildlife Manager: Mathieu Dumond (2014 meeting only)

HTO Board

**Comments and questions:**

HTO member's expressed that the community harvested few grizzly bears but there has recently been an increase in sightings. They feel that grizzly bears are more dangerous and unpredictable than polar bears. They observed it is mostly mothers and cubs doing damage to cabins. Members asked whether there is funding to get training from experienced hunters on how to deal with grizzly bears. One member expressed concern about the impact of grizzly bears and other predators on caribou calving. At the same he mentioned that he has experience from the 1970s bounty program and feels that bounty programs are not successful. Members asked for clarification regarding the necessity of tags for a subsistence harvest. The Board supports the management plan and understands the importance of developing and putting in place a management system to show other jurisdictions that there is adequate management in place. The Board understands that protecting the reproductive potential of the population (protection of family groups) is required to ensure the viability of the grizzly bear population. The HTO also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program.

**Recommendation:**

The HTO board, during the November 01, 2015 meeting, passed a motion (Appendix A) supporting the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The Gjoa Haven HTO agrees to work with the GN to reduce people/bear conflicts to limit defense kills.
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.3 Kugaaruk Consultation Summary

A consultation was organized with the Kurairojuark HTO and community members in November 2015 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Date**: November 04, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

HTO Board and community members

**Comments and questions:**

The HTO member's expressed that the community harvested a grizzly bear in 2012 but there has since been an increase in sightings. Hunters are also harvesting more wolverines in the area as both grizzly bear and wolverine have been extending their range. The Board supports the management plan and understands the importance of developing and putting in place a management system to show other jurisdictions that there is adequate management in place. The chair said that he feels proud that there are no legal restrictions for protection of family groups and bears in dens, but Inuit would support the restrictions to preserve the resource. One member reported that in early days Inuit were harvesting polar bears in dens. The Board understands that to protect the reproductive potential of the population, protection of family groups is required. The HTO also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program.

**Recommendation:**

The Kurairojuark HTO board, in the November 04, 2015 meeting, passed motion#11-004-001 (Appendix A) supporting the development of a grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The HTO agrees to work with GN to reduce people/bear conflicts to limit defense kills.
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.4 Bay Chimo and Bathurst Inlet HTO Consultation Summary

**Purpose of the Consultations:**

A consultation meeting was organized in Yellowknife in October 2015. The draft management plan was presented in order to get their input and discuss the issues the two attending HTOs have regarding grizzly bear management.

**Date**: October 16, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

GN-DoE, Regional Wildlife Manager: Mathieu Dumond

HTO Bay Chimo, Chairperson: Peter Kapolak, Sam Kapolak

HTO Bathurst, Chairperson: Martina Kapolak

KIA: Luigi Torreti

KIA: Environmental Officer

**Comments and questions:**

All three Board members said there are now more grizzly bear sightings in the area. They also indicated there are more grizzly bears in the Bathurst Inlet area, which may impact the caribou on the calving grounds.

**Recommendation:**

The attending members were in support of the management plan. All three members said they support the protection of family groups and bears in dens to maintain the reproductive potential of the population. Board members asked for an increase in sport hunt tags. Only three members were present from two HTOs so there was no quorum for the motion.

### 3.5 Kugluktuk Consultation Summary

A consultation was organized with the Kugluktuk HTO in February 2014 to identify the management goals and priorities of the community regarding the management plan. A second HTO and public meeting was organized on October 2015 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice on the draft plan.

**Meeting Dates**: February 20, 2014 and October 21, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

GN-DoE, Regional Wildlife Manager: Mathieu Dumond

Conservation Officer: Monica Angohiatok

HTO Board

**Comments and questions:**

The HTO and community members expressed that there are now more grizzly bears around the town and on the land during June/July. Safety in the camps was discussed. One member shared his experience of observing a muskox freshly killed by a grizzly bear. The community and HTO Board are interested to work more on camp cleaning and garbage management, especially in summer camping areas, to reduce the number of defense kills. They want to start a traditional knowledge study about grizzly bears. Members also expressed their concern regarding an increase in the number of wolf and grizzly bears and their impact on caribou. At the same they expressed the importance of predators taking the diseased animals and maintaining herd health. We need a balance but there are fewer hunters harvesting predators.

**Recommendation:**

The Kugluktuk HTO board passed the motion 031/2015 (Appendix A), accepting the draft grizzly bear co-management plan. They also recommended an increase in grizzly bear tags from three to five per year. To better manage the grizzly bear population, habitat and harvest, the HTO board will follow the following harvest practices:

- Report all human related bear deaths/harvest,
- provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The Kugluktuk HTO agrees to work with the GN to reduce human-bear conflicts to limit defense kills.
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

## 3.6 Taloyoak Consultation Summary

Community consultations were organized with Taloyoak HTO in October 2015 and the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Date**: October 30, 2015

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

Conservation Officer: David Anavilok

HTO Board

**Comments and questions:**

There is no reported grizzly bear harvest in Taloyoak, but board members indicated that hunters are harvesting wolverines every year and assume grizzly bears will soon be in their area due to increasing numbers and an extension in range. The board supports the management plan and understands the importance of developing and implementing management to show other jurisdictions that there is adequate management in place. The board understands that to protect the reproductive potential of the population, protection of family groups is required.

**Recommendation:**

The HTO Board, during the October 30, 2015 meeting, passed motion #15-10-04 (Appendix A) supporting the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (females with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The HTO agrees to work with GN to reduce people/bear conflicts to limit defense kills.
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.7 Arviat Consultation Summary

A community consultation was organized with the Arviat HTO in October 2011 to identify the management goals and priorities of the community for the management plan. A second HTO and public meeting was organized in January 2016 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the draft plan.

**Meeting Dates:** October 03, 2011 and January 25/27, 2016

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

Kivalliq Regional Wildlife Manager: Dave Vetra/Rob Harmer

Conservation Officer: Joe Savikataaq/Joe Saviktaaq Jr

HTO Board

**Comments and questions:**

The HTO members' main concern was that in recent years they have seen more grizzly bears, and the possibility that their range has expanded. Public safety in summer and cabin damage were the main concerns expressed. The HTO provided some suggestions on how to reduce human-bear conflicts or reduce damage to property. The HTO also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program. The HTO seemed interested in potential economic benefits from a healthy grizzly bear population and may be considering sport hunting to balance grizzly bear numbers in future. The members present enquired about more detail on the harvest of lone cubs and the harvest of black bears. At the end of the board meeting, board decided to arrange a potluck supper in the evening of January 26, 2016 in HTO office with Carnivore Biologist. All board members brought country food and desserts. Leah Muckpah, KWB regional coordinator also participated in supper.

**Recommendation:**

The HTO, in October 03, 2011, supported protection of family groups and bear in dens. On the question of the proposed KWB buffer zone suggestion the HTO wanted more time to discuss with the community.

The HTO Board, during the January 25, 2016 meeting, passed motion #16/01/155 (Appendix A), supported the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.8 Baker Lake Consultation Summary

A community consultation was organized with Baker Lake HTO in February 2012 to identify the management goals and priorities of the communities for the management plan. A later HTO and public meeting was organized in January 2016 where the draft management plan was presented. The aim of this meeting was to gather the community members' concerns and input about the draft plan.

**Meeting Dates**: February 04, 2012 and January 21/22, 2016

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

Kivalliq Regional Wildlife Manager: Dave Vetra/Rob Harmer

Conservation Officer: Russell Toolooktook

HTO Board

**Comments and questions:**

The HTO members' main focus was regarding caribou meat caches. Some members expressed that the situation in Baker Lake is different from other communities; they are dependent only on caribou meat (no seal or walrus available) so to protect and save their meat caches is very important for them. The HTO provided some suggestions how to reduce human-bear conflicts or reduce damage to property and they emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program. The HTO seemed interested in potential economic benefits from a healthy grizzly bear population and may be considering sport hunting to balance grizzly bear numbers in future. One board member was in support of harvest restrictions, and a full ban on the hunting of family groups. He suggested that people may say that a family group was shot in defense of life.

The HTO members commented that their grandparents did not have issues with grizzly bears and that this is only a recent issue. The number of bears encountered around communities and on the land more recently, has been increasing and Inuit families no longer feel safe in camps on land in summer. They are concerned that, because of the loss of so much cached meat, it is beginning to change hunting practices and affect their culture. Fewer community members are going to hunt and then cache because of the fear of loss to grizzly bears. This could affect future practices and lead to the loss of these skills.

**Recommendation:**

The HTO, in the February 04, 2012 meeting, supported KWB motion #KWB-AGM-2011 -06-02-J (letter attached Appendix A).

The HTO board, in motion #2016-01-22-01 (Appendix A), supported the development of the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (females with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.9 Chesterfield Inlet Consultation Summary

A community consultation was organized with the Aqiqiq HTO in February 2012 to identify the management goals and priorities of the communities for the management plan. A second HTO and public meeting was organized in early February 2016 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Meeting Dates**: February 14, 2012 and February 02, 2016

**Representatives:**

GN-DoE, Carnivore Biologist : Malik Awan

Kivalliq Regional Wildlife Manager: Dave Vetra

Conservation Officer: Peter Katagatsiak

HTO Board

**Comments and questions:**

The Aqiqiq HTO members expressed that there are not too many grizzly bears in their area, but the board supports the management plan and understand the importance of developing and implementing the management system. The board understands that to protect the reproductive potential of the population, protection of family groups is required. The HTO also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program.

**Recommendation:**

The Aqiqiq HTO, in the February 14, 2012 meeting, supported KWB motion #KWB-AGM-2011 -06-02-J (letter attached Appendix A).

The Aqiqiq HTO board, in motion #048/16 (Appendix A), supported the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### 3.10 Rankin Inlet Consultation Summary

A community consultation was organized with the Kangiqliniq HTO in March 2011 to identify the management goals and priorities of the community for the management plan. A second consultation was organized in February 2012, during the HTO regular meeting, to discuss the KWB June 2011 letter and supported KWB motion. In early February 2016 the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Meeting Dates**: March 02, 2011 and February 03, 2016

**Representatives:**

GN-DoE, Carnivore Biologist: Malik Awan

Kivalliq Regional Wildlife Manager: Dave Vetra

NTI: Director of Wildlife: Gabriel Nirlungayuk (2011 meeting)

NTI: Bert Dean (2011 meeting)

NTI: Robert Karetak

HTO Board

**Comments and questions:**

At the March 2011 meeting, representatives of NTI (Gabriel and Bert) also participated and further highlighted the importance of the Environment and Climate Change Canada NDF process for CITIES and its impacts on potential economic benefits. The members present agreed that there is a need for a management plan. The members discussed that their community does not harvest grizzly bear as a practice and they are not in support of this high harvest, but grizzly is a dangerous species, destroying property and meat caches. To reduce human- bear conflict, members suggested a buffer zone around the community (30-50 miles radius). Every grizzly bear in this buffer zone should be shot, and all bears outside the buffer zone should be protected. The HTO suggested that the Wildlife Damage Prevention and Compensation program should be executed by HTOs. The cost to own and maintain cabins is increasing and the compensation amount should increase according to that cost. The Kangiqliniq HTO is in support of more research on grizzly bears but against capturing/handling of bears. Member's expressed that there is not an overabundance of grizzly bears in their area, but the Board supports the management plan and understands the importance of developing and implementing a management system. The board members understand that to protect the reproductive potential of the population, protection of family groups is required. The HTO members also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program.

**Recommendation:**

The HTO, in the February, 2012 meeting, supported the KWB motion #KWB-AGM-2011 -06-02-J regarding the protection of family groups and bears in dens.

During the February 03, 2016 meeting, the HTO board agreed and indicated they understand the need of a management system. Their main concern was public safety and they want to harvest every grizzly bear close to town, but at the same they are in support of developing and implementing a management system to maintain the opportunity to trade and sell hides. The board did not support the protection of family groups and bears in dens and requested additional time to discuss the issue with their community.

### 3.11 Repulse Bay Consultation Summary

A community consultation was arranged with the HTO for February 4th and 5th. The HTO Chair was willing to conduct this meeting on February 4th, but board members were not available for the meeting and it was cancelled. The second draft of the co-management plan was submitted to the HTO for their comments and review on March 31, 2016. The board approved the co-management plan (email attached appendix A).

### 3.12 Whale Cove Consultation Summary

A community consultation was organized with the Issatik HTO in October 2011 to identify the management goals and priorities of the community for the management plan. A second HTO and public meeting was organized in January 2016 where the draft management plan was presented. The aim of this meeting was to gather the community members' input and advice about the plan.

**Meeting Dates**: October 05, 2011 and January 29/30, 2016

**Representatives:**

GN-DoE, Carnivore Biologist : Malik Awan

Kivalliq Regional Wildlife Manager (trainee): Jonathan Pameolik

HTO Board/Public meeting

**Comments and questions:**

The Issatik HTO member's expressed that there are now more grizzly bears in the area and the grizzly bear range is extending in the east. Board members said that due to forest fires and development in the south, grizzly bears seem to be moving further north. The HTO chair mentioned that low harvest rates before 2008 were due to less reporting because people thought there was a harvest quota; bears were harvested but not reported. Public safety and human-bear conflict was their main concern expressed during the consultation. The board reported that grizzly bears are more dangerous than polar bears but the board supports the management plan and understand the importance of developing and implementing a management system. The HTO also emphasized the need to improve the GN Wildlife Damage Prevention and Compensation program.

**Recommendation:**

The Issatik HTO, in the October 05, 2011 meeting, supported the KWB motion #KWB-AGM-2011-06-02-J (letter attached Appendix A).

The Issatik HTO board, in motion #142-17-16 (Appendix A) on March 04, 2016, supported the grizzly bear co-management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

## 4.0 Summary

The primary concerns, as expressed by HTO members during the consultations, focused on the increasing number of bears observed and the increasing range bears are occupying. This was followed by concerns for public safety and property damage and the need to ensure programs are in place to address these concerns. HTOs want appropriate compensation for property damage, are interested in improving garbage and campsite clean-up on the land, and are willing to work toward improved cooperation on reducing human-bear conflict. There was expressed understanding of and support for a management system to ensure that the harvest was sustainable and defendable, and to ensure that any economic benefits were maintained. Support was provided in the forms of official motions by HTO boards in support of specific management actions including:

- Reporting of all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups (sows with cubs) shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

### Appendix 1- Support letters/Motions

Appendic A support letters_1.pdf

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**Kivalliq Wildlife Board**

June 7, 2011

Malik Awan
Wildlife Biologist Carnivores
Government of Nunavut
Igloolik, Nunavut

RE: Grizzly Management in the Kivalliq Region

Dear Malik,

The Kivalliq Wildlife Board Held their Annual General Meeting on May 31st to June 2nd and had the opportunity to discuss Grizzly Bear management in Nunavut. The statistics provided during your presentation were very informative and greatly assisted the Board in establishing the foundation for a management system.

Board Members raised numerous concerns pertaining to the safety of residents within the Kivalliq, particularly during vulnerable periods such as berry season, but also at camps, concerns of destruction of property and there is certainly no argument that the Grizzly Bear is an invasive species to this region. Inuit just recently found out that no restrictions exist for the harvesting of Grizzly Bears, which would account, in part, for the high numbers of animals harvested in the last few years.

The KWB however feels, as do all Inuit, that all species must be harvested based on need and/or purpose and must be preserved and managed accordingly. The KWB passed motion #KWB-AGM-2011-06-02-J supporting the development of a management plan for Grizzly Bears for the Kivalliq Region and urges their Members to adopt local hunting rules that include the following statements.

1. A buffer zone will be established around each Kivalliq community from which local harvesters will be allowed to harvest Grizzly Bears without further restrictions mentioned below. The area of the buffer zone or distance from the community is yet to be determined through consultation with the communities.
2. Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother and within the designated buffer zone.
3. Grizzly Bears in dens shall be protected and shall not be harassed or disturbed in any way.

**Kivalliq Wildlife Board** :: P.O. Box 219 :: Rankin Inlet, NU :: X0C 0G0 :: tel. 867.645.4860 :: fax. 867.645.4861
ᑭᕙᓪᓕᕐᒥ ᐅᒪᔪᓕᕆᔨᐊᒃᑯᑦ :: ᑎᑎᕐᑲᓂᐊᕐᕕᐊᑕ ᕿᔪᕐᑯᑖ 219 :: ᑲᖏᕿᓂᕐᒃ, ᓄᓇᕗᑦ :: X0C 0G0 :: ᐅᖄᓗᑖ 867.645.4860 :: ᓱᑲᔪᒃᑯᑦᑎᑖ 867.645.4861

The Board wishes to point out that the above restrictions do not apply to circumstances where human safety or destruction of property occurs.

The KWB looks forward to working with the GN and other co-management partners in the development of this management plan. Please do not hesitate to contact us if you have any questions.

Sincerely,

Ross Tatty
KWB Chairman

David Vetra, GN
Jonathan Pameolik, GN
Mitch Campbell, GN
Mathieu Dumond, GN
Gabe Nirlungayuk, NTI
David Lee, NTI
Jim Noble, NWMB
Raymond Ningeocheak, NWMB
Mikki Akkavak, NWMB
Alex Ishalook, HTO Arviat
Mike Panika, HTO Whale Cove
Jack Kabvitok, HTO Rankin Inlet,
Jayko Kimmaliardjuk, HTO Chesterfield Inlet
Richard Aksawnee, HTO Baker Lake
Michel Akkuardjuk, HTO Repulse Bay
Noah Kudluk, Coral Harbour
Attima Hadlari, KRWB

ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ

Kivalliq Wildlife Board

ᔫᓐ 7, 2011

ᒪᓕᒃ ᐊᕙᓐ
ᐆᒪᔪᓂᒃ ᖃᐅᔨᓴᖅᑎᒻᒪᕆᐅᔪᖅ
ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᖏᑦ
ᐃᒡᓗᓕᒃ, ᓄᓇᕗᑦ

ᐱᔾᔪᑎᖓ: ᐊᒃᓚᐃᑦ ᐊᐅᓚᑕᐅᓂᖏᑦ ᑭᕙᓪᓕᕐᒥ

ᒪᓕᒃ,

ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᑲᑎᒪᓂᖃᓚᐅᕐᒪᑕ ᐅᑭᐅᑕᒫᖅᓯᐅᑎᒥᒃ ᒦ 31ᒥᒃ ᔫᓐ 2ᒧᑦ ᐅᖃᐅᓯᖃᓚᐅᖅᐳᑦ ᐊᒃᓚᐃᑦ ᐊᐅᓚᑕᐅᓂᖏᓐᓂᒃ ᓄᓇᕗᒻᒥ. ᖃᐅᔨᓴᕈᑎᕕᓂᐅᔪᑦ ᓴᕿᑕᐅᓚᐅᖅᑐᑦ ᑐᓴᖅᑎᑦᓯᑦᓯᐊᕐᑐᒻᒪᕆᐅᓚᐅᖅᐳᑦ ᖃᓄᐃᑦᑑᓂᖓᓂᒃ ᐊᒻᒪ ᐃᑲᔪᖅᓯᓂᖃᑦᓯᐊᖅᓯᓂ ᑲᑎᒪᔨᓂᒃ ᓴᕿᑎᕆᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᒐᔭᖅᑐᒥᒃ.

ᑲᑎᒪᔩᑦ ᐊᑕᐅᓯᐅᖏᑦᑐᒥᒃ ᐃᓱᒫᓗᑎᒥᓂᒃ ᓴᕿᑦᓯᒪᐅᖅᐳᑦ ᐃᓕᖓᔪᓂᒃ ᓄᓇᓕᐅᔪᑦ ᑭᕙᓪᓕᕐᒥ ᐅᓗᕆᐊᓇᖅᑐᒦᑦᑕᐃᓕᒪᓂᖏᓐᓂᒃ ᐱᓗᐊᖅᑐᒥ ᐸᐅᕐᖓᖅᑕᖅᓇᖅᑎᓪᓗᒍ ᑭᓯᐊᓂᑦᑕᐅᖅ ᐊᐅᓛᖅᓯᒪᒡᕕᐅᔪᓂ, ᐃᓱᒫᓗᑎᖃᓚᐅᕐᒪᑕ ᓯᕐᑯᑦᑎᕆᖅᑦᑕᕐᓂᖏᓐᓂᒃ ᐱᕐᑯᑎᒋᔭᐅᔪᓂᒃ ᐊᒻᒪ ᓇᓗᓇᖏᑦᓯᐊᒻᒪᕆᖕᒪᑦ ᑕᒪᒃᑯᐊ ᐊᒃᓚᐃᑦ ᐸᕕᓴᖅᑎᒻᒪᕆᐅᖕᒪᑕ ᑕᐃᒪᓐᓇ ᑕᒫᓂ ᑭᕙᓪᓕᕐᒥ. ᐃᓄᐃᑦ ᖃᐅᔨᓕᖅᑳᓚᐅᕐᒪᑕ ᑕᒪᒃᑯᓄᖓ ᖃᓄᓕᓚᒃ ᓄᖅᑲᖓᔪᐊᑎᖅᑲᕆᓕᐊᖓᓂᒃ ᐊᖑᓇᓱᖕᓂᕐᒧᑦ ᐊᒃᓚᓂᒃ, ᑕᒪᓐᓇᓗ ᓇᓗᓇᐃᖅᓯᔾᔪᖅ ᓱᖓᒪᑦ ᐊᒥᓱᓂᒃ ᐊᕐᓚᖅᑦᑕᖅᓯᒪᖕᒪᖔᖓᑦ ᐅᑭᐅᖑᖅᑲᐅᔪᓂ.

ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᑭᓯᐊᓂ ᐃᓱᒪᖕᒪᑕ, ᐃᓄᐃᓪᓗ ᑕᐃᒪᐃᒃᑭᓪᓗᑎᒃ, ᑕᒪᒃᑯᐊ ᐆᒪᔪᑦ ᐊᖑᓇᓱᒃᑕᐅᖃᑦᑕᕆᐊᖃᕐᓂᖏᓐᓂᒃ ᐱᔭᕆᐊᖃᒻᒪᕆᒃᐸᑕ ᑭᓯᐊᓂ ᐊᒻᒪ ᐊᐅᓚᑕᐅᑦᓯᐊᕆᐊᖃᕐᓂᖏᓐᓂᒃ ᓈᒻᒪᑦᓯᐊᖅᑐᒃᑯᑦ. ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᐱᕐᑯᔨᕗᖕᒐᕈᑎᒥᒃ ᓴᕿᑦᓯᓕᓚᐅᖅᐳᑦ ᓈᓴᐅᑎᓕᖕᒥᒃ #KWB-AGM-2011-06-02-J ᐃᑲᔪᖅᓯᔪᒥᒃ ᓴᕿᑎᕆᓂᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᐊᒐᒃᓴᒥᒃ ᐊᒃᓚᐃᑦ ᐱᔾᔪᑎᒋᓪᓗᒋᑦ ᑭᕙᓪᓕᕐᒥ ᐊᒻᒪ ᐊᔭᐅᖅᑐᐃᓪᓗᑎᒃ ᑲᑎᒪᔨᓂᒃ ᑎᒍᓯᕐᑯᔨᓪᓗᑎᒃ ᐱᕐᑯᔭᓂᒃ ᓄᓇᓕᖕᓂ ᐊᖑᓇᓱᖕᓂᕐᒧᑦ ᐅᑯᓂᖓ ᐃᓚᖃᕐᓗᑎᒃ.

1. ᓱᑯᑦᓯᐊᓂ ᐊᖑᓇᓱᒍᓐᓇᕐᒪᖕᒪᑦ ᓇᓗᓇᐃᖅᓯᒪᔪᑦ ᑭᕙᓪᓕᕐᒥ ᓄᓇᓕᐅᔪᓂᒃ ᐊᒃᓚᒐᓱᒡᕕᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᓯᖏᓐᓂᒃ ᓄᖅᑲᖑᔪᐊᑎᖅᑲᖏᓪᓗᑎᒃ ᐅᖃᐅᓯᐅᔪᓂᒃ ᐊᑖᓂ. ᑕᒪᓐᓇ ᓱᑯᑦᓯᐊᓂ ᐊᖑᓇᓱᒃᑕᑉᐸᓐᓇᕋᔭᕐᓂᐅᔪᑦ ᓱᓕ ᐋᕿᒃᑕᐅᒋᓂᒃᓯᒪᖏᑦᑐᖅ ᓄᓇᓕᖕᓂ ᑐᓴᕆᐊᖅᑕᖏᓐᓂᕐᒥᓂᒃ.
2. ᖃᑦᖑᒍᑎᒋᒃᑐᑦ, ᐊᑎᖅᑕᓕᑦ ᐱᔭᐅᑦᑕᐃᓕᓂᐊᖅᐳᑦ ᓇᓕᖅᑎᒌᓕᓚᐅᒃᖄᖅᑎᓐᓇᒋᑦ ᐊᓈᓇᒥᓂᒃ ᐊᒻᒪ ᐊᖑᓇᓱᒡᕕᐅᔪᓐᓇᖅᑐᒦᖏᑐᐊᕐᐸᑕ.
3. ᓇᓄᐃᑦ ᐃᒡᓗᒥᓃᑦᑐᑦ ᐱᔭᐅᑦᑕᐃᓕᓂᐊᖅᐳᑦ ᐊᒻᒪ ᐸᕝᕕᓴᒃᑕᐅᖏᓪᓗᑎᒃ ᖃᓄᑐᐃᓐᓇᖅ.

ᑲᑎᒪᔩᑦ ᖃᐅᔨᒪᕐᑯᔨᕗᑦ ᑕᒪᒃᑯᐊ ᐊᑐᓇᐊᖅᑯᓂᐊᖅᑐᑦ ᐃᓕᖓᓂᐊᕐᒥᒪᑕ ᐃᓄᖕᒥᒃ ᐅᓗᕆᐊᓇᖅᑐᒦᑦᑐᖃᓕᕐᓂᐊᖅᐸᑦ ᐅᕙᓘᓐᓃᑦ ᐱᕐᑯᑎᖏᓐᓂᒃ ᓯᕐᑯᑦᑎᕆᔭᐅᓕᕐᓂᐊᕐᐸᑦ.

ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ ᓂᕆᐅᓐᓂᖃᑦᓯᐊᖅᐳᑦ ᐱᓕᕆᖃᑎᖃᑦᓯᐊᕐᓂᐊᕐᓂᕐᒥᒃ ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᓐᓂᒃ ᐊᒻᒪ ᐊᓯᖏᓐᓂᒃ ᐱᓕᕆᖃᑕᐅᒐᔭᖅᑐᓂᒃ ᑕᒪᑐᒥᖓ ᓴᕿᑎᕆᓕᖅᑎᓪᓗᑎᒃ

**Kivalliq Wildlife Board** :: P.O. Box 219 :: Rankin Inlet, NU :: X0C 0G0 :: tel. 867.645.4860 :: fax. 867.645.4861

ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔩᑦ :: ᑎᑎᖅᑲᓂᐊᕝᕕᐊ ᕿᔪᖅᑯᑦ 219 :: ᑲᖏᖅᖠᓂᖅ, ᓄᓇᕗᑦ :: X0C 0G0 :: ᐅᖄᓚᑦ 867.645.4860 :: ᓱᑲᔪᒃᑯᕈᑦ 867.645.4861

ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᖃᓄᖅᑰᕈᑎᐅᓚᔭᖅᑐᒥᒃ. ᐅᕙᑦᑎᓐᓄᑦ ᐅᖃᓗᒃᑕᐃᓕᓂᐊᕐᒥᓚᑎᑦ ᐊᐱᕐᑯᑎᒃᓴᖃᓚᖕᓂᕈᕕᑦ.

ᑎᑎᕋᖅᑐᖅ,

ᕌᔅ ᑕᑎ,
ᑭᕙᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦᑕ ᐃᒃᓯᕙᐅᑕᖓ

ᑎᕕᑦ ᕕᑐᐊ, ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᑦ
ᔮᓇᑕᓐ ᐸᒥᐅᓕᒃ, ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᑦ
ᒥᑦᓯ ᑳᒻᐳᓪ, ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᑦ
ᒫᑎᐅ ᑐᒫᓐᑦ, ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᑦ
ᒦᑉ ᓂᕐᓘᖕᒐᔪᖅ, ᓄᓇᕗᒻᒥ ᑐᖕᒐᕕᒃᑯᑦ
ᑎᕕᑦ ᓖ, ᓄᓇᕗᑦ ᑐᖕᒐᕕᒃᑯᑦ
ᐹᒻ ᓅᐳᓪ, ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᐊᐅᓚᑦᑎᔨᖏᑦᑕ ᑲᑎᒪᔨᖏᑦ
ᓈᒪᓐ ᓂᖏᐅᑦᓯᐊᖅ ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᐊᐅᓚᑦᑎᔨᖏᑦᑕ ᑲᑎᒪᔨᖏᑦ
ᒥᑭ ᐋᑲᕙᒃ, ᐆᒪᔪᓕᕆᔨᕐᔪᐊᒃᑯᑦ ᐊᐅᓚᑦᑎᔨᖏᑦᑕ ᑲᑎᒪᔨᖏᑦ
ᐋᓕᒃᓴ ᐃᓴᓗᒃ, ᐊᕐᕕᐊᓂ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᒪᐃᒃ ᐸᓂᑲ ᑎᑭᕋᕐᔪᐊᓂ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᔮᒃ ᖃᕐᕚᑦᑐᖅ ᑲᖏᖅᖢᓂᕐᒥ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᔭᐃᑯ ᑭᒪᓕᐊᕐᔪᒃ, ᐃᒡᓗᓕᒑᕐᔪᖕᒥ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᓇᑦᓯᑦ ᐊᖅᓴᕐᓂᖅ, ᖃᒪᓂᒃᑐᐊᕐᒥ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᒪᑦᓯᓪ ᐊᑯᐊᕐᔪᒃ, ᓇᐅᔮᑦ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
ᓄᐊ ᑲᓪᓚᒃ, ᓴᓪᓕᕐᒥ ᐆᒪᔪᓕᕆᔨᐊᓖᒃᑯᑦ
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**Ekaluktutiak Hunters & Trappers Organization**
*P.O. Box 1270 Cambridge Bay, Nunavut X0B 0C0*
*Telephone #: (867) 983-2426 Facsimile #: (867) 983-2427*
**Email: ehtocb@qiniq.com**

January 22, 2016

To Whom it may concern:

RE: Letter of Support

The Ekaluktutiak Hunters & Trappers Organization supports *The Grizzly Bear Management Plan* for the Cambridge Bay area submitted and co-managed by Malik Awan, Wildlife Biologist Carnivores from Department of Environment, Government of Nunavut.

Upon a Board meeting with Malik on October 28, 2015 it was discussed that this management plan is much needed in order to reduce the people bear conflict in Cambridge Bay area, start grizzly bear research studies and sustainable harvest of the species. We need management system in place to convince the other provinces that our harvest is sustainable.

Board supports the local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;

The above restrictions do not apply to circumstances where human safety or destruction of property occurs

Bobby Greenley
Chairman, Ekaluktutiak HTO

28-JAN-2016
Date

Cc: Malik Awan, Wildlife Biologist Carnivores
Department of Environment
Government of Nunavut
Igloolik, NU

Kugluktuk Angoniatit Association • Hunters' and Trappers' Organization
P.O. Box 309, Kugluktuk, Nunavut X0B 0E0 • Phone: (867) 982-4908 • Fax: (867) 982-5912
E-mail: kugluktukhto@qiniq.com

January 5, 2015

Malik Awan
Wildlife Biologist Carnivore
Department of Environment
Government of Nunavut
P.O. Box 209
Igloolik, Nunavut X0A 0L0
Ph: (867) 934-2179
Fx: (867) 934-2190

On a meeting dated November 09, 2015 at 7 p.m. (Adjukak Centre), the Kugluktuk Angoniatit Association, Board of Directors made the following recommendation and motion in order to accept the DRAFT Nunavut Grizzly Bear Co-Management Plan.

Motion # ______031/2015__________ Meeting # ________006/2015______
Motion moved by: __________Jorgen Bolt____________________________
Seconded by: __________Chrissy Newman______________________

**"Whereas the Kugluktuk Angoniatit Association, Board of Directors makes a motion to recommend an increase of the grizzly bear sports hunting tags from three to five tags in the Grizzly Bear Management Plan for Kugluktuk.**
**M/C # 031/2015 Jorgen Bolt/Chrissy Newman Carried"**

Also the following practices will be followed in order to better manage the grizzly bear population, habitat(s) and harvesting practices:

- To report all human related bear deaths/harvest(s).
- To provide appropriate harvest samples and harvest information to provide data to better monitor harvesting.
- The family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother.
- Grizzly bears in dens shall be protected and shall not be harassed or disturbed.
- The Kugluktuk HTO agrees to work with partners to reduce people/bear conflicts to limit defense kills.
- The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

Signed: Chairperson David Nivingalok
David Nivingalok

Signed: ViceChairperson ____________________
Colin Adjun

Gjoa Haven HTO:

There are no restrictions/limits on beneficiary subsistence harvest of grizzly bears. However, Inuit perspective is that all species must be harvested based on need and/or purpose and must be preserved and managed accordingly.

The HTO supports (through motion) the development of a management plan for Grizzly Bears and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The HTO agrees to work with partners to reduce people/bear conflicts to limit defense kills.

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

Motion passed on November 01, 2015 in HTO board meeting:

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ORGANIZATION

**KURTAIROJUARK HUNTERS & TRAPPERS ASSOCIATION**

***Board of Directors Meeting***

Motion #__11-04-001_______________

Motion moved by:__Barnaby Immingark___

Seconded by:__Jocelino Sigguk__________

WHEREAS, ______Kurtairojuark Hunters and Trappers Association Board of Director's suppots the development of a management plan for Grizzly Bears and local hunting practices that includes the following:

- ____ Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The HTO agrees to work with partners to reduce people/bear conflicts to limit defense kills.

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In favor:____________
Against:____________
Abstentions:__________

Carried: ✓
Defeated: ____

Date: ____November 04_____________________________,2015

Columban Pujuardjuk, Chairperson

Joshua Kringorn, Manager

**Kurtairojuark Hunters & Trapper Association**
P.O. Box 114 Kugaaruk, Nunavut X0B 1K0
Tel: (867) 769-7002 Facsimile: (867) 769-6713
Email: kugaarukhto@netkaster.ca

# Taloyoak HTO

**Taloyoak HTO understand that there are no restrictions/limits on beneficiary subsistence harvest of grizzly bears. However, Inuit perspective is that all species must be harvested based on need and/or purpose and must be preserved and managed accordingly.**

**The HTO supports (through a motion) the development of a management plan for Grizzly Bears and local hunting practices that include the following:**

- **Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;**
- **Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;**
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;
- The HTO agrees to work with partners to reduce people/bear conflicts to limit defense kills.

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

Motion made by David Irquit, second by Abel Aqqaq Carried motion # 15-10-04

ᖃᒪᓂᑦᑐᐊᕐ ᐊᖑᓇᓱᒃᑎᖕᑎᑦ Baker Lake H.T.O.
PH: 867-793-2520 Box 255 FAX-867-793-2034
BAKER LAKE, NU. X0C-0A0

February 6, 2012

Malik Awan
Wildlife Biologist Carnivores
Government of Nunavut
Igloolik, Nunavut

**RE: Grizzly Management in the Kivalliq Region**

Dear Malik,

The Baker Lake HTO held their special meeting on February 4, 2012, during your presentation, board discussed in detail KWB letter dated June 7, 2011 and buffer zone around community.
HTO supports the KWB motion (#KWB-AGM-2011-06-02) and recommended 80 km area of buffer zone around community.
HTO look forward to working with you in the development of grizzly bear management plan.

Joan Scottie
Manager
Baker Lake HTO
Baker Lake, NU
X0C 0A0

# AQIGIQ HUNTERS & TRAPPERS ORGANIZATION

February 14, 2012

Malik Awan
Wildlife Biologist Carnivores
GN Department of Environment
Igloolik, Nunavut

**<u>RE: Grizzly Management in the Kivalliq Region</u>**

Dear Malik,

Aqigiq Hunters and Trappers Organization (HTO) held their special meeting on February 13, 2012, and discussed KWB letter dated June 7, 2011 about protection of family groups, bear in dens and buffer zone around community. HTO board supports the KWB motion (#KWB-AGM-2011-06-02) and recommended 80 km area of buffer zone around the community.

HTO board look forward to working with you in the development of grizzly bear management plan.

Jayko Kimmaliardjuk
Chairman
Aqigiq HTO
Chesterfield Inlet, NU, Box 94 X0C 0B0

P.O. Box 94, Chesterfield Inlet, Nunavut X0C 0B0
Telephone (867) 898-9063 Fax (867) 898-9079

Malik Awan

Wildlife Biologist Carnivores

Government of Nunavut

Igloolik, Nunavut

RE: Grizzly Management in the Kivalliq Region

Dear Malik,

Hunters & Trappers Organization in Whale Cove had a regular board meeting regarding Grizzly Management in the Kivalliq Region; the Board of Directors made a Motion # 54/17/10/2011 in support of KWB's letter from June 7, 2011.

Manager for Whale Cove HTO

Lisa Jones

Dated: January 25, 2016

Motion # 16/01/155

Motion moved by: Gordy Kidlapik

Seconded by: Jamie Kablutsiak

WHEREAS, Arviat Hunters and Trappers Organization Board of Director's support the grizzly bear management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In favour:6

Against:0

Chair:

Alex Ishalook

ᖃᒪᓂᑦᑐᐊᖅ ᐊᖑᓇᓱᒃᑎᖏᑦ Baker Lake H.T.O.
PH: 867-793-2520 Box 255 FAX-867-793-2034
BAKER LAKE, NU. X0C-0A0

Dated: January 22, 2016

Motion:

Board of Directors Meeting

Motion # 2016-01-22-01

Motion moved by: Jamie Seeteenak

Seconded by: Thomas Anirniq

WHEREAS, Baker Lake Hunters and Trappers Organization Board of Director's supports the development of a management plan for Grizzly Bears and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In favor: 5

Against: 0

Manager/Chair: [illegible]

Dated: February 02, 2016

Motion #048\16

Motion moved by: Mark Amarok

Seconded by: Leonie Mimialik

WHEREAS, Aqigiq Hunters and Trappers Organization Board of Director's support the grizzly bear management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In favour: 4

Against Ø

Barney Aggark
Chairperson
Aqigiq HTO
Chesterfield Inlet

**Aqigiq Hunters and Trappers Organization ᐊᕿᒋᖅ ᐆᒪᔪᓕᕆᔨᐋᓗᑦ ᑲᑎᒪᔨᖏᑦ**
P.O. Box 94 Chesterfield Inlet, Nunavut, X0C 0B0 ᑎᑎᖅᑲᒃᑯᕕᒃ 94 ᐃᒡᓗᓕᒑᕐᔪᒃ, ᓄᓇᕗᑦ, X0C 0B0
(867) 898-9063 (867) 898-9079 htochester@qiniq.com

## Awan, Malik

**From:** Dolly Mablik <repulsebayhto@qiniq.com>
**Sent:** April 13, 2016 11:42 AM
**To:** Awan, Malik
**Subject:** Re: draft Grizzly Bear Management Plan
**Attachments:** repulsebayhto.vcf

Good morning,

The board of director's in Naujaat do approve the co-management plan.

Dolly

On 3/31/2016 5:27 PM, Awan, Malik wrote:
> Hi All,
> Please find attached draft grizzly bear management plan for your boards review. It reflects what was discussed during our consultations in January/February 2016 with your board/community on the 1st draft of the management plan. If you have any further comments or questions please respond before the end of April 2016.
> Thanks for your support for the management plan.
>
> Best regards,
> Malik Awan
>
> ___________________________________________
> Malik  Awan
> Wildlife Biologist Carnivores
>
> Department  of Environment
> Government of Nunavut
> Box 209 Igloolik, NU X0A 0L0
> Ph: 867-934-2179
> Fax: 867-934-2190
>

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ISSATIK HUNTERS AND TRAPPERS ORGANIZATION

Dated: March 4, 2016

Motion # 142-17-16
Moved by: Chris Jones
Seconded by: James Enuapik
- Carried -

WHEREAS, Issatik Hunters and Trappers Organization Board of Director's support the grizzly bear management plan and local hunting practices that include the following:

- Report all human related bear deaths/harvest, provide appropriate harvest samples and harvest information for the harvest monitoring;
- Family groups, sows with cubs, shall be protected and not be harvested unless the cubs have reached the same size as the mother;
- Grizzly Bears in dens shall be protected and shall not be harassed or disturbed;

The above restrictions do not apply to circumstances where human safety or destruction of property occurs.

In favour: 4

Against: 0

Robert Enuapik
Chairperson,
Issatik Hunters and Trappers Organization

**Issatik Hunters and Trappers Organization** ᐃᓵᑎᒃ ᐆᒪᔪᓕᕆᔨᐊᓛᑦ ᑲᑎᒪᔨᖏᑦ
P.O. Box 119 Whale Cove, Nunavut, X0C 0J0 ᑎᑎᖅᑲᒃᑯᕕᒃ 119 ᑎᑭᕋᕐᔪᐊᖅ, ᓄᓇᕗᑦ, X0C 0J0
(867) 896-9944 (867) 896-9143 whalecovehto@qiniq.com

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information:** **Decision: X**

**Issue:** There needs to be a limit for the sport hunt of grizzly bears set through the Nunavut Wildlife Management Board since there is no Total Allowable Harvest (TAH) and currently no mechanism to assign tags for sport hunting purposes.

**Background:**

- Historical sport hunting limits for both the Kivalliq and Kitikmeot regions had been set at 10 tags per region by the government of Northwest Territories.
- Sport hunting is an activity that provides economic benefits to communities; the Department of Environment supports the continuation of sport hunting and use of commercial tags.

**Current Status:**

- There is currently no TAH set for Grizzly Bear harvest in Nunavut and no plans to establish one.
- The Inuit harvest of grizzly bears is currently unlimited and included as part of the Wildlife Act and regulations.
- The Government of Nunavut has recently determined that the current wildlife regulations do not properly allow sport hunting tags to be issued in the Kivalliq and Kitikmeot regions.
- A decision from the NWMB on sport hunting limits would be required to facilitate sport hunting tags to be issued as described in the Nunavut Land Claims Agreement (NLCA; e.g. 5.2.33(C) and 5.2.35).
- The Wildlife regulations do not include grizzly bear in the schedule of annual or daily harvest limits for residents, non-residents, and non-resident foreigners
- The current estimated territorial annual harvest average of 22 bears/year does not present an immediate conservation concern for grizzly bear (Appendix 1; Draft Nunavut Grizzly Bear Co-Management Plan)

- The DOE has developed a draft Grizzly Bear Management Plan which includes scientific research and Inuit Qaujimajatuqangit collection and extensive community consultation from both the Kivalliq and Kitikmeot regions (Appendix 1).
- The Department of Environment consulted with Hunters and Trappers Organizations (HTOs) to determine an acceptable number of sport hunt tags for grizzly bears as there is no TAH and currently no mechanism to assign tags to non-Inuit sport hunters (Appendix 2; Sport Hunting Consultation Summary).

Kivalliq community recommendations

| Community | Date of Consultation | In Favor of Sport Hunting | Recommended Number of Sport Hunt Tags |
|---|---|---|---|
| Arviat | May 4, 2017 | Yes | 8 sport hunts per Kivalliq community |
| Baker Lake | May 4, 2017 | Does not support sport hunting near Baker Lake | 0 |
| Chesterfield Inlet | June 27, 2017 | Yes | 5 sport hunts for Chesterfield Inlet |
| Coral Harbour | May 8, 2017 | Yes | 20 sport hunts for the region (4 for Coral Harbour) |
| Naujaat | May 3, 2017 | Does not support sport hunting near Naujaat | 0 |
| Rankin Inlet | No HTO meetings for several months | N/A | N/A |
| Whale Cove | May 17, 2017 | Yes | 10 sport hunts for the region |

Kitikmeot community recommendations

| Community/HTO | Date of Consultation | In Favor of Sport Hunting | Recommended Number of Sport Hunt Tags |
|---|---|---|---|
| Cambridge Bay | May 11, 2017 | Yes | 10 sport hunts for Victoria Island; 15 for Kitikmeot region |
| Burnside HTO | June 14, 2017 | Yes | No number |

| | | | |
|---|---|---|---|
| | | | recommended |
| Omingmaktok HTO | Not available for consultation | N/A | N/A |
| Gjoa Haven | July 20, 2017 | Yes | 10 sport hunts for region |
| Kugaaruk | May 17, 2017 | Does not support sport hunts | 0 |
| Kugluktuk | June 21, 2017 | Yes | 10 tags recommended for both sport hunts and resident harvest combined |
| Taloyoak | May 4, 2017 | Does not support sport hunts | 0 |

- Most HTOs commented that they would like the ability to revisit the quota should concerns arise.
- The HTO recommendations for the amount of sport hunts does not differ significantly from the historical sport hunting limits of 10 per region, set by the Government of Northwest Territories.
- The DOE has ongoing research to better understand the current abundance and population trends for grizzly bear in Nunavut.
- The allocation of sport hunting tags would allow for better harvest information to complement research efforts.
- The Department is not planning to establish a TAH for grizzly bear but in order for HTOs to assign sport hunt tags to non-Inuit hunters, there must be a limit set through the Nunavut Wildlife Management Board.

**Recommendations:**

- The Nunavut Wildlife Management Board considers using historical sport hunting numbers to set grizzly bear sport hunting limits to 10 tags per region until such time that there is more comprehensive information on the grizzly bear population within the regions.
- Sport Hunting tag allocation within each region would be the responsibility of the Regional Wildlife Organizations.
- Administration of the tags to outfitters would occur, based on HTO approval, by the Conservation Officers in the local Wildlife Office.

**Appendix 1: Draft Nunavut Grizzly Bear Co-Management Plan (attached as separate document)**

**Appendix 2: Grizzly Bear Sport Hunt Consultation Summary (attached as separate document)**

## CONSULTATION SUMMARY FOR GRIZZLY BEAR SPORT HUNTING LIMITATIONS

3 May, 2017: Arviq HTO, Naujaat

4 May, 2017: Arviat HTO, Arviat

4 May, 2017: Baker Lake HTO, Baker Lake

4 May, 2017: Spence Bay HTO, Taloyoak

8 May, 2017: Aiviit HTO, Coral Harbour

11 May, 2017: Ekaluktutialik HTO, Cambridge Bay

17 May, 2017: Kurtairojuark HTO, Kugaaruk

17 May, 2017: Issatik HTO, Whale Cove

14 June, 2017: Burnside HTO, Cambridge Bay

21 June, 2017: Kugluktuk HTO, Kugluktuk

27 June, 2017: Aqigiq HTO, Chesterfield Inlet

20 July, 2017: Gjoa Haven HTO, Gjoa Haven

Department of Environment, Government of Nunavut

Iqaluit, NU

Prepared: 14 August, 2017

## Executive Summary

There is currently no Total Allowable Harvest (TAH) established for grizzly bears in Nunavut and the current Wildlife regulations do not have a sport hunting limit set for residents, non-residents, and non-resident foreigners. As a result, there is no appropriate mechanism to assign sport hunting tags without a decision on sport hunting limitations from the Nunavut Wildlife Management Board (NWMB).

Historically, the Government of Northwest Territories had set sport hunting limits to 10 tags per region for both the Kivalliq and the Kitikmeot. When the territory of Nunavut was formed, this harvesting limitation was no longer part of the new regulations. Sport hunting is an activity that provides economic benefits to communities and the Department of Environment (DOE) supports the continuation of sport hunting but there needs to be a proper mechanism for the issuance of sport hunting tags. Based on current research done in the Kivalliq and Kitikmeot regions and Inuit Qaujimajatuqangit (IQ) collected during the drafting of the draft Grizzly Bear Management Plan, the current average grizzly bear harvest does not present an immediate conservation concern. The Inuit harvest of grizzly bears is unlimited and would remain unchanged but the harvest through sport hunting needs to have a set limitation.

DOE Conservation Officers consulted with as many Hunters and Trappers Organizations as possible during their regular meetings in the Kivalliq and Kitikmeot regions of Nunavut between May and July of 2017. The primary purpose of these consultations was to determine sport hunting limitation recommendations from each community to assist the DOE in providing appropriate recommendations to the NWMB for decision.

The recommendations from each of the consulted community HTOs were sent by the attending conservation officers to the two regional wildlife managers who then reported the information back to the Coordinator of Operations and Regulations. The recommendations were compiled and used to form the DOE recommendations for grizzly bear sport hunting limitations.

The recommendations that were offered by the consulted communities did not differ greatly from the historical sport hunting limitations that had been set by the Government of Northwest Territories. Due to ongoing research on grizzly bear abundance and population trends, the historical sport hunting limitations are likely appropriate until such time that there is more comprehensive information, scientific and IQ, within both regions.

## Preface

This report represents the Department of Environment's best efforts to accurately capture all of the information that was shared during consultation meetings with the Hunters and Trappers Organizations of the Kitikmeot and Kivalliq regions.

The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

# Table of Contents

## 1.0 Report Purpose and Structure

This report is intended to: 1) provide the details of why and how DOE consulted with various Hunting and Trapping Organizations (HTOs) in the Kivalliq and Kitikmeot regions to discuss grizzly bear sport hunting limitations and community recommendations and 2) collate and summarize recommendations provided by the HTOs. The following community HTOs were consulted between May and July 2017:

- 3 May, 2017: Arviq HTO, Naujaat
- 4 May, 2017: Arviat HTO, Arviat
- 4 May, 2017: Baker Lake HTO, Baker Lake
- 4 May, 2017: Spence Bay HTO, Taloyoak
- 8 May, 2017: Aiviit HTO, Coral Harbour
- 11 May, 2017: Ekaluktutialik HTO, Cambridge Bay
- 17 May, 2017: Kurtairojuark HTO, Kugaaruk
- 17 May, 2017: Issatik HTO, Whale Cove
- 14 June, 2017: Burnside HTO, Cambridge Bay
- 21 June, 2017: Kugluktuk HTO, Kugluktuk
- 27 June, 2017: Aqigiq HTO, Chesterfield Inlet
- 20 July, 2017: Gjoa Haven HTO, Gjoa Haven

After these consultations, the DOE will provide a submission to the NWMB for decision that includes a recommendation on sport hunting limitations for both regions.

## 2.0 Purpose of Consultations

The purpose of these consultations was to discuss grizzly bear sport hunting limitations for each of the regions of Nunavut that currently hunt grizzly bear. Each community consulted was asked whether or not they support grizzly bear sport hunting and to provide a recommendation for their region that reflects how their community values grizzly bear sport hunting. After the consultations, the DOE will submit grizzly bear sport hunt limitation recommendations for the Kivalliq and Kitikmeot regions to the NWMB for decision. This decision will allow for the continuation of grizzly bear sport hunting through the proper issuance of sport hunting tags.

### *2.1 Format of Meetings*

Conservation officers (COs), in each of the Kivalliq and Kitikmeot communities, were instructed to attend their local HTO regular meeting to discuss sport hunting limitations. The meetings were held in the evenings and the CO-led consultation was part of the regular agenda. The CO asked each HTO how many tags they would like to see being made available for sport hunts since there was no TAH for the species.

The following questions were asked at each consultation:

- What does the HTO consider to be a reasonable number of bears to be made available for sport hunting for their community and or for the region?
- Does the HTO have any concerns surrounding the hunting of grizzly bears?

## 3.0 Summary by Community

### *3.1 Arviat Consultation Summary*

**Date**: 4 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Joe Savikataaq Jr.
- Arviat HTO: Thomas Alikaswa
- Arviat HTO: Dicky Hapanaq
- Arviat HTO: Gordy Kidlapik
- Arviat HTO: Sam Garry Muckpa

**Comments and questions:**

In response to questions asked by Officer Savikataaq regarding the sport hunting of grizzly bears, all HTO members present were in support of having grizzly bear sport hunts. The was unanimous support for 8 grizzly bear sport hunt tags available for Arviat, as well as 8 per community for the rest of the Kivalliq Region. There were no concerns in relation to grizzly bear sport hunting; they feel that too many caribou meat caches and cabins are broken into on a regular basis

### *3.2 Baker Lake Consultation Summary*

**Date**: 4 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Russell Toolooktook
- Baker LakeHTO Members

**Comments and questions:**

The Baker Lake HTO does not support sport hunts for residents (non-beneficiary) or non-residents. They do not want to see a TAH implemented on Inuit.

### *3.3 Burnside HTO Consultation Summary*

**Date**: 14 June, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Candice Sudlovenick
- Burnside HTO memebers

**Comments and questions:**

The Burnside HTO was in favour of grizzly bear sport hunting but did not provide a recommendation of how many should be set as a limitation.

### *3.4 Cambridge Bay Consultation Summary*

**Date**: 11 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Shane Sather
- Ekaluktutialik HTO Members

**Comments and questions:**

The Ekaluktutialik HTO was in support of grizzly bear sport hunting and recommended 15 sport hunts for the Kitikmeot region.

### *3.5 Chesterfield Inlet Consultation Summary*

**Date**: 27 June, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Peter Kattegatsiak Sr.
- Aqigiq HTO Members

**Comments and questions:**

There was unanimous favour for grizzly bears being made available for sport hunting. They recommended 5 tags for Chesterfield Inlet for sport hunts, but did not provide input as to what a regional number should be.

### *3.6 Coral Harbour Consultation Summary*

**Date**: 8 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Peter Kattegatsiak Sr.
- Aiviit HTO Members

**Comments and questions:**

The Aiviit HTO stated that they wouldn't mind seeing up to 20 sport hunt tags made available for the Kivalliq Region. They would like to see 4 of those 20 tags allocated to Coral Harbour to open up more outfitting opportunities in Coral Harbour, in order to be able to offer muskox/grizzly bear sport hunt packages.

### *3.7 Gjoa Haven Consultation Summary*

**Date**: 27 June, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Peter Aqqaq
- Gjoa Haven HTO Members

**Comments and questions:**

The Gjoa Haven HTO board passed a motion supporting 10 grizzly bear sport hunt tags being made available for the Gjoa Haven area. They had no comment on what limit should be made on the regional level.

### *3.8 Kugaaruk Consultation Summary*

**Date**: 17 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Chad Bruneski
- Kurtairojuark HTO Members

**Comments and questions:**

The Kurtairojuark HTO does not support sport hunts in the Kugaaruk area, as not many grizzly bears are seen. They did not provide input as to how many should be made available on the regional level.

### 3.9 Kugluktuk Consultation Summary

**Date**: 21 June, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Allen Niptanatiak
- Kugluktuk HTO Members

**Comments and questions:**

The Kugluktuk HTO was in favor of increasing the tags usually made available for Kugluktuk from 5 tags to 10 tags for Kugluktuk. The 10 recommended tags would be for both sport hunts and resident (non-beneficiary harvest).

### 3.10 Naujaat Consultation Summary

**Date**: 3 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: Peterloosie Papatsie.
- Arviq HTO Members

**Comments and questions:**

The Arviq HTO feels that there should be no grizzly bear sport hunts in the Naujaat area. This is due to the low number of grizzly bears in the area. They did state that the subject could be revisited if the grizzly bear numbers were to rise. They did not comment on sport hunting at a regional/territorial level, just specifically to the Naujaat area.

### 3.11 Omingmaktok HTO Consultation Summary

**Date**: N/A

**Representatives:** N/A

**Comments and questions:**

The Omingmaktok HTO did not have any input to provide in regards to grizzly bear sport hunts.

### 3.12 Rankin Inlet Consultation Summary

**Date**: N/A

**Representatives:** N/A

**Comments and questions:**

There were no HTO board members present in Rankin Inlet available for a meeting when requested. HTO has not had meetings for an extended period of time.

### *3.13 Taloyoak Consultation Summary*

**Date**: 4 May, 2017

**Representatives:**

- GN-DOE, Conservation Officer: David Anavilok
- Spence Bay HTO Member: Sam Tulurialik
- Spence Bay HTO Member: George Aklah
- Spence Bay HTO Member: Bruce Takolik

**Comments and questions:**

No grizzly bears seen around Taloyoak, did not have input on how many sport hunts should be available. They do not support sport hunts in the Taloyoak area, and did not want to comment on the regional levels.

### *3.14 Whale Cove Consultation Summary*

**Date**: 17 May, 2017

**Representatives:**

- GN-DOE, Regional Manager: Rob Harmer
- Issatik HTO Members

**Comments and questions:**

The Issatik HTO was in support of 10 tags being made available for sport hunting in the Kivalliq Region. They want to make sure that the quota may be revisited should concerns arise.

## 4.0 Summary

All but two HTOs within the Kivalliq and Kitikmeot regions were available for consultation between May and July of 2017. The communities that were consulted expressed whether or not they were in favour of grizzly bear sport hunting around their community and most provided a recommendation for the number of sport hunting tags that should be set for their community and/or their region. The overall recommendations did not differ significantly from the historical sport hunting limitations that had been set by the government of Northwest Territories before the creation of Nunavut. Most HTOs expressed that they would like the ability to revisit any set limitation in the future should concerns arise. Higher limitation recommendations were given by communities in the parts of the regions with higher grizzly bear densities and regions with fewer bears tended to offer lower limitation recommendations or a recommendation or no sport hunting at all for their community.

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Qikiqtaaluk Wildlife Board

Shewchuk

Daniel [redacted], Acting Chair
Nunavut Wildlife Management Board
Iqaluit, Nunavut
Sent to: receptionist@nwmb.com

July 19, 2017

**Re: QWB request for a flexible quota system for Devon Island Muskoxen**

Hello Daniel,

I am writing to the Nunavut Wildlife Management Board to request the implementation of a flexible carry-forward system for Devon Island muskox TAH.

Currently, the TAH for Devon Island muskoxen is 100. At our July Executive meeting, QWB confirmed that for the 2017/18 year, each of the eligible communities: Grise Fjord, Resolute Bay, Pond Inlet and Arctic Bay should be allocated 25 tags each. The Executive also discussed improvements to the TAH system. The attached resolution was passed confirming this discussion and decision. The proposed system would allow unused tags to be carried forward for up to three years.

QWB understands that current population numbers of this subpopulation are healthy, and current harvest rates would not pose a significant impact to the population. QWB believes implementing a flexible quota system would not impact the sustainability of the population. As you are well aware, such a system is in place for both Narwhal and Polar Bear.

We believe that there are significant benefits of establishing such a flexible, carry-forward TAH system. The communities must travel significant distances to harvest this subpopulation. A flexible system could allow the communities to organize larger harvests, either on their own or in conjunction with the other communities. This could enable economies of scale with the results of such organized hunts being distributed amongst participating communities or sold commercially.

Thank you for your consideration,

J Qillaq

James Qillaq, Chair
Qikiqtaaluk Wildlife Board

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Qikiqtaaluk Wildlife Board

ᔪᓚᐃ 19, 2017

Dᐋᓂᐅᓪ ᓯᐅᑦᓵᒃ, ᐃᒃᓯᕙᐅᑕᐅᑲ ᐃᓐᓇᖅᑐᖅ
ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᖅᓯᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ
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ᑎᑎᖅᑲᖅ ᑖᑲ ᐅᑎᕆ ᕕᖕᒪᓂᑦ ᑐᓯᖅᑕᐅᓗᓂ ᐅᕗᖕᖓ: receptionist@nwmb.com

**ᐱᔾ ᔪᑎᖅᖢᖅ: ᕿᑭᖅᑖᓗᒃ ᐆᒪᔪᓕᕆᔨᑦ ᑲᑎᒪᔨᖏᓐᓂᒃ ᑐᒃᓯᕋᐅᑎᑦ ᐋᕿᒋᐊᖅᑕᐅᖃᑦᑕᕆᐊᓕᓐᓂᐊᖅᑐᓂᒃ ᐅᒪᖕᒥᒍᓐᓇᐅᑎᖃᕈᒪᓂᖏᑦ ᑕᐅᕙᖕᖓ ᑖᓐ ᓄᕈᑎᑉ ᐅᒥᖕᒪᖏᓐᓂᒃ**

Dᐋᓐ ᓂᐊᓖᖕᐃ,

ᑎᑎᕋᕝᕕᖓ ᕙᓯ, ᓄᓇᕗᒻᒥ ᐆᒪᔪᓕᕆᔨᖅᓯᐊᒃᑯᑦ ᑲᑎᒪᔨᖏᑦ, ᑐᒃᓯᕋᕝᕕᖓᓐᓂ ᒍᑦ ᐊᑐᕐᓂᖅᑎᑦ ᑎᓯᓇᖅᓂᖏᑦ ᐋᕿᒋᐊᖅᑕᐅᖃᑦᑕᕆᐊᓕᓐᓂᐊᖅᑐᓂᒃ ᐱᔭᓐᓇᐅᑎᖃᕈᒪᓂᖏᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᖏᓐᓂᒃ ᑖᓐ ᓄᕈᑎᓂᒃ, ᑕᐃᒃ ᑯᐊᓗᓯᕗᒍᑦ ᐊᑐᓕᒃ ᓴᐅᑲᓐᓂᕈᓐᓇᖅᑕᑦ ᓄᑎᒃ ᑕᒪᐃᓐᓂᒃ ᑲᑎᓐᓂᕐᒥᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᒃ ᓴᓇᕙᒃ ᑖᖏᑦ.

ᒫᓐᓇᐅᓕᖅᑐᖅ, ᑕᒪᕐᒥᒃ ᑲᑎᑕᐅᓗᑎᒃ ᐅᒥᖕᒪᖏᓐᓇᖏᑦ ᑕᐅᕙᖕᖓ ᑖᓐ ᓄᕈᑎᓂᒃ 100-ᖑᓂᓪᓗ. ᑕᐃᑲ ᓂ ᑲᑎᒪᔨᑦᑕ ᐊᐅᓚᑦᑎᔨᖏᑦ ᑲᑎᒪᓂᖏᑦ ᓂᔭᓚᐃᖑᑎᓪᓗᒍ, ᕿᑭᖅᑖᓗᒃ ᐆᒪᔪᓕᕆᓂᖅ ᒧᑦ ᑲᑎᒪᔨᖏᑦ ᓇᓗᓇᐃᖅᓯᑎᑦᑎᓚᐅᖅᑐᑦ ᐊᕿᒍᒥ 2017/18-ᒥ ᓗ, ᐊᑐᓂ ᓄᓇᓖᑦ ᐃᓚᒋᔭᐅᓂᐊᓕᖅᑐᓂᒃ ᐅᑯᓂᖕᓂ ᐊᐅᔨᐃᕝᑐᖅ, ᖃᐅᔨᐃᑦᑐᖅ, ᒥᑦᑎᒪᑕᓕᒃ ᐊᓪᓗ ᐃᒃ ᐱᐊᕐᔪᒃ, ᐊᑐᓂᓗ ᐱᔭᓐᓇᕐᓂᐊᓕᖅᓯᑎᒃ 25-ᓂᒃ. ᐊᐅᓚᑦᑎᔨᒥᔭᕗᑦ ᑕᐅᕙ ᐅᖃᐅᓯᖃᓚᐅᖅᑐᑦ ᒥᔪᑦ ᐱᐅᓯᕆ ᐊᕈᑎᒃ ᓴᓂᒃ ᑕᒪᐃᓐᓂᒃ ᑲᑎᓐᓂᕐᒥᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᖏᓐᓂᒃ ᐋᕿᒃᓯᒪᔾᔭᐅᔭᓂᒃ ᒫᓐᓇᐅᔭᖅ. ᑖᒃ ᑯᓇᓐᓂᖅᑕᐅᕙᑦ ᐱᖁᔨᕗᖕᒋᐅᓐᑦ ᑲᔪᓯᑎᑕᐅᓚᐅᖅᑐᑦ ᐅᓂᒃ ᑳᖅᓯᒪᑦᑎᐊᖅᑐᑦ ᐅᖃᐅᓯᐅᓚᐅᖅᓯᓂᖏᓐᓂᒃ ᐊᓪᓗ ᐃᓯᒪᓕᕈᑕᐅᓚᐅᖅᓯᓂᖏᓐᓂᒃ. ᐱᒋᐊᖅᑎᑕᐅᔭᒪᔭᑦ ᐊᑐᓕᒃ ᓴᓄᑦ ᐋᕿᒃᑲᓕᖅᓯᖅᑐᑦ ᐱᔭᓐᓇᐅᑕᐅᔭᖅᑐᑦ ᑕᐃᒃ ᑯᓂᖕᐊᑐᖅᑕᐅᓚᐅᖏᑦᑐᓂᒃ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᓂᒃ ᐃᓚᓯᒃ ᑲᓐᓂᕈᓐᓇᖅᓯᔪᓐᑦ ᐊᑐᓕᒃ ᓴᐅᓂᐊᓕᖅᒥᔪᓐᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᓄᑦ, ᐱᖕᖑᓄᑦ ᐊᕿᒍᓄᒃ ᓄᑕᐅᔭᓐᓇᕐᓂᒃ ᓯᕗᓪᓕᐊᒃ ᑕᐅᕝᕙᖅᑕᕐᓂᒃ ᓄᒃ.

ᕿᑭᖅᑖᓗᒃ ᐆᒪᔪᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᑦ ᑐᑭᓯᐅᒪᕗᑦ ᒪᓐᓇᐅᔪᖅ ᐅᒥᖕᒪᐃᑦ ᐊᒥᓲᓂᖏᑦ ᖃᓄᐃᖏᑦ ᑎᐊᕐᒪᑕ, ᐊᓪᓗ ᒫᓐᓇᐅᔪᖅ ᐅᒥᖕᒪᑦ ᑕᐅᔭᓐᓇᖏᑦ ᐱᓪᓚᕆᐊᓗᐊᕐᒥᒃ ᐊᔾᔨᐅᓇᔭᖅᑐᑎᒃ ᐊᒥᓲᓂᖏᓐᓂᒃ ᑕᐅᕙᓂ ᐅᒥᖕᒪᖏᑦ. ᕿᑭᖅᑖᓗᒻᒥ ᐆᒪᔪᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᑦ ᓯᓚᑦᑐᓴᖕᒪᑕ ᐊᑐᓕᖅᑎᑕᐅᓂᖏᑦ ᐋᕿᒋᐊᖅᑕᐅᖃᑦᑕᕆᐊᓕᓐᓂᐊᖅᑐᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᖏᓐᓂᒃ ᐋᕿᒃᓯᒪᓕᖅᑎᑕᐅᓇᖅᑐᑦ ᐊᒃ ᑐᖅᓯᓯᒪᓇᔭᖏᑦᑐᑦ ᐊᒥᓲᓂᖏᑦ ᐊᒥᓲᖏᓐᓂᒃ. ᖃᐅᔨᒪᓕᖅᑎᑕᐅᖅᐳᓯ ᑕᐃᒪ, ᑕᐃᒪ ᐃᓕᖕᖑᓂᖅᑎᒥᒪᓕᑕ ᐊᔾᔨᖏᓐᓂᒃ ᐆᒪᔪᑦ ᓂᕆᐊᕈᓐᓇᐅᑎᖏᓐᓂᒃ, ᑕᐃᒃ ᑯᓂᖕᖑᑐᓕᕐᓂᒃ ᕿᓚᒧᒃᑯᓐᓇᐅᑎᖏᓐᓂ ᐊᓪᓗ ᓇᓐᓄᓐᓇᐅᑎᖏᓐᓂ.

ᐅᒃ ᐱᖁᑦᑎᒍᑦ ᐱᓪᓚᕆᐅᔭᓂᒃ ᐃᑲᔪᖅᓂᖅᑯᓐᓇᖏᓐᓂᒃ ᓴᕿᑎᑦᑎᓇᔾᔪᑎᒃ ᐋᕿᒋᐊᖅᑕᐅᖃᑦᑕᕆᐊᓕᓐᓂᐊᖅᑐᓂᒃ, ᓯᕗᓪᓕᖅᐊᑐᓕᒃ ᓴᓕᐊᓇᔭᐅᒃ ᑲᓐᓂᕈᓐᓇᖅᓯᐊᖅᑐᓂᒃ, ᑕᐃᒃ ᑯᐊ ᑕᒪᐃᓐᓂᒃ ᑲᑎᓐᓂᕐᒥᑦ ᐅᒥᖕᒪᖏᓐᓇᐅᑎᒃ ᓴᖏᓐᓂᒃ. ᓄᓇᓖᑦ ᐅᖑᕝ ᑐᒃ ᑲᓪᓚᕆᐊᓗᒍᖅᐳᔭ ᓇᐊᖅᓴᓕᑕᐅᒥᓪᓕᑦ ᓯᐅᓂᖅ ᒧᑦ ᐅᒥᖕᒪᖅᕕᐅᔪᓂᒃ. ᐋᕿᒋᐊᖅᑕᐅᔭᓐᓇᖅᓯᒍᑎᒃ, ᓄᓇᓖᑦ ᐊᒥᓲᓂᖅᓴᐅᔪᓂᒃ ᐅᒥᖕᒪᖕᓂᐊᖅᑕᖅᓯᒪᓕᕐᓂᐊᖅᑐᑦ ᐃᓚᖅ ᓱᒃ ᓱᓐᓂᐊᖏᑦᑐᓂᒃ ᓄᓇᓕᖕᓂ ᐱᓇᓱᖅᑎᓯᐊᖅᑖᖏᑦ ᓂ. ᐱᔭᓐᓇᐅᑕᐅᔪᓐᓇᖅᓯᓚᑦ ᐱᓇᔪᓕᐅᑕᐅᔭᓐᓇᖅᓯᓂᕐᒧᑦ ᓴᕿᑦᑐᓐᓇᖅᑐᓂᒃ ᑲᑐᔾᔨᖅᑎᕆᑦ ᑐᑦ ᐊᖕᒋᖅᑎᐊᖅᑕᕈᑎᒃ ᑕᐃᒃ ᑯᓇᓂ ᐃᓚᒌᒍᓐᓇᖅᑐᓂ ᓄᓇᓕᖕᓂ ᐃᓚᒋᔭᐅᓂᐅᒃ ᕙᓗᓐᓃᑦ ᓂᐅᕐᕈᑎᒃ ᓴᖅᑯᓐᓇᕐᓯ ᑐᑎᒃ.

ᖁᔭᓐᓇᒦᒃ ᐃᓯᒪᒃ ᓴᖅᓯᐅᕈᑎᒋᓯᒪᓂᐊᕋᕕᐅᒃ ᑕᒪᓐᓇ,

J Qillaq

ᔾᔭ ᐃᒥᓯ ᕿᓪ ᓚᖅ, ᐃᒃᓯᕙᐅᑕᖅ
ᕿᑭᖅᑖᓗᒃ ᐆᒪᔪᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔨᖏᓐᓂ

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information:** **Decision: X**

**Issue:** Polar Bear Total Allowable Harvest Recommendations for the Western Hudson Bay Sub-population

**Background:**

- The Western Hudson Bay (WH) polar bear subpopulation is shared with Manitoba (Figure 1).
- In 2005/2006, polar bear Memoranda of Understanding (MOUs) came into effect and the Total Allowable Harvest (TAH) for WH polar bears was increased from 47 per year to 56 per year. The WH MOU (Section 5.7.1) states that when new research information becomes available the TAH will be corrected as necessary.
- New information from Canadian Wildlife Service (CWS), Environment and Climate Change Canada (ECCC) in February 2005 indicated that the estimated abundance had decreased by approximately 22% from 1200 to 935 bears between 1984 and 2004. The researchers attributed this decline in population size to the combined effects of progressive sea-ice decline causing reductions to survival and recruitment rates, and subsequent unsustainable control and harvest removals.
- In contrast to the scientific findings, the observations by local hunters in Nunavut and Inuit traditional ecological knowledge (TEK) suggested that the population may not be declining.
- Climate change may have altered polar bear distribution patterns and behaviour, giving Inuit hunters the impression that there are more bears because there are more bear-human encounters. However, it may also be true that both population numbers and population performance have been underestimated by previous scientific studies which failed to include the entire summer retreat area used by WH polar bears.
- The Nunavut TAH for WH was reduced to 38 bears for 2007-2008, and then set at 8 bears per year for the 2008-2009, 2009-2010 and 2010-2011 seasons. Removals for control actions (defense kills), combined with regular harvest, exceeded the TAH (8) every year following the reduction.

- In 2011, the TAH was set at 21 bears as an interim measure in anticipation that new research results would be available in 2012.
- An aerial survey of the entire summer range of the WH population was conducted by the Government of Nunavut (GN) in 2011 in collaboration with the Government of Manitoba. The survey estimated the population size at approximately 1030 bears (754 – 1406, 95% CI). The report stated that, "the aerial survey-derived estimate is consistent with the 2004 capture-based estimate but inconsistent with projections suggesting continued decreases in abundance".
- The Nunavut Wildlife Management Board (NWMB) set a new TAH for WH at 24 polar bears for three years, to be formally reviewed following the 2014-15 harvest season, or at such time as new relevant information becomes available.
- The NWMB made an initial decision on 31 March 2015 to increase the TAH for WH by 14 to a total of 38 bears, which the Minister disallowed in his initial reply. The NWMB's final decision was made on 7 October 2015 which remained at 38 bears. The Minister varied the NWMB decision on 23 October 2015 to an increase of 4 bears to a total regional TAH of 28 bears for the 2015/2016 harvest season (Figure 2).
- Since the 2011 aerial survey of the WH subpopulation, new information became available from the analyses of long-term mark-recapture work (1984 – 2011) conducted by ECCC. Their results indicated that the 2011 WH polar bear estimate was 806 bears (715-1398, 95% CI), which was roughly consistent with the abundance estimate derived from the aerial survey.
- A declining trend in population size was detected between 1987 and 2004, but the population appears to have remained relatively stable over the past decade. Female growth (the proportion of females in the population) also appeared to have been stable with a female population growth rate of 2% annually for the period 1991-2011(Lambda = 1.02 (0.98-1.06, 95% CI)).
- The study also indicated that survival of females of all ages was correlated with sea ice conditions, and was generally lower in years of earlier break-up. However, although the study found long-term (1979-2012) trends in earlier break-up and freeze-up, no such trends were apparent during the last decade (2001-2011), suggesting there has been a period of relative stability in sea-ice conditions.

**Current Status:**

- A new collaborative aerial survey study was conducted between 12 – 22 August, 2016 to re-assess the abundance of the WH polar bear subpopulation (Figure 3).
- The new sub-population estimate was assessed at 842 bears (562-1121, 95% CI; 16.9% Coefficient of Variation) during August of 2016.
- During the time of the survey, very few bears (~5.3%) were sighted in Nunavut, with the vast majority summering in Manitoba.

- As with the last survey, indicators of reproductive performance were poorer in WH polar bears during 2016 when compared to any other subpopulation in the Hudson Bay complex (e.g. polar bear cubs-of-the-year and yearlings presented a small proportion of the total observations).
- The new population estimate is lower than that of the previous (2011) aerial survey, but not significantly since confidence intervals overlap. The current estimate is not significantly different from the 2011 aerial survey estimate of 949 bears (618–1280, 95% CI) based upon similar transect sampling methods and analysis of covariates ($t=0.48$, $df=452$, $p=0.63$).

**Consultations:**

- Community consultations were held with HTO representatives from Rankin Inlet, Arviat, Whale Cove and Chesterfield Inlet between 4 and 7 July 2017, also including participants from Nunavut Tunngavik Inc. (NTI) and the Kivalliq Wildlife Board (KWB).
- During those meetings, results of the 2016 GN-led aerial survey were discussed, in addition to the GN recommendation of no change to the current TAH of 28 bears, given the results of the study.
- Several communities indicated their support for fall coastal surveys to assess bear distribution that could assist in preventing problem bear occurrences, as well as support for a more detailed traditional knowledge study.
- The Arviat HTO requested that polar bear tag credits be zeroed so that full allocation of tags becomes available for the polar bear harvest but also for potential problem bears.
- The Government of Manitoba was provided with the 2016 WH aerial survey report, and notified of the Government of Nunavut's TAH recommendation of no change to the current TAH of 28 bears, with a recommendation to the NWMB to re-set credits and TAH.
- The Report has also been provided to ECCC and Parks Canada Agency. Government of Manitoba and ECCC officials have been encouraged to participate in the NWMB's decision-making process, and to provide any additional information, concerns or recommendations they consider relevant, in the interest of helping the Board make an informed decision.

**Recommendations:**

1. DOE recommends **no change** to the current WH TAH of 28 bears.
2. DOE recommends a **re-set to the TAH** by zeroing-out existing polar bear tag credits so that all communities harvesting from WH will be in a position to have

their full allocation available to cover any harvested bears and problem bears if necessary.

This recommendation was derived by taking various sources into consideration, and by carefully evaluating additional important relevant data, as follows:

- The GN aerial survey results of 2011 and 2016 are both very similar in that they are not statistically significantly different. That means that although a decline of approximately 18% in the population was observed, results and comparisons of both studies indicate that the WH polar bear population has remained relatively stable.
- The ECCC analysis indicated that the WH subpopulation has remained relatively stable over the past decade, whereas a declining trend was apparent between 1987 and 2004.
- Sea-ice freeze-up and break-up patterns over the past decade have not indicated any significant trends; however, when a larger time-frame (1979-2012) is considered, break-up and freeze-up of sea-ice has been occurring three weeks earlier and three weeks later on average, respectively.
- Average body condition (body mass) of solitary adult female polar bears has been declining since 1980. As body condition declined over this period so did recruitment rates (or litter production). Similar observations were made during both aerial surveys, where both cubs-of-the-year and yearling observations were lower as compared to any other seasonal ice-free polar bear population with available data.
- The mean combined annual Nunavut-Manitoba removal for the WH subpopulation was approximately 32 bears (harvest season 2003/2004 – 2015/2016). Manitoba in the past has retained 8 tags for potential defense of life and property kills (their removal for the same time period was 2.8 bears/year).
- DOE will continue to work with communities to ensure that public safety is maintained, and bear-human interactions are minimized through a strong emphasis on polar bear deterrent efforts.
- DOE recommends that as per section 5.7.6 of the Nunavut Land Claims Agreement, the TAH should be distributed among the communities that share the WH polar bear sub-population as identified by the Regional Wildlife Organization, and that consideration should also be given to communities that endure a higher level of polar bears that become a risk to public safety and property.
- DOE believes the recommendation to maintain the current TAH of 28 bears balances the best current available scientific information and Inuit observations to ensure that the harvest does not cause a conservation concern for the WH polar bear sub-population over the short and long-term.

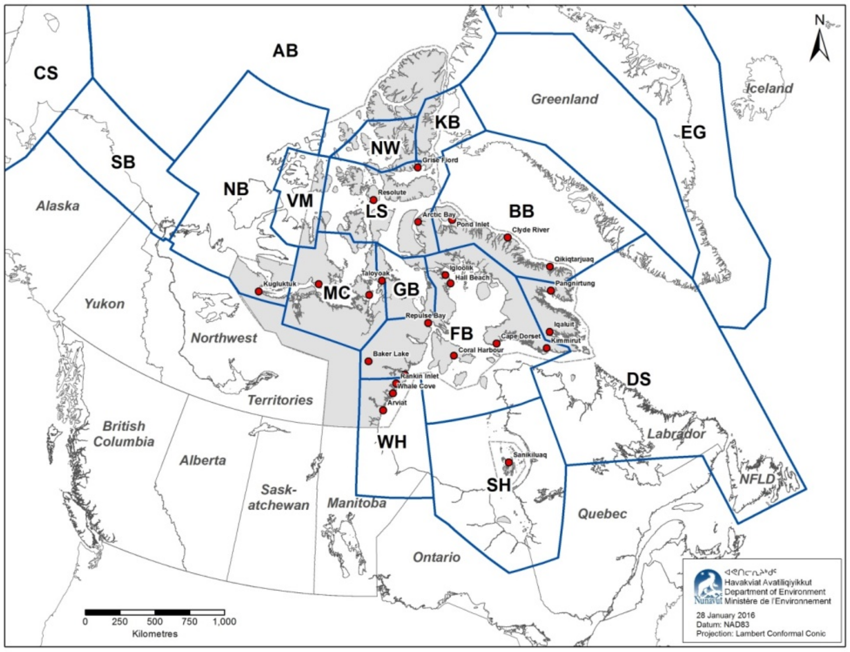


Figure 1. Overview of Nunavut polar bear subpopulations (WH = western Hudson Bay; SH = southern Hudson Bay, FB = Foxe Basin).

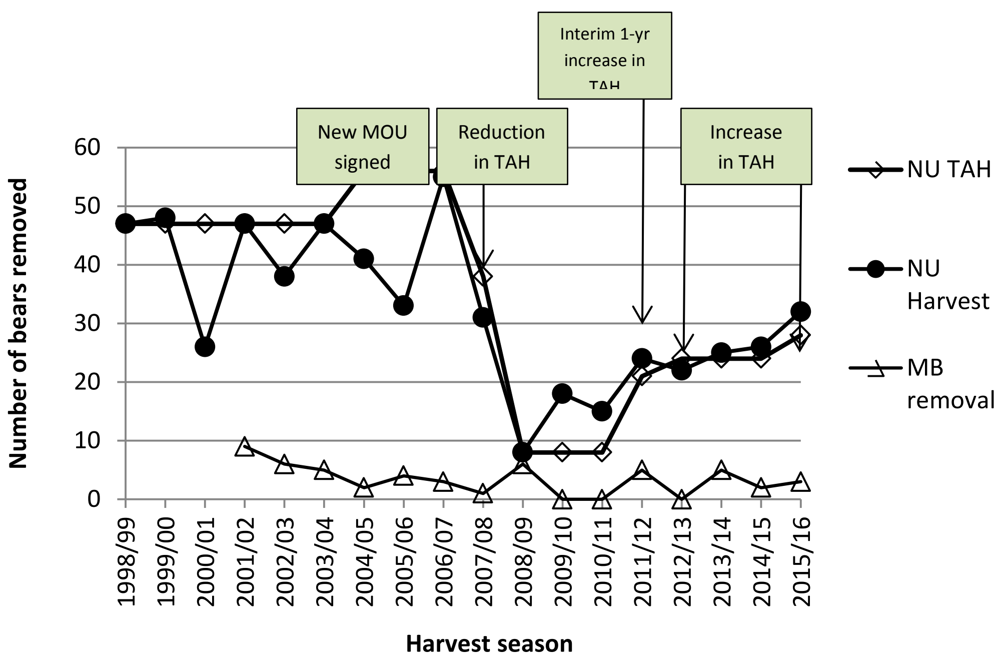


Figure 2. Overview of the removals from the western Hudson Bay polar bear population and management actions between 1998/99 and 2015/16

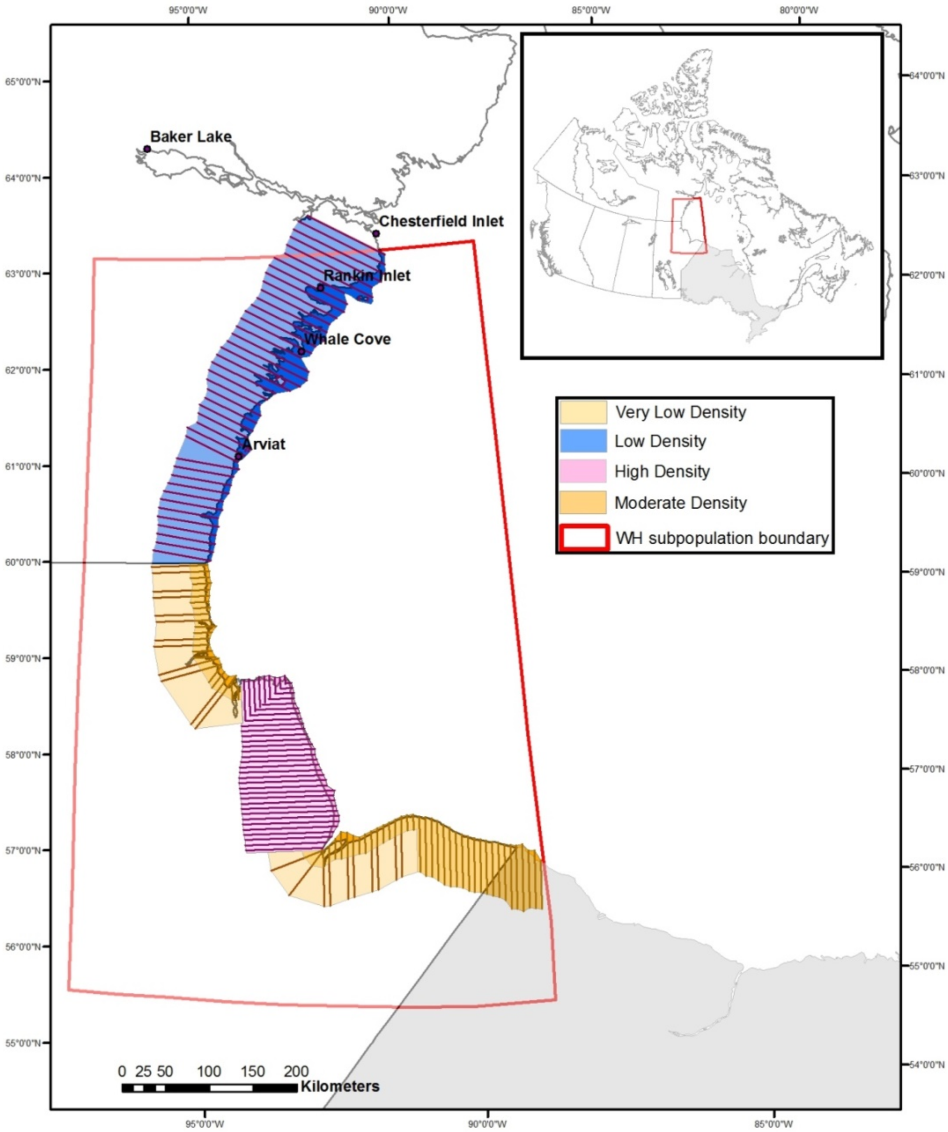


Figure 3. An overview of the various strata that were employed during the August 2016 aerial survey in western Hudson Bay.

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Building Nunavut Together
Nunavuliuqatigiingniq
Bâtir le Nunavut ensemble

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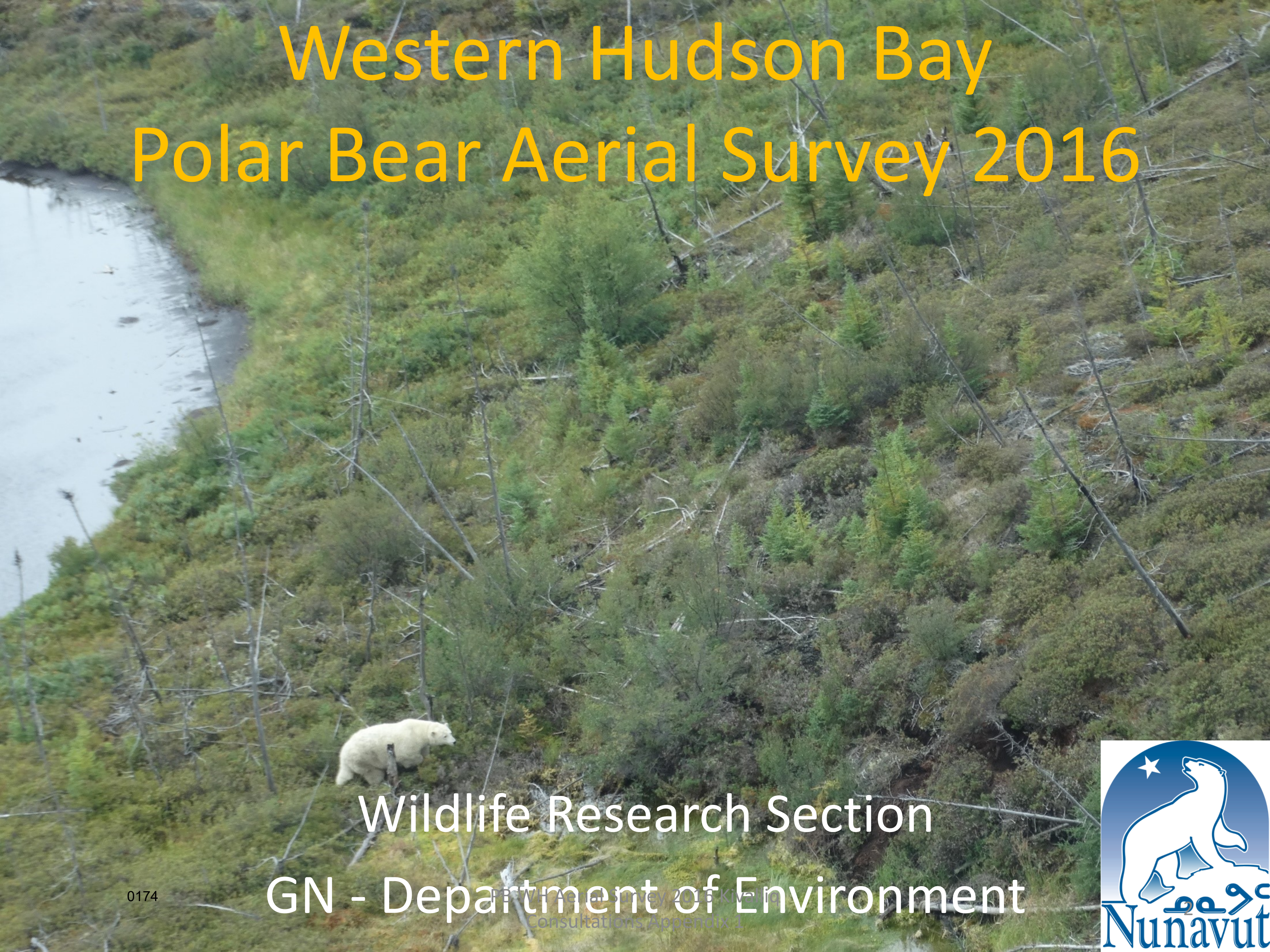
Department of Environment
Avatiliqiyikkut
Ministère de l'Environnement

# CONSULTATION MEETING TO DISCUSS THE RESULTS OF THE 2016 AERIAL SURVEY FOR THE WESTERN HUDSON BAY POLAR BEAR SUBPOPULATION

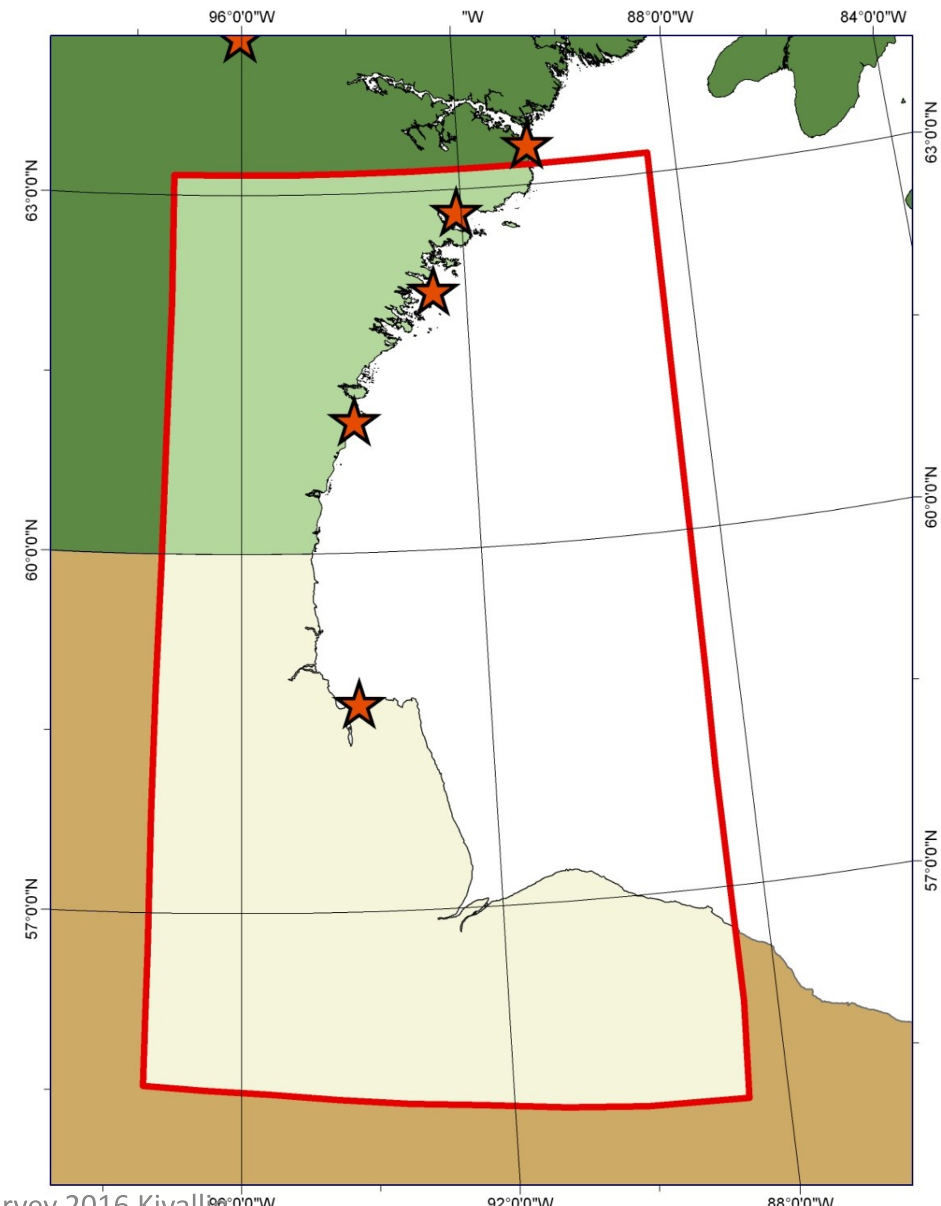
## POLAR BEAR RESEARCH GROUP

**Government of Nunavut – Department of Environment**


Western Hudson Bay
Polar Bear Aerial Survey 2016
Wildlife Research Section
GN - Department of Environment
Nunavut

# Background

- Concern about status of sub-population
- Science:
  - 1030 bears (last GN-led aerial survey [2011])
  - EC results agree that WH has been stable for last decade
- IQ and local observations:
  - More bears seen
  - Increasing numbers & range
  - Concern about accuracy & impacts of tagging studies



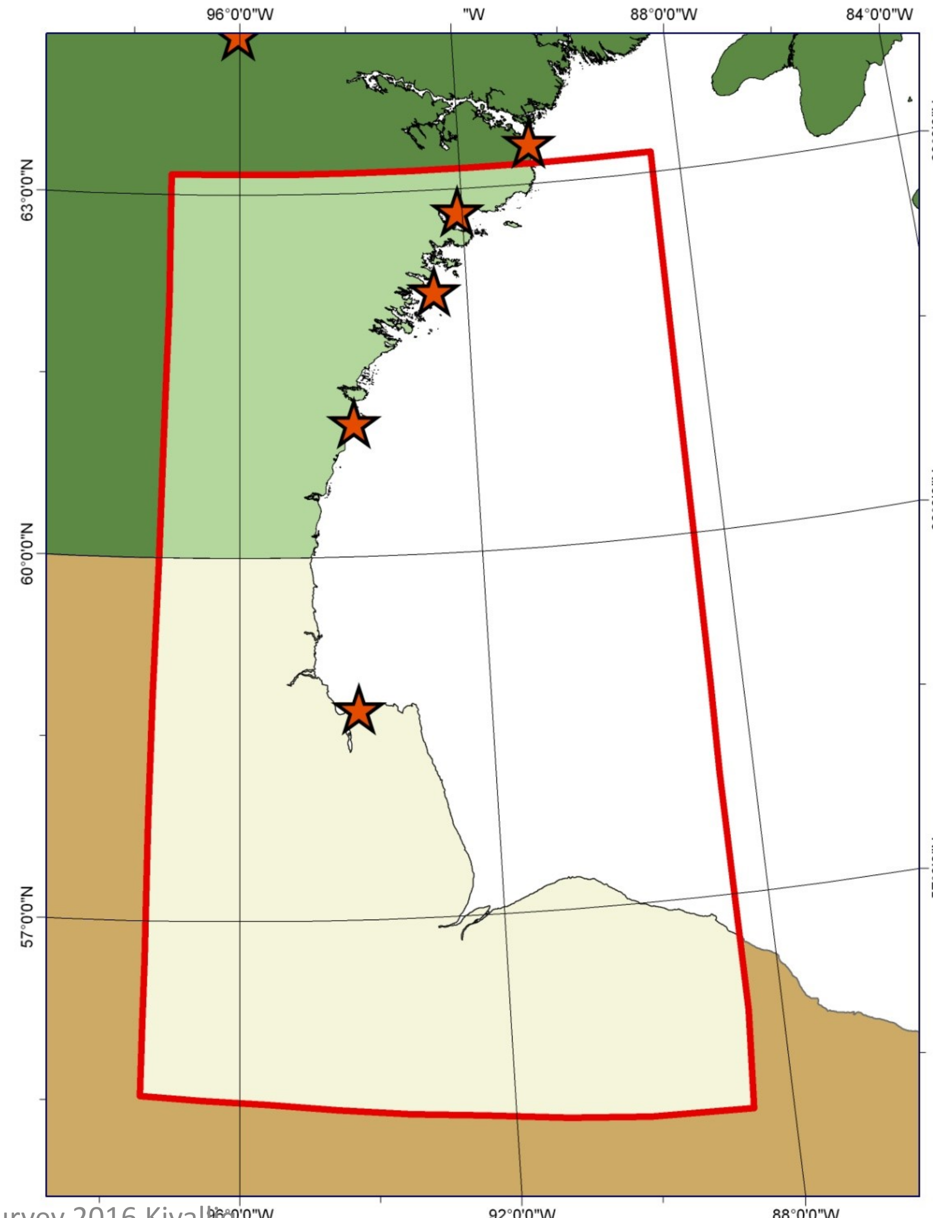
# Background

- Disagreement between science and IQ

- Need for new study
  - Tried new non-invasive method = aerial survey

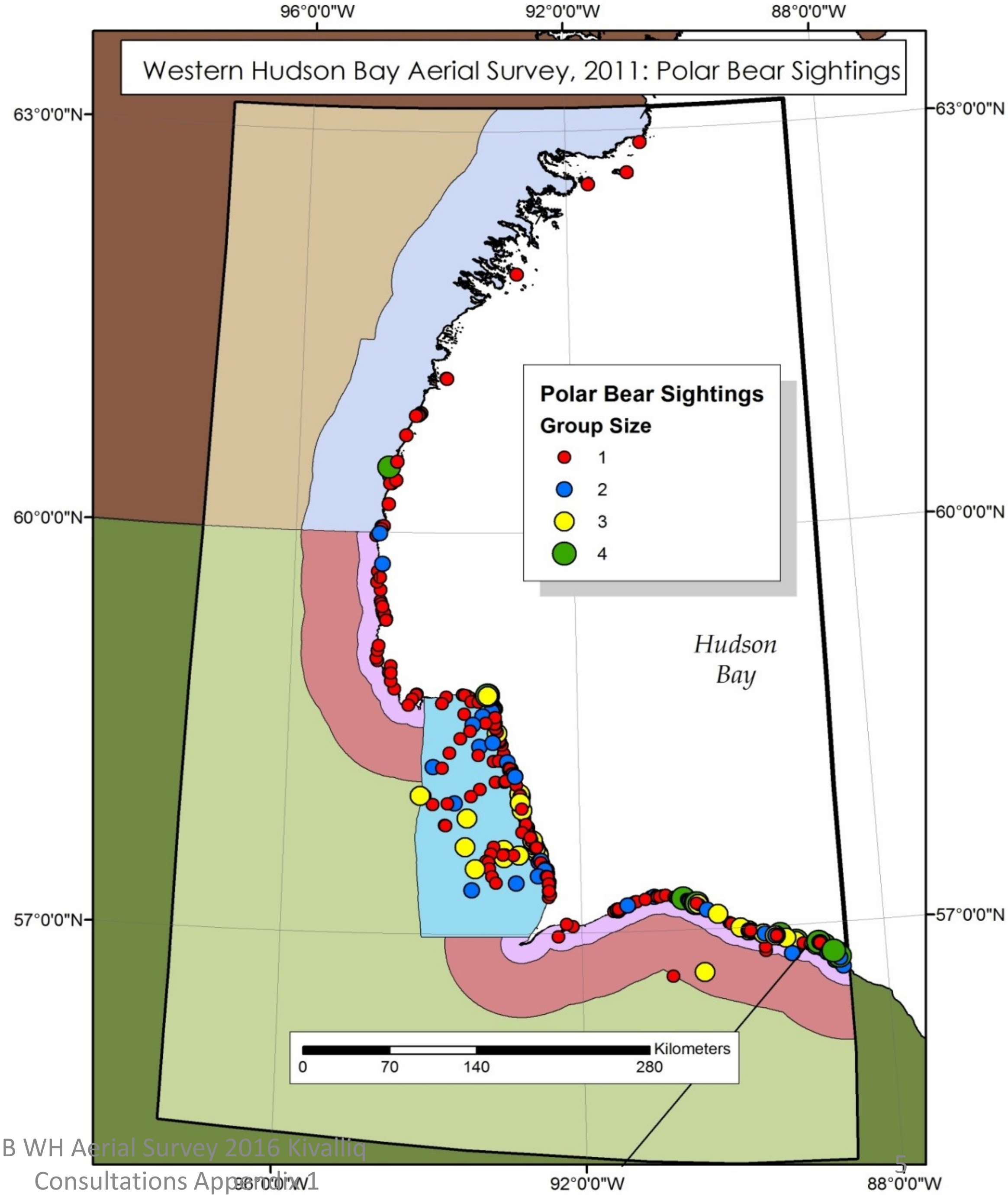
  - Resolve disagreement

  - Continue to monitor population to establish trend



# Aerial Survey 2011: Results

- 1030 polar bears
- High densities in southeast WH
- Large portion of the population outside area where tagging studies occur
- Evidence of poor reproductive performance

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# Mark-recapture Studies and Sea-ice Monitoring

- Environment Canada long-term study
- Analysis of data for 1987 to 2011
- Key Results:
  - Survival linked to sea-ice conditions
  - Estimated 806 bears (in 2011)
  - Long-term declines in sea-ice and bears numbers but stability over the last decade
  - No recent trends in sea-ice or bear numbers
  - Predictions of future trend highly dependent on sea-ice conditions

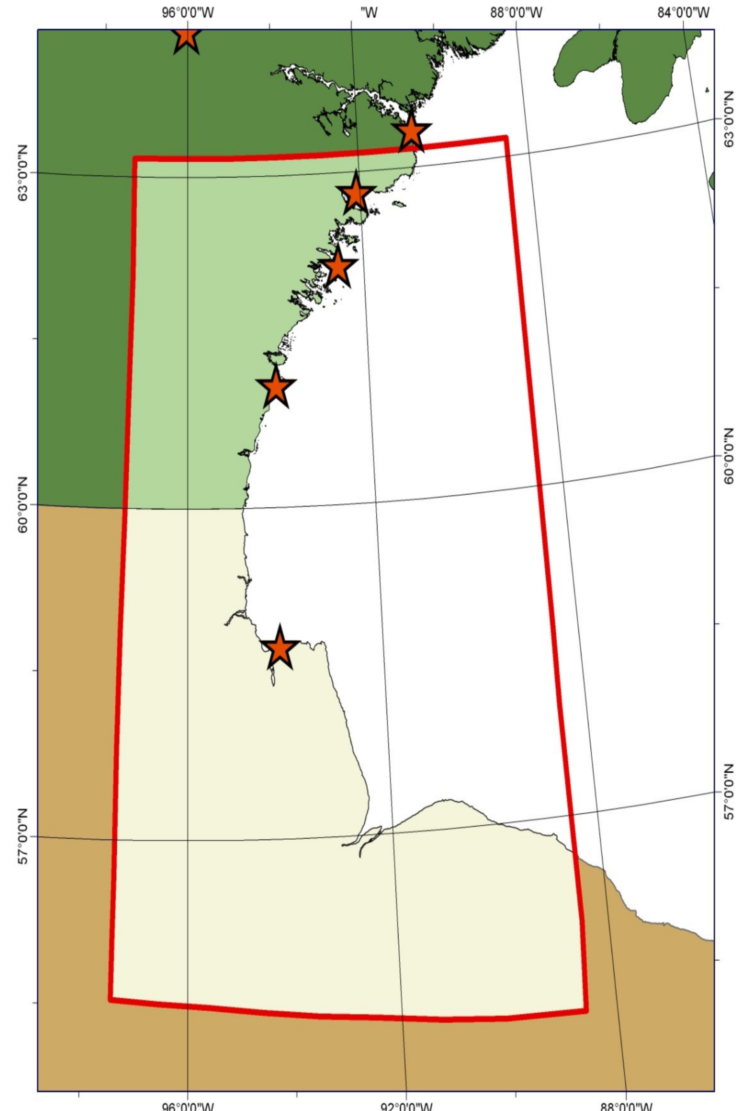
# Using Aerial Surveys to Monitor WH

- Adaptive management requires more frequent monitoring
- Methods like aerial survey are well suited
- Fast, less invasive, cost effective, community involvement
- Can detect trends in populations and respond accordingly
- Scope of information limited: Trade-off

# Aerial Survey 2016

**Objectives:**

- Estimate abundance of PB in WH
- Comparison with last aerial survey (2011)
- Evaluate as a monitoring method
- PB distribution in relation to habitat & environmental conditions where possible

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# Research Plans 2016

- Aerial survey
  - Alternative to tagging
  - used in 2011

- On-going collection of IQ and hunter observations
  - HTO's, NTI, GN

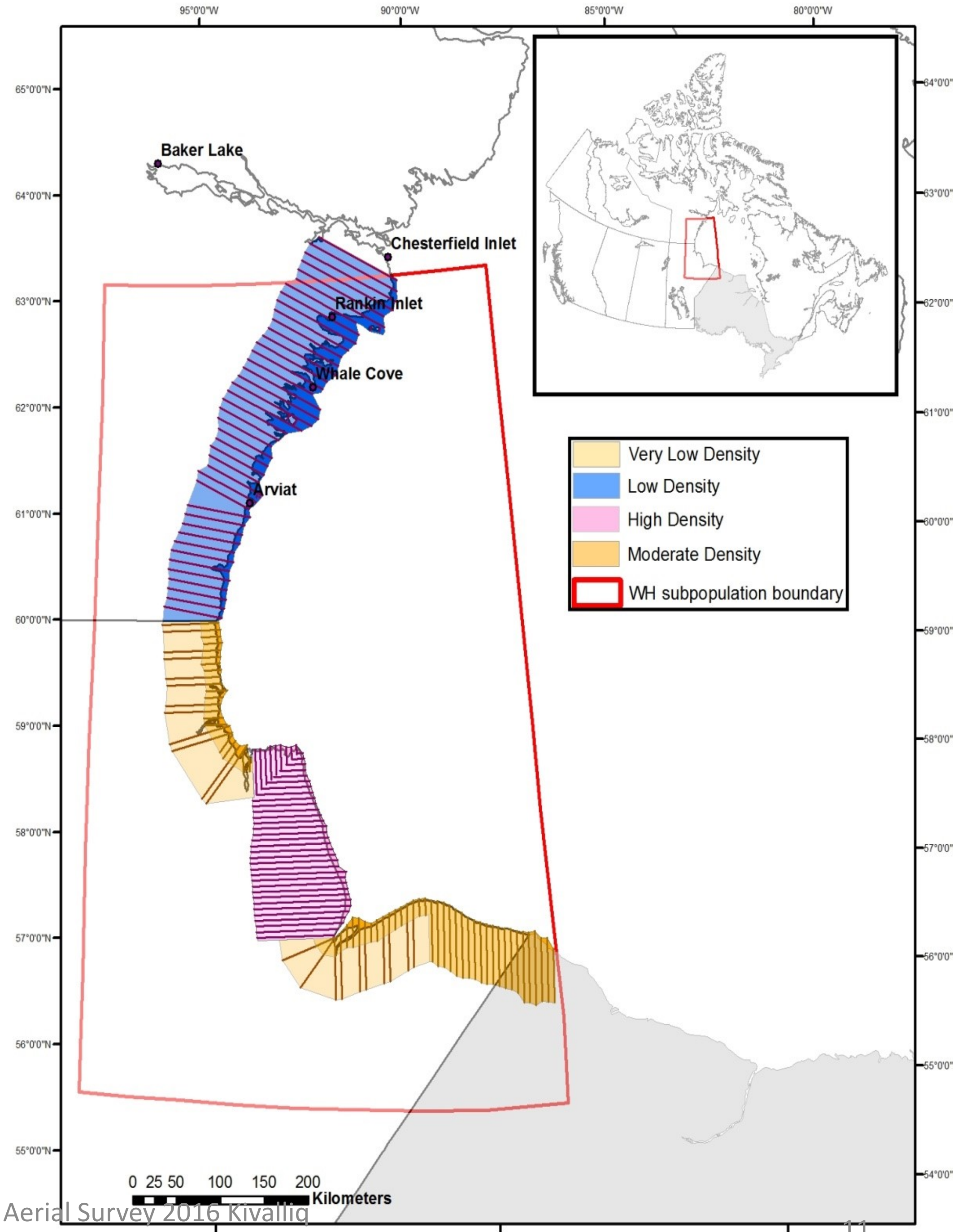
# Design

Sources of Information:

- Tagging Studies in Manitoba (>40 years)
- Coastal surveys in Manitoba (>40 years)
- Movements on satellite collared bears
- Workshop with HTO members, 2010*
- Tested aerial survey in Nunavut, 2010 and 2011*

- All of this information was used to divide the study area into blocks ('strata') based on density of bears

- Transects extended 60-100 km inland in places and along coast

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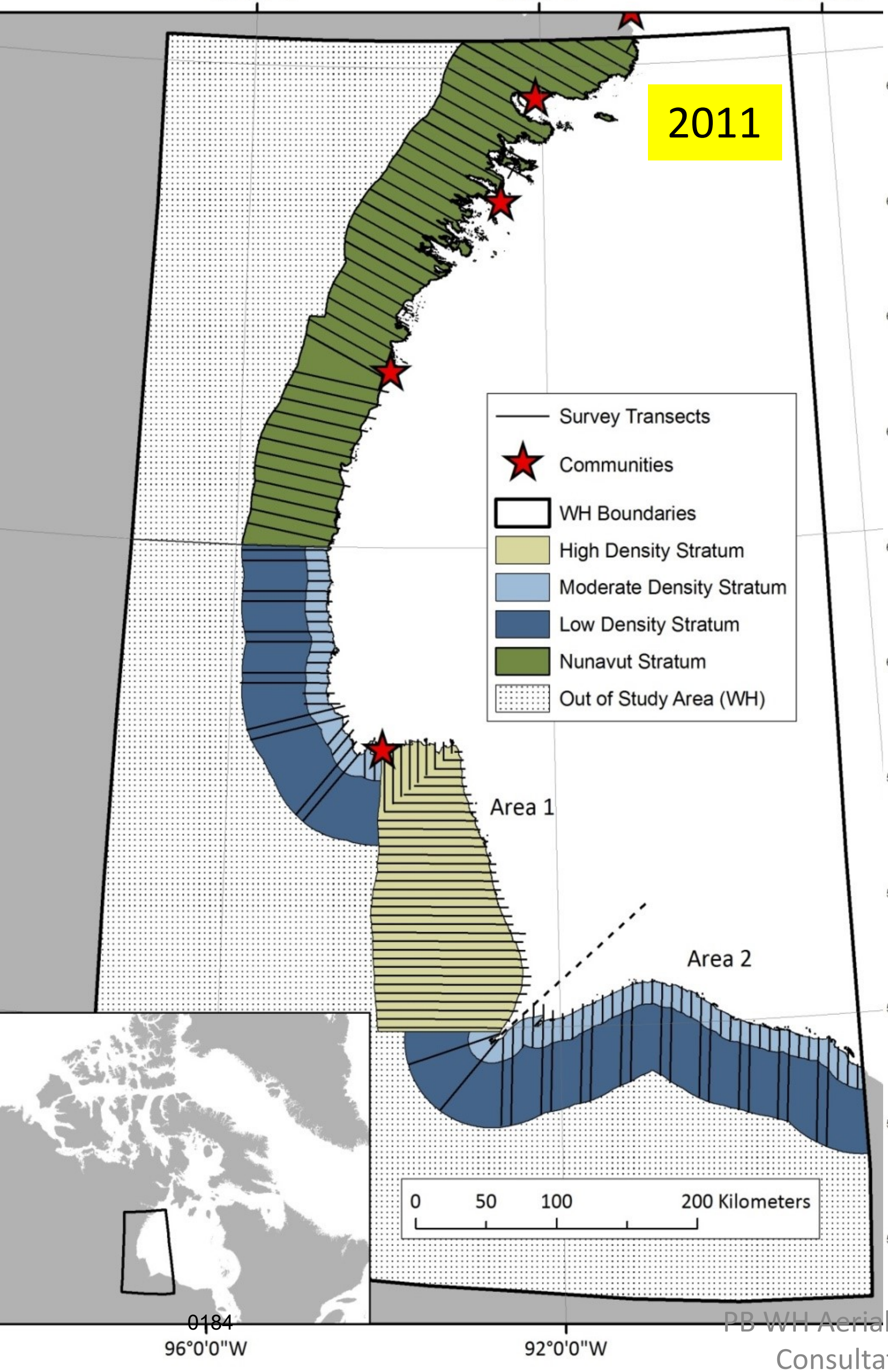
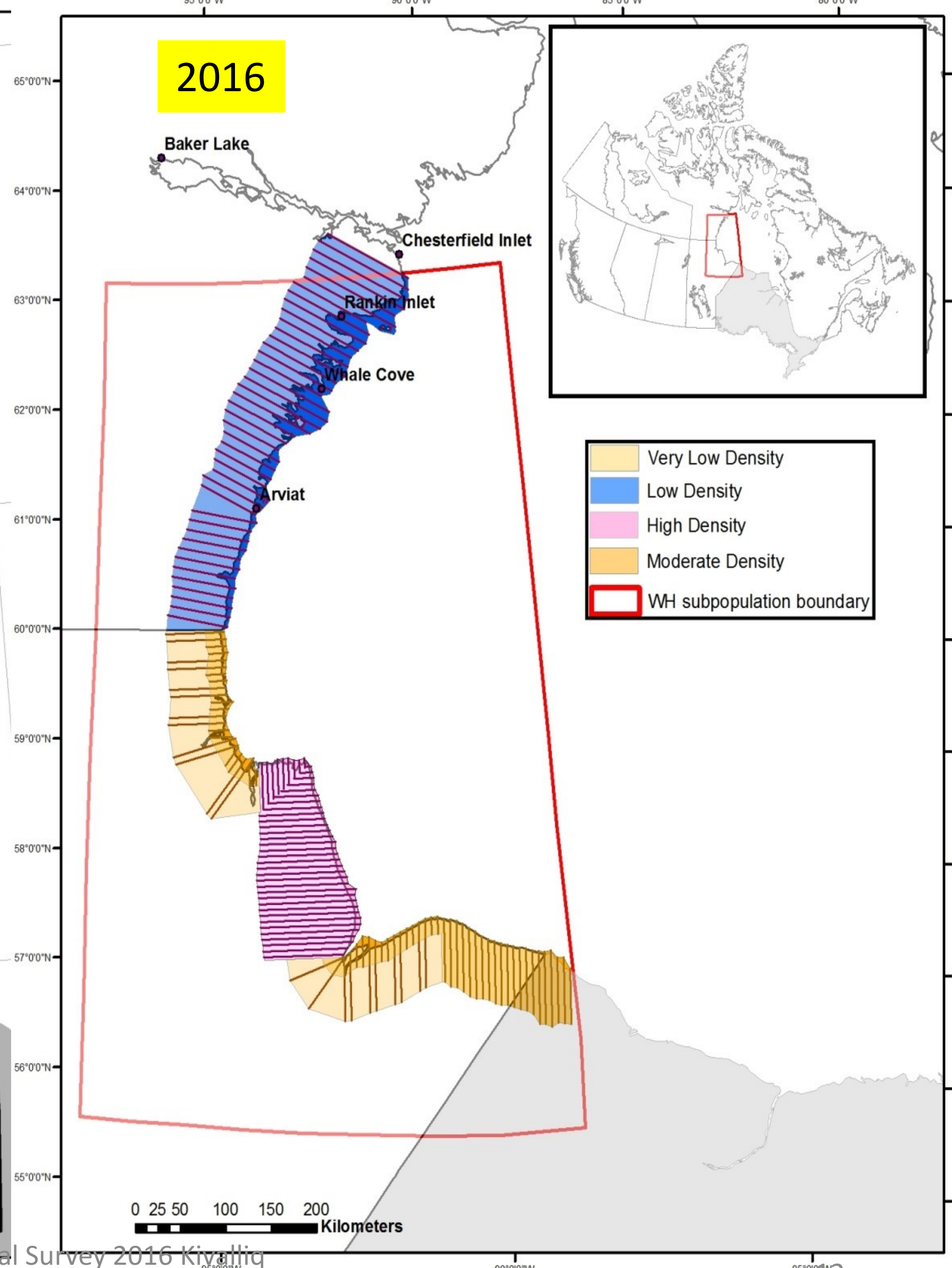

2011
Survey Transects
Communities
WH Boundaries
High Density Stratum
Moderate Density Stratum
Low Density Stratum
Nunavut Stratum
Out of Study Area (WH)
Area 1
Area 2
0 50 100 200 Kilometers
96°0'0"W
92°0'0"W


2016
Baker Lake
Chesterfield Inlet
Rankin Inlet
Whale Cove
Arviat
Very Low Density
Low Density
High Density
Moderate Density
WH subpopulation boundary
0 25 50 100 150 200
Kilometers

# Timing of Survey: Late August

Why?

- All bears are off the sea-ice and it is before they return (e.g., concentrated on land)
- Minimize number of denned bears
- Good sighting conditions (i.e. lack of snow cover, longer days, weather, light conditions)
- Coincides usually with timing of tagging studies

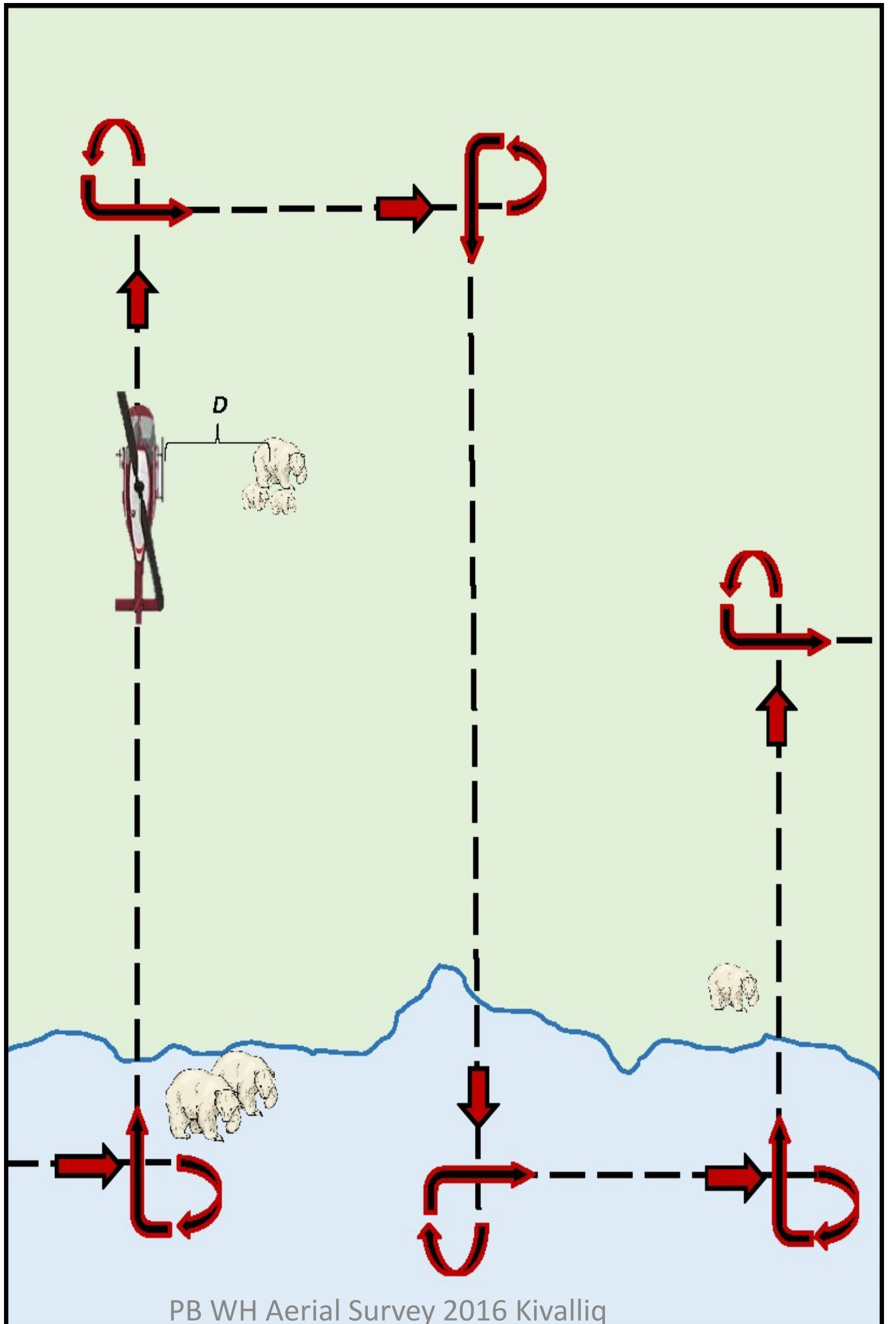
# How we flew the last survey

- Survey teams: Nunavut - Twin Otter (13-17 Aug 2016)
- 2 Helicopters (17-22 August 2016) in Manitoba
- 4 observers per team
- Front and back observers working independently
- Recording type and location of bears seen, habitat



# flying transects


# flying transects

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# Challenges

- Islands and offshore waters

- Tidal flats

# Challenges

- Vegetation

- Glare

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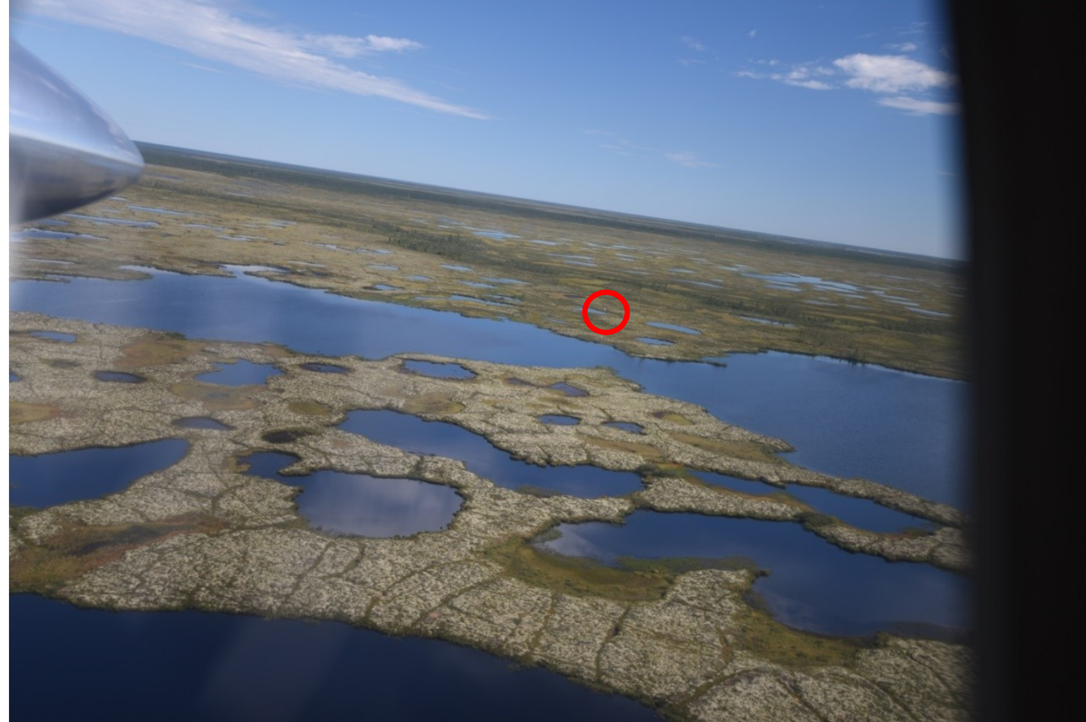
# Challenges

- Vegetation



# Challenges

- Denning

Nunavut Wildlife Management Board

Nunavut

Environment Canada

ONTARIO
Ministry of
Natural Resources

Manitoba
Conservation

Parks Canada Parcs Canada

# Results

- Survey flown August 12 – 22nd

- More than 130 hours of flying

- Over 9500 km of inland transects flown plus extended over water

# Participants

- Mitch Campbell, Kelly Owlijoot, M. Dyck (GN Dept. Of Environment)
- David Lee, Robert Karetak (NTI)
- Leo Ikakhik (Arviat HTO)
- Louis Tattuinee (Rankin HTO)
- Daryll Hedman, Vicki Trim (Manitoba Conservation)
- Kevin Burke, Chantal Ouimet (Parks Canada)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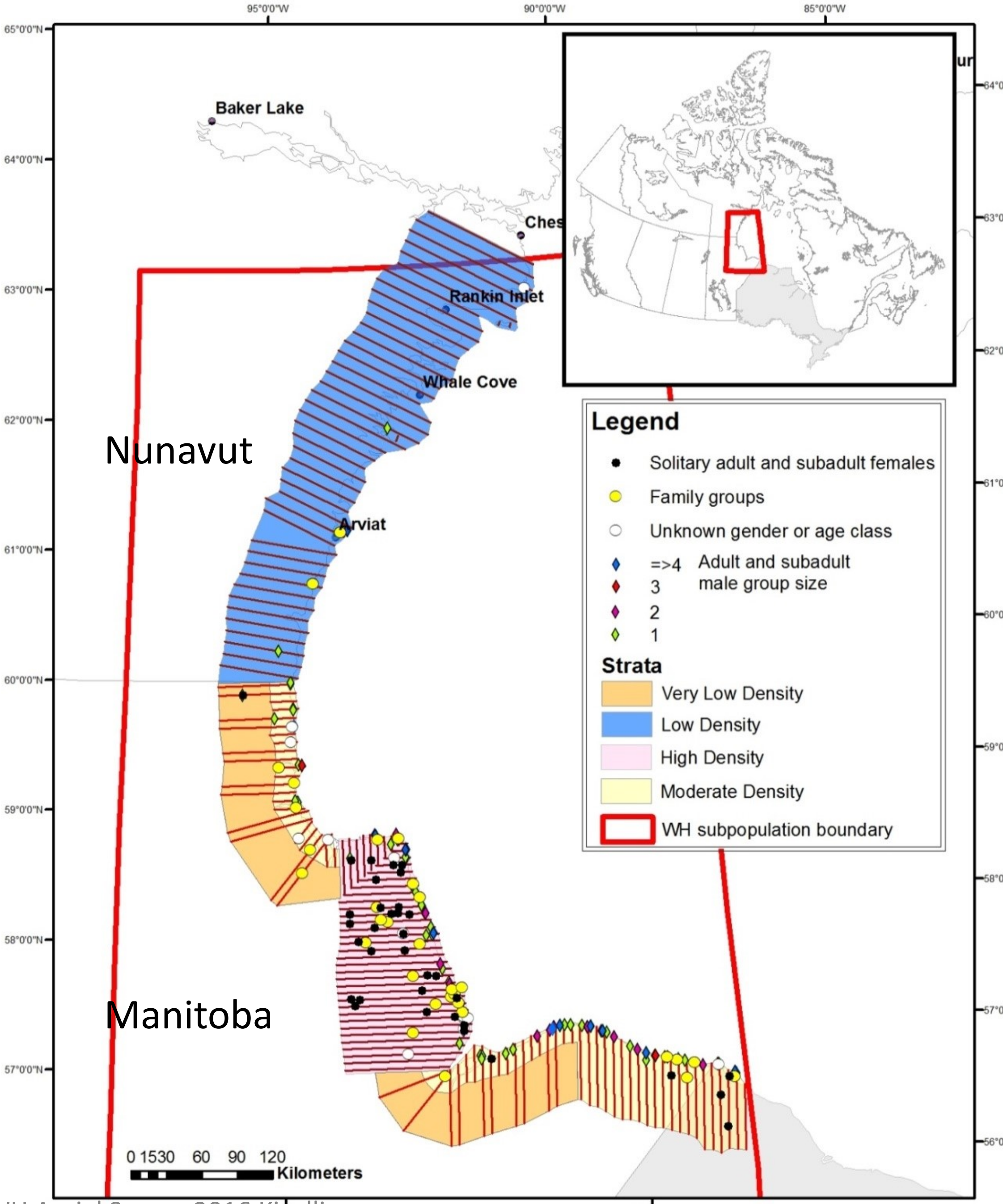
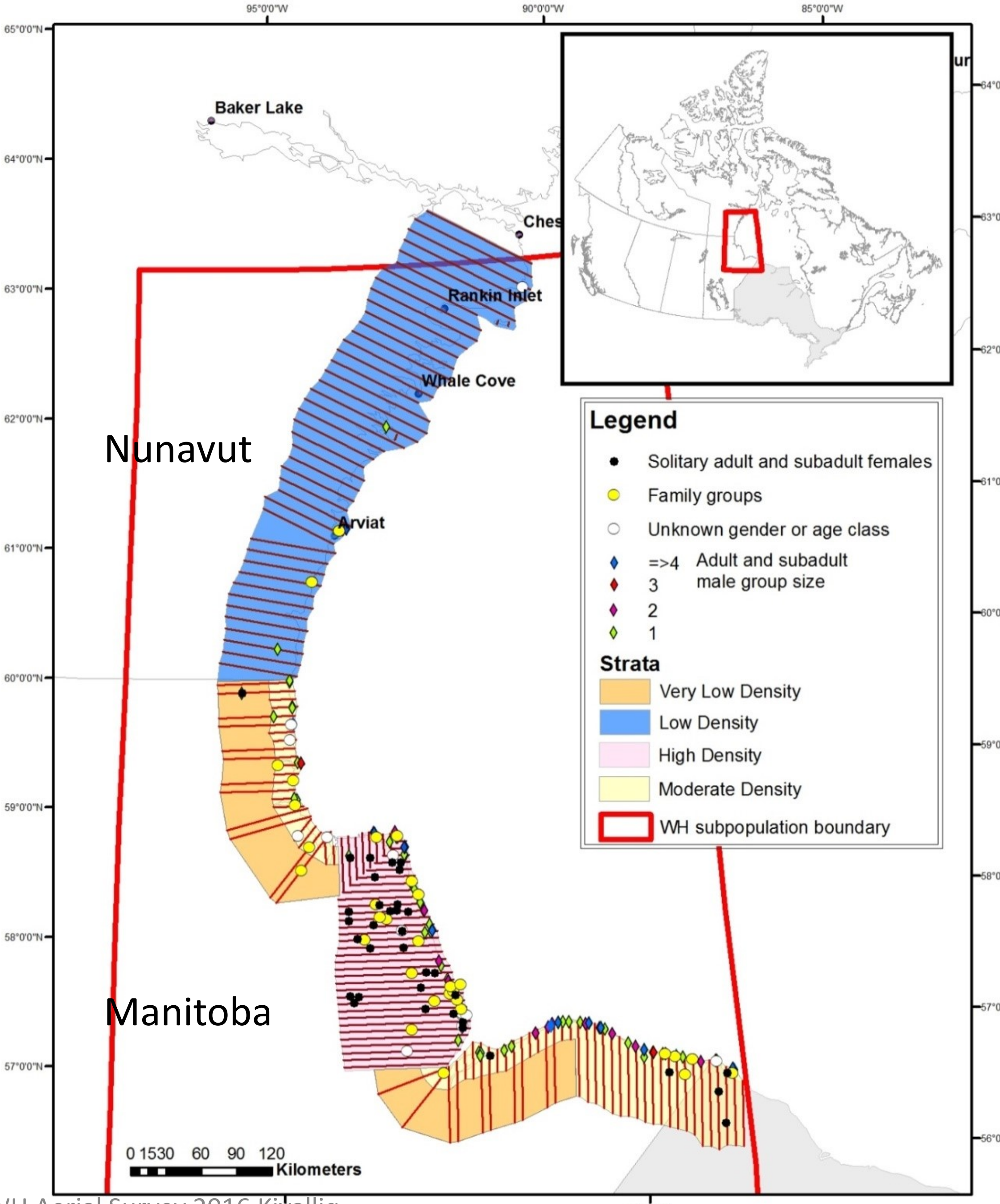
# Results

- 339 polar bear sightings
  - 18 in Nunavut
  - 321 in Manitoba
- Groups of 1 to 11
- Includes swimming bears



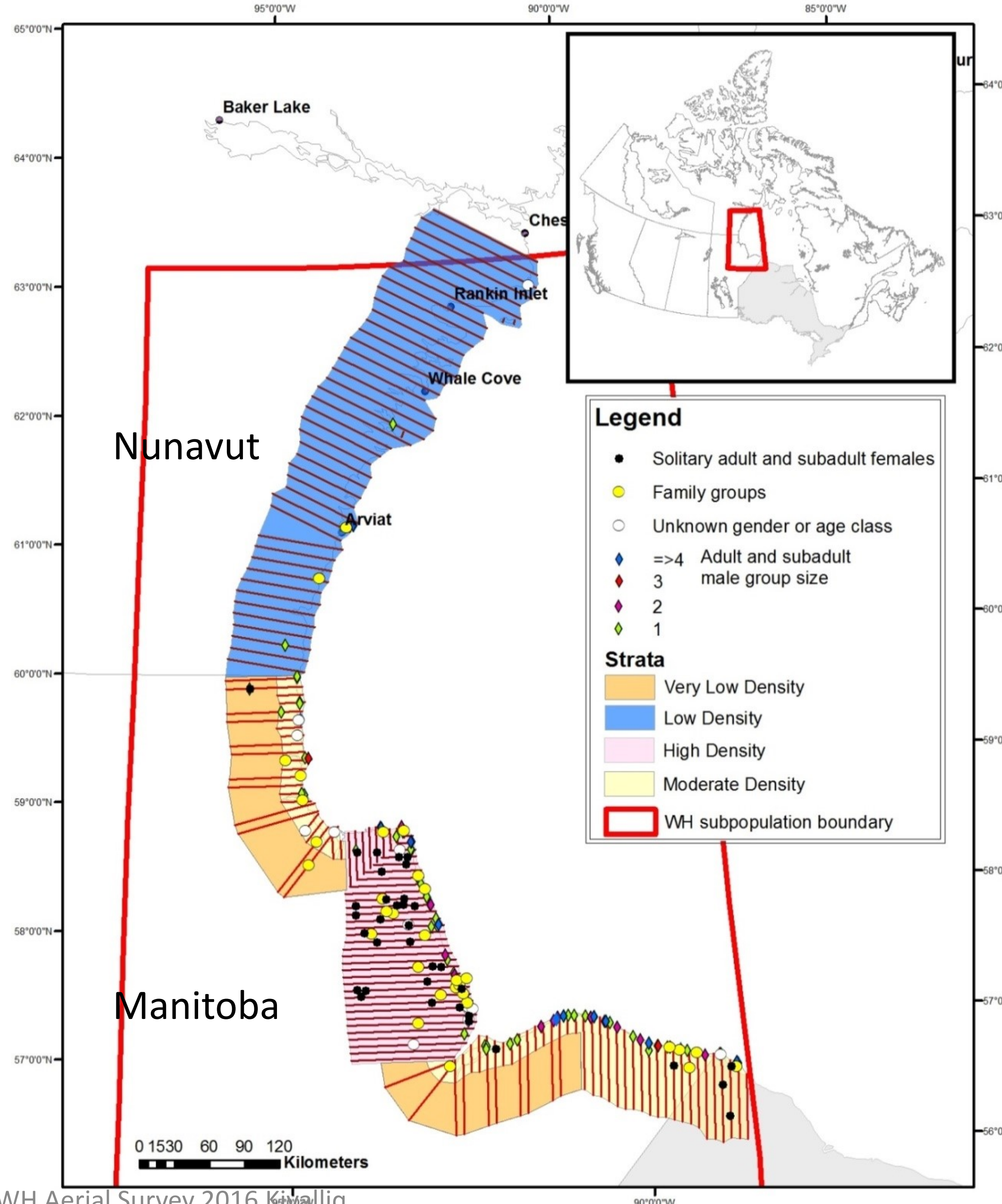
# In Nunavut

- Distribution similar to 2007, 2010, 2011
- Low densities during August
- Most bears south of Arviat (coast, islands)



# In Manitoba

- Distribution similar to previous studies
- Over 80km inland in Wapusk (family groups, pregnant females)
- High density in southeast WH (many adult males)



| Subpopulation | Litter size | | Proportion of total observations | | Source |
|---|---|---|---|---|---|
| | COY | YRLG | COY | YRLG | |
| Western Hudson Bay (2016) | 1.63 (0.10) | 1.25 (0.16) | 0.11 | 0.03 | GN (unpublished data) |
| Western Hudson Bay (2011) | 1.43 (0.08) | 1.22 (0.10) | 0.07 | 0.03 | Stapleton et al. (2014) |
| Southern Hudson Bay (2011) | 1.56 (0.06) | 1.49 (0.08) | 0.16 | 0.12 | Obbard et al. 2015 |
| Foxe Basin (2009-2010) | 1.54 (0.04) | 1.48 (0.05) | 0.13 | 0.10 | Stapleton et al. (2015) |

Western Hudson Bay has some of the lowest yearling litter sizes recently recorded in Hudson Bay, and low proportions of offspring

# Body Condition

- Variable across WH

- Best body condition in southeast WH

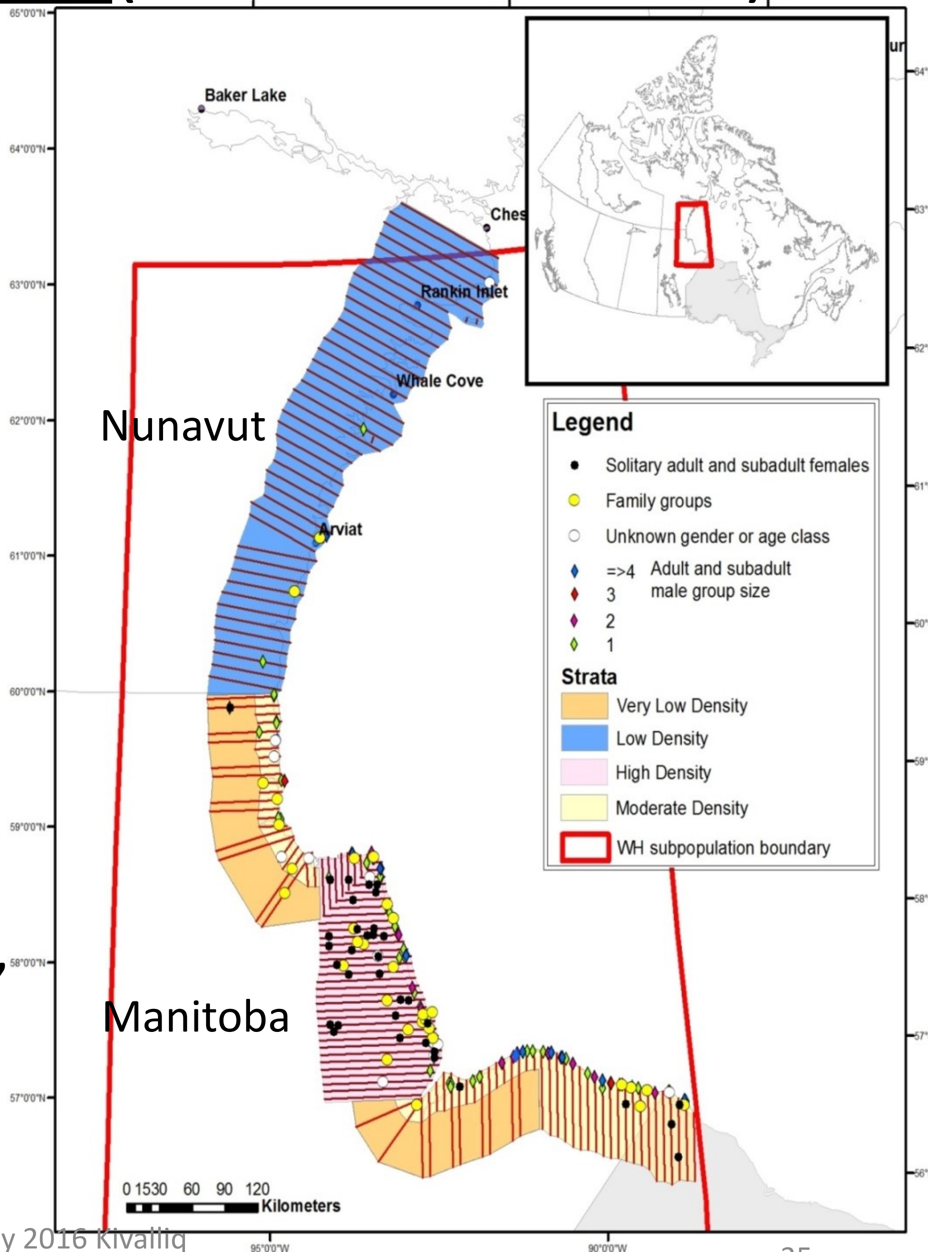
# 2016 Estimate of 842 bears (95% CI: 562-1121)

Precision

- Met expectations
- Coefficient of Variation = 16.9%

Accuracy

- Near 100% detection on transect
- Bears outside study area
  - Far inland bears (unlikely)
  - Swimming bears
- Other factors: Dens (checked all), habitat (trees)




- Tendency to underestimate abundance

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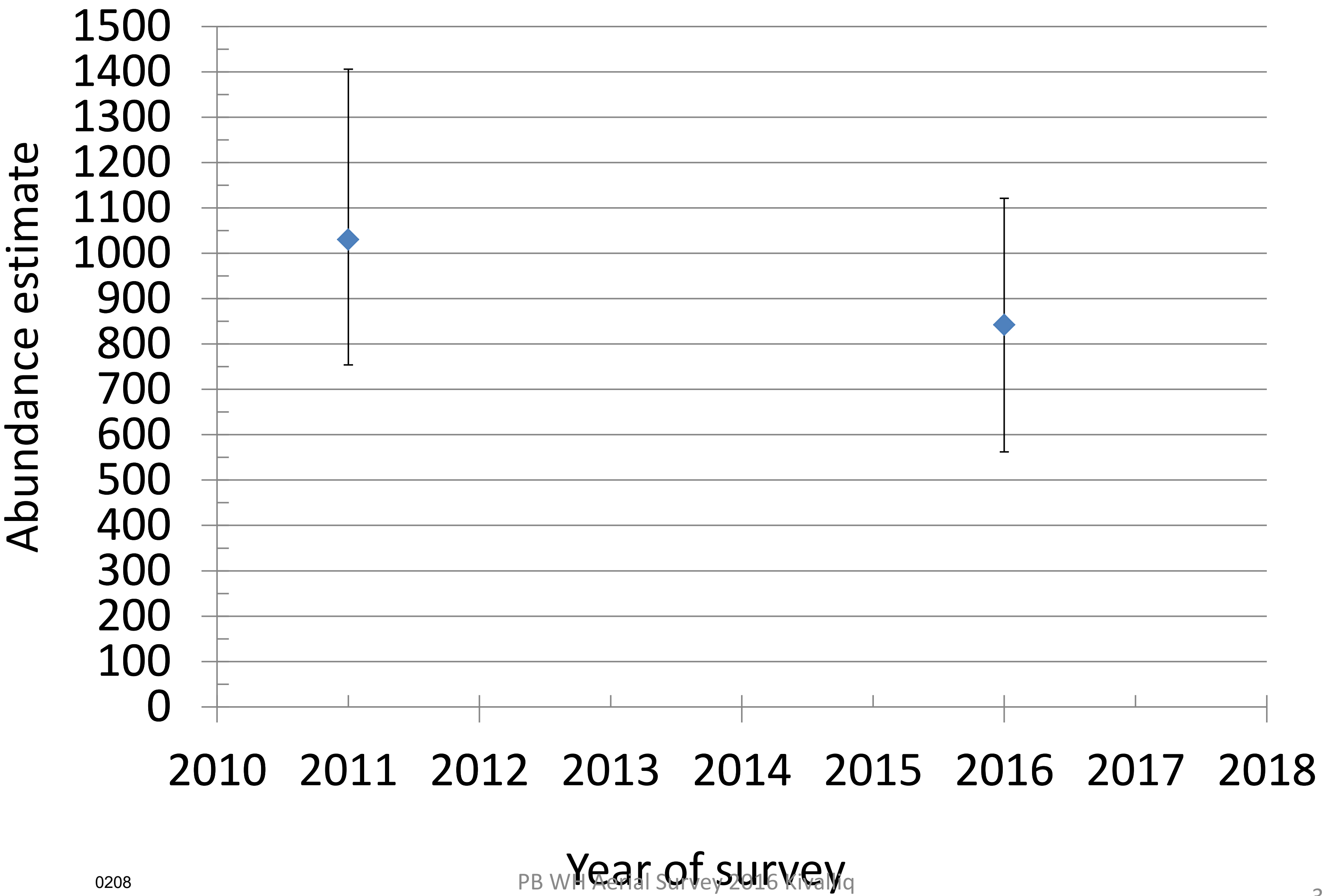

1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
Abundance estimate
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year of survey

# Summary

- Estimated 842 bears in 2016 (August) (not sig. different than 2011 study)

- Low densities and distribution in Nunavut during August consistent with 2 previous studies

- Majority of bears are in Manitoba during August

- 2016 aerial survey estimate similar to 2011 estimate

# Summary

- Evidence of low offspring production in 2016 as in previous aerial survey study
- Body condition variable across WH

# Next Steps

Further analyses:

- Comparison between aerial survey & future mark-recapture?
- Comparison with 2016 aerial survey in SH

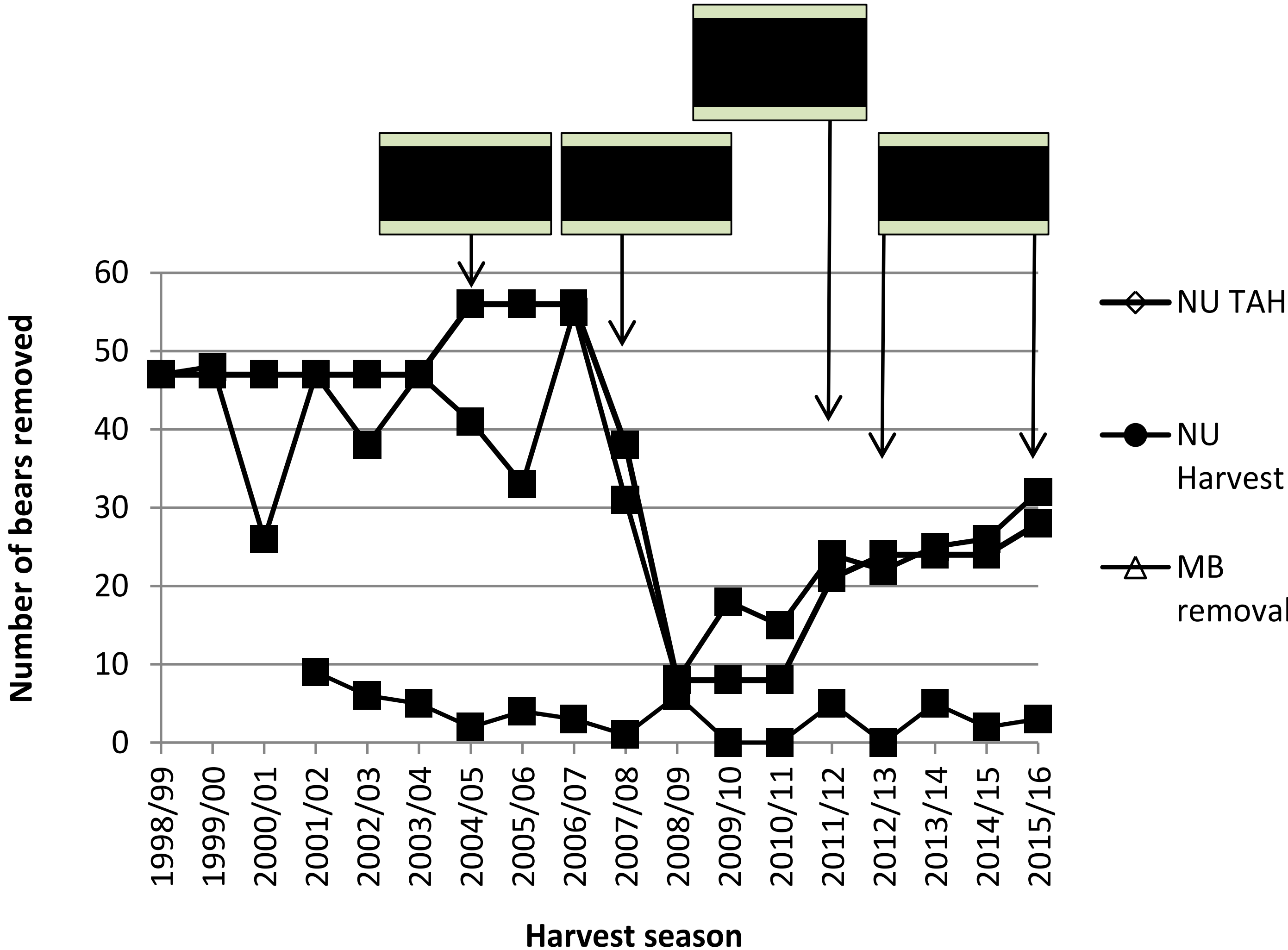
Sea ice monitoring

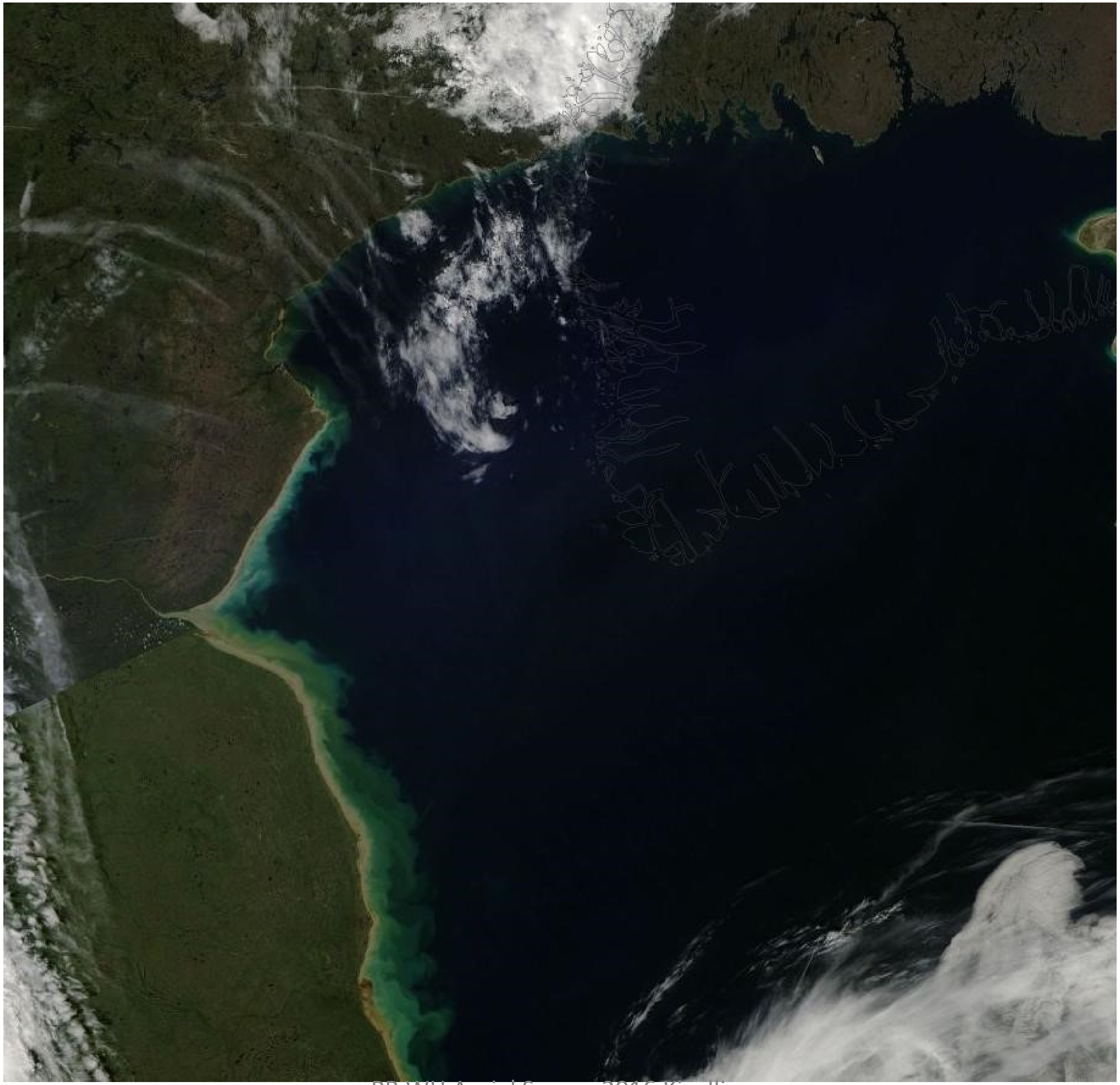
Assessment of status

Collect more available IQ

# Thank you – Questions?

# Explanation of variation and estimate


[redacted]
[redacted]
[redacted]
[redacted]
60
50
40
30
20
10
0
Number of bears removed
1998/99
1999/00
2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
Harvest season
NU TAH
NU Harvest
MB removal



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# 2016 AERIAL SURVEY OF THE WESTERN HUDSON BAY POLAR BEAR SUB-POPULATION

## FINAL REPORT

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[4] Integrated Ecological Research, Nelson, BC, V1L 5T2
[5] Manitoba Department of Sustainable Development, Thompson, MB, R8N 1X4

June 26, 2017

Submitted to meet requirements of:

Wildlife Research Permit WL 2016-004
Nunavut Wildlife Research Trust Project 2-16-04
Wapusk National Park Research and Collection
Permit Number WAP-2016-21838

STATUS REPORT 2017-xx
NUNAVUT DEPARTMENT OF ENVIRONMENT
WILDLIFE RESEARCH SECTION
IGLOOLIK, NU

M. Dyck, Campbell, M., Lee, D.S., Boulanger, J., and Hedman, D. 2017. Aerial survey of the western Hudson Bay polar bear sub-population 2016. 2017 Final Report. Government of Nunavut, Department of Environment, Wildlife Research Section, Status Report 2017-xx, Igloolik, NU. 82 pp + 2 Supplements.

## Disclaimer

The opinions in this report reflect those of the authors and not necessarily those of the Government of Nunavut, Department of Environment.

**Summary**

Climatic change has been experienced across the globe during the past 30 years with some transformations now being observed in the Arctic. For example, the sea-ice habitat for some polar bear subpopulations is now experiencing later freeze-up and earlier melt. Other studies documented correlations between these environmental changes and reduction of body mass, survival rates, and reproductive performance of a few polar bear subpopulations. These type of population-wide changes require careful, and at times intense, monitoring in order to inform the status of these subpopulations.

In August 2016, the Government of Nunavut (GN) conducted an aerial survey of the Western Hudson Bay (WH) polar bear subpopulation in order to update its status. Pre-survey consultations with Nunavut HTOs and communities, and with the Manitoba Department of Sustainable Development were conducted in order to utilize local and traditional knowledge in the study design. Nunavummiut living within the range of this subpopulation have repeatedly indicated that they feel the abundance of polar bears has increased within Nunavut. Other studies of WH suggest that numbers appear to have stabilized between 2001-2011 following a period of decline between 1987-2004. The last GN aerial survey produced an estimate of 1030 bears (95% CI: 745–1406) in 2011. Final survey results of this study (2016) produced an estimate of 842 bears (95% CI: 562–1121). The estimate is not significantly different from the 2011 aerial survey estimate of 949[1] bears (95%CI: 618–1280) based upon similar transect sampling methods and analysis of covariates.

A double observer distance-sampling method was employed to estimate abundance. During this survey, bears were observed by front and rear observers from aircraft following inland transects oriented perpendicularly to the coastline. During August 2016, the majority of bears were distributed within 10km of the coast, with the exception of Wapusk National Park where some bears were observed greater than 80 km inland. Very few bears were observed in Nunavut, and a substantial proportion of

[1] During the 2011 aerial survey, coastal and inland transects were flown, which were not identical to the 2016 survey and therefore these estimates are not directly comparable. Regardless, when the derived abundance estimate of 1030 bears from the 2011 survey is statistically compared with the 2016 estimate, no significant difference between those two estimates can be detected.

bears, mostly adult males, were encountered in large concentrations in the south-east section of the study area towards the Manitoba-Ontario border. Cubs and yearlings comprised a small proportion of the sample size, which was also observed during previous studies. This suggests that reproductive performance is low for this subpopulation but this was not a specific objective of this study.

## ᓇᓗᓇᐃᖅᓯᒪᔪᖅ

ᓯᓚᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖓ ᖃᐅᔨᔾᔪᑕᐅᓯᒪᖕᒪᑦ ᓄᓇᕐᔪᐊᓕᒫᒥ ᐊᕐᕌᒍᑦ 30 ᐊᓂᒍᖅᑎᓪᓗᒋᑦ ᐊᓯᔾᔩᓂᖃᖅᑐᓂ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᓂ ᐅᑭᐅᖅᑕᖅᑐᒥ. ᐆᑦᑑᑎᒋᓗᒍ, ᐃᒪᕐᒥᐅᑕᓄᑦ ᐃᓚᖏᓐᓄᑦ ᓇᓄᕐᓄᑦ ᓇᓅᖃᑎᒃᑲᓂᖏᓐᓄᑦ ᖃᐅᔨᔾᔪᑎᖃᖅᓯᒪᓕᕐᒪᑕ ᕿᐊᖅᓴᕋᐃᖏᓐᓂᖅᓴᐅᓕᖅᑐᒥᒃ ᐊᒻᒪ ᐊᐅᒃᓵᓕᓂᖅᓴᐅᓕᖅᑐᒥᒃ. ᐊᓯᖏᑦ ᖃᐅᔨᓴᕈᑕᐅᔪᑦ ᑎᑎᖅᑕᐅᔪᑦ ᐊᕙᑎᒧᑦ ᐊᓯᔾᔨᕐᓂᒃᑯᑦ ᐊᒻᒪ ᐊᑦᑎᒃᓯᒋᐊᕐᓂᒃᑯᑦ ᑎᒥᐅᑉ ᐅᕐᑯᒪᐃᓐᓂᖓᓂᒃ, ᖃᓄᖅ ᐊᑯᓂᐅᑎᒋᔪᖅ ᐆᒪᕙᒪᖕᒫᑕ, ᐱᓕᕆᔪᓐᓇᑦᑎᐊᕐᓂᕐᒧᑦ ᐱᓕᕆᓂᕆᔭᖏᑦ ᓇᓄᕐᓄᑦ ᓇᓅᖃᑎᒃᑲᓂᖏᓐᓄᓪᓗ. ᑕᒪᒃᑯᐊ ᐃᓄᒋᔭᐅᔪᓕᒫᓄᑦ-ᐊᔾᔨᒌᖏᑭᓘᔭᖅᑐᓄᑦ ᐊᓯᔾᔨᕐᓃᑦ ᐅᔾᔨᖅᓱᑦᑎᐊᕐᓗᓂ, ᐃᓛᓐᓂᒃᑯᓪᓗ ᐊᒃᓱᕈᕐᓴᕐᓗᓂ, ᓇᐅᑦᑎᓱᖅᐸᓪᓕᐊᓂᖅ ᓇᓗᓇᐃᖅᓯᓂᕐᒧᑦ ᖃᓄᐃᓕᖓᓕᕐᓂᕆᔭᐅᔪᓂᑦ ᑖᒃᑯᐊ ᓇᓅᖃᑎᒃᑲᓂᖏᓪᓗ.

ᐊᐅᒍᔅᑎ 2016-ᒥ, ᓄᓇᕗᑦ ᒐᕙᒪᖓ ᐱᓕᕆᐊᖃᓚᐅᕐᒪᑦ ᖃᖓᑕᓲᒃᑯᑦ ᓈᓴᐃᓂᕐᒥᒃ ᑕᓯᐅᔭᕐᔪᐊᑉ ᐱᖓᓐᓇᖓᓂ ᓇᓄᖏᑦ ᓇᓅᖃᑎᒃᑲᓂᖏᓪᓗ ᓄᑖᙳᕆᐊᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᓄᐃᓕᖓᓕᕐᓂᕆᔭᐅᔪᒥᒃ. ᓇᐃᓴᖅᑕᐅᓚᐅᙱᑎᓪᓗᒋᑦ ᐅᖃᖃᑎᒌᒃᑎᑦᑎᓂᖅ ᓄᓇᕗᒻᒥ ᐊᖑᓇᓱᒃᑐᓕᕆᔩᖏᓐᓂᒃ ᓄᓇᓕᖏᒥᐅᓂᓪᓗ, ᐊᒻᒪ ᒫᓂᑑᐸᒥᑦ ᐃᑯᐱᒡᕙᓕᕆᔩᒃᑯᑦ ᐱᓕᕆᐊᖃᓚᐅᖅᑐᑦ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᓄᓇᓕᖏᓂ ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᓂᑐᖃᖏᑦ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᓂᖓᓂᒃ. ᓄᓇᕗᒻᒥᐅᑦ ᓄᓇᖃᖅᑐᑦ ᐊᔪᙱᓐᓂᖃᖅᓱᑎᒃ ᓇᓅᖃᑎᒃᑲᓂᖏᓐᓂᒃ ᓇᓗᓇᐃᖅᔫᓇᖅᑐᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᓐᓂᒃ ᓄᓇᐃᑦ ᐅᓄᖅᓯᒋᐊᖅᓯᒪᔪᖅ ᓄᓇᕘᑉ ᐃᓗᐊᓂ. ᐊᓯᖏᑦ ᖃᐅᔨᓴᕈᑎᑦ ᑕᓯᐅᔭᕐᔪᐊᑉ ᐱᖓᓐᓇᖓᓂ ᐅᖃᖅᓯᒪᔪᖅ ᖃᑦᓯᐅᓂᖏᑦ ᓴᖅᑮᓂᖏᓐᓄᑦ ᓇᒋᐊᕐᓇᖅᑐᒦᑦᑎᑦᑐᓐᐆᖅᑎᑕᐅᔭᕆᐊᖃᕐᓂᖏᓐᓄᑦ 2001-ᓗ 2011-ᓗ ᐊᑯᓐᓂᖓᓂᒃ ᒪᓕᒡᓗᓂ ᐊᖏᖅᑕᐅᓚᐅᖅᓯᒪᙱᑦᑐᒥᑦ 1987-ᒥᑦ 2004-ᒧᑦ. ᑭᖑᓪᓕᖅᐹᖅ ᓄᓇᕗᑦ ᒐᕙᒪᖓᑕ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖓᑦ ᓴᖅᑭᑎᓚᐅᖅᐳᖅ ᐃᒪᓐᓇᐅᓇᓱᒋᔭᐅᔪᓂᒃ 1030 ᓇᓄᐃᑦ (95% CI: 745-1406) 2011-ᒥ. ᐋᖅᑭᒋᐊᖅᑕᐅᒃᑲᓂᔾᔫᙱᑦᑐᑦ ᓇᐃᓴᖅᑕᐅᓂᖏᑦᑕ ᓴᖅᑭᓐᓂᖏᑦ ᑕᒪᑐᒨᖓ ᖃᐅᔨᓴᕐᓂᐅᔪᒧᑦ (2016□ᒧᑦ) ᓴᖅᑭᑎᓚᐅᖅᐸᑦ ᐃᒪᓐᓇᐅᓇᓱᒋᔭᐅᔪᓂᒃ 842 ᓇᓄᐃᑦ (95% CI: 562–1121). ᑕᒪᓐᓇ ᐃᒪᓐᓇᐅᓇᓱᒋᔭᐅᓂᖅ ᐅᔾᔨᕐᓇᖅᑐᒻᒪᕆᖓᒥ ᐊᓯᔾᔨᕐᓂᖃᕐᒪᑦ 2011-ᒥᑦ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖅ ᐃᒪᓐᓇᐅᓇᓱᒋᔭᐅᔪᖅ 949[2] ᓇᓄᐃᑦ (95% CI: 618-1280) ᐊᑐᖅᓱᑎᒃ ᐊᔾᔨᑲᓴᖏᓐᓂᒃ ᐃᓂᖏᓐᓂᒃ ᖃᐅᔨᓴᕆᒃᓴᑦ ᓇᓗᓇᐃᔭᖅᓯᒪᔪᑦ ᐅᕝᕙᓘᓐᓃᑦ ᖃᐅᔨᓴᕈᑕᐅᓯᒪᔪᑦ ᓇᓗᓇᐃᔭᖅᓯᒪᓂᖏᑦ.

ᖃᐅᔨᓴᐃᒃᑲᓂᖅᑎ ᐅᖓᓯᒃᑎᒋᔫᓇᕐᓂᕆᔭᖓᓂᒃ ᐊᑐᖅᑕᐅᔾᔪᓯᖓᓄᑦ ᐃᖅᑲᓇᐃᔭᕐᕕᐅᓚᐅᖅᑐᖅ ᒥᒃᓴᐅᓴᒃᑕᐅᓯᒪᔪᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᑦ. ᑕᒪᑐᒪᓂ ᓇᐃᓴᐃᓂᕐᒥ, ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᓯᕗᓂᐊᒍᑦ ᑭᖑᓂᐊᒍᓪᓗ ᖃᐅᔨᓴᖅᑎᓂᒃ ᖃᖓᑕᓲᒃᑯᑦ ᒪᓪᓕᒃᓱᑎᒃ ᖃᕝᕙᓯᒃᑐᖅ ᐃᓂᖏᑦ ᖃᐅᔨᒪᑎᑕᐅᓂᖅ ᓴᓐᓂᖓᔪᓕᖏᓐᓂᒃ ᓯᒡᔭᒧᑦ. ᐊᐅᒍᔅᑎ 2016-ᒥ, ᐅᓄᕐᓂᖅᓴᐃᑦ ᓇᓄᐃᑦ ᓇᓂᔭᐅᓚᐅᖅᑐᑦ 10km□ᒥ ᐅᖓᓯᒃᑎᒋᔪᒥ ᓯᒡᔭᒥ, ᑕᐃᒪᓐᓇᐅᓚᐅᖅᓯᒪᒐᓗᐊᕆᓪᓗᓂ ᕗᐊᑳᓐ ᒥᕐᖑᐃᖅᓯᕙᖏᒥᑦ ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᑦ 80km ᐅᖓᑖᓂ ᖃᕝᕙᓯᒃᑐᒥ. ᖃᔾᔫᓇᑯᓗᐃᑦ ᓇᓄᐃᑦ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᑦ ᓄᓇᕗᒻᒥ, ᐊᖏᕚᑎᒻᒪᕆᖕᓂᒃ ᓄᓇᓕᒃ, ᐃᓇᐅᓂᖅᓴᐅᓪᓗᑎᒃ ᐊᖑᓴᓪᓗᐃᑦ, ᓇᓂᔭᐅᓚᐅᖅᑐᑦ ᓂᒋᖅ□ᑲᓇᖕᓇᖅᐸᓯᖏᒥ ᖃᐅᔨᓴᖅᑕᐅᓂᕆᔭᖏᓐᓂᒃ ᒫᓂᑑᐸ□ᐋᓐᑎᐅᕆᔩ ᑭᒡᓕᖓᓂ. ᐊᑎᖅᑕᓖᑦ ᐊᒻᒪ ᐊᑎᖅᑕᕙᓃᑦ ᐃᓚᒋᔭᐅᓚᐅᖅᑐᑦ ᒥᑭᑦᑑᒐᓗᐊᒥᑦ ᖃᐅᔨᓴᒐᒃᓴᓄᑦ, ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᓚᐅᖅᑎᓪᓗᒋᑦ. ᑕᐃᒪᓐᓇ

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[2]2011-ᒥ ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖅᑕᖅᖅᑎᓪᓗᒍ, ᓯᔾᔭᖅᐸᓯᖏᒥᐅᑦ ᐊᒻᒪ ᖃᕝᕙᓯᒃᑐᑦ ᐃᓂᖏᑦ ᓇᒃᓯᐅᔾᔭᐅᓚᐅᕐᒪᑕ, ᐊᔾᔨᒋᙱᑦᑐᓂᒋᑦ 2016-ᒥ ᓇᐃᓴᖅᑕᐅᓯᒪᔪᓂ ᑕᐃᒪᐃᓐᓂᖓᓄᑦ ᑖᒃᑯᐊ ᒥᔅᓴᐅᒃᑕᐅᓯᒪᔪᑦ ᐊᔾᔩᒍᓐᓇᙱᓐᓂᖏᓐᓄᑦ. ᑕᐃᒪᐃᒃᑲᓗᐊᖅᑎᓪᓗᒍ, ᐱᔭᐅᓚᐅᖅᑐᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᑦ ᒥᔅᓴᐅᒃᑕᐅᓯᒪᔪᑦ 1030 ᓇᓄᐃᑦ 2011-ᒥ ᓇᐃᓴᖅᑕᐅᓂᖏᑦ ᐊᔾᔩᙱᓐᓂᖏᓐᓂᒃ ᐊᔾᔩᓐᓂᖏᓐᓂᓪᓘᓐᓃᑦ ᖃᐅᔨᓴᕐᓂᒃᑯᑦ 2016-ᒥ ᒥᔅᓴᐅᒃᑕᐅᓯᒪᔪᓂᑦ, ᐊᔾᔩᙱᓂᖃᓗᐊᓚᐅᙱᑦᑐᑦ ᑖᒃᑯᐊᒃ ᒪᕐᕉᒃ ᒥᔅᓴᐅᒃᑕᐅᓯᒪᔪᑦ ᐅᔾᔨᕆᔭᐅᔪᓇᕐᓂᖏᓐᓄᑦ.

ᐃᓱᒪᒋᔭᐅᖕᒪᑦ ᐃᕐᓂᐅᕐᓂᖅ ᐊᑦᑎᖕᓂᖕᖓᓄᑦ ᓇᓅᖃᑎᒋᖕᓄᑦ ᑭᓯᐊᓂ ᑕᒪᓐᓇ ᑐᕌᖓᕆᔭᐅᖖᒋᒻᒪᑦ ᑕᒪᑐᒧᖕᖓ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ.

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**Person Days**

Field work during the 2016 field season (12 – 21 August) involved approximately 76 person days (24 person days by Twin Otter, 52 person days by helicopters).

### Aircraft Hours

We flew a total of approximately 132.5 hrs during our field study, including ferry times. These hours were distributed as follows: 55.2 hrs by Twin Otter, 33.7 hrs by the EC135, and 43.6 hrs by the Bell 206 L4.

### Field Dates

Field activities for the aerial survey of the western Hudson Bay (WH) polar bear subpopulation took place between 12 and 21 August 2016. There was only one weather delay day during the survey affecting only the EC135 crew. The Bell LR4 crew was stationed in a different field location and was able to fly all survey days.

### Fieldwork Location

The survey began with a Twin Otter aircraft positioned initially in Rankin Inlet, Nunavut. We worked the Nunavut coastline including islands, south towards Churchill, Manitoba. During the Nunavut portion of the survey we were positioned in Rankin Inlet and Arviat, finally completing the Twin Otter portion in Churchill, Manitoba. Once in Churchill, the survey utilized two helicopters including an EC135, which was based in Churchill and working south, and a Bell LR4 which was positioned in the York Factory area (Marsh Point) and working north within Wapusk National Park. Once the high-density area between Churchill and the Nelson River was completely surveyed, the EC135 relocated to York Factory National Historic Site while the LR4 remained positioned at Marsh Point, and surveyed the Cape Tatnam area west to Kaskattama near the Manitoba/Ontario border. Both field camps were used to complete the survey area between the Nelson River and the eastern extent of the study area (Figure 1). For this survey we flew a total (transect) distance of approximately 9,700 km.

# 1. INTRODUCTION

Polar bears (*Ursus maritimus* Phipps, 1774) hold a place of cultural and spiritual significance in Inuit traditional lifestyles (Honderich 2001; Henri et al. 2010). Aside the spiritual value, in many communities polar bears are also utilized as a source of food, material for clothing and crafts, social/cultural bonding, transfer of hunting and land-use skills, and economic benefits through sport hunting and the sale of hides and skeletal materials (Wenzel 1983, 1995, 2004; Freeman and Wenzel 2006; Freeman and Foote 2009). As the Arctic became more attractive to European explorers in their efforts to map northern sea routes, other resource exploitation including the harvest and sale of marine mammal products including the fur trade, polar bears began facing threats largely due to their prized hides. Historical records estimate a non-native harvest of 55,000 polar bears within the Canadian arctic alone between 1700 and 1935 (Honderich 2001; Wenzel 2004). With seemingly unsustainable harvest rates, and drastically reduced abundance levels on a global scale, the polar bear was becoming endangered (Prestrud and Stirling 1994; Freeman 2001). Concern over such depletion caused the five range states (Canada, United States, Russia, Greenland [Denmark before Home Rule Government], and Norway) to sign an international agreement and to implement conservation and management actions, including quotas, protection of family groups, and hunting prohibitions/restrictions to allow recovery (Fikkan et al. 1993; Prestrud and Stirling 1994; Freeman 2001).

After approximately 45 years of conservation actions as laid out in the international agreement (Fikkan et al. 1993; Prestrud and Stirling 1994), global polar bear abundance estimates increased from a questionable 5,000-19,000 in 1972 to about 26,000 (95% CI: 22,000-31,000) in 2015 (Freeman 1981, 2001; Wiig et al. 2015). This increase in abundance also was confirmed and supported by many Inuit living across the Canadian Arctic (Tyrrell 2006, 2009; Dowsley and Wenzel 2008; Henri et al. 2010). Despite this management success (Prestrud and Stirling 1994; Freeman 2001), polar bears are facing a new potential threat in the form of climatic changes (Derocher et al. 2004; Stirling and Derocher 2012). Across the Arctic, warming temperatures and changes in circulation patterns have led to a deterioration of sea-ice availability, quality and quantity (Maslanik et al. 2007; Stroeve et al. 2012; Intergovernmental Panel on Climate Change 2013; Overland and Wang 2013; Stern and Laidre 2016).

Out of the 19 polar bear subpopulations recognized world-wide (Obbard et al. 2010), the western Hudson Bay subpopulation (WH) in Canada is one of the most-studied large carnivore populations (Jonkel et al. 1972; Stirling et al. 1977; Derocher and Stirling 1995; Regehr et al. 2007; Stapleton et al. 2014). Long-term monitoring and research, predominantly through a capture-mark-recapture program, suggest that the abundance increased during the 1970s, remained somewhat stable, and then declined by an estimated 22% between 1987 and 2004 (Derocher and Stirling 1995; Lunn et al. 1997; Regehr et al. 2007). A more recent analysis suggests that the population remained stable between 2001 and 2011 which appears to be due to temporary stability in sea-ice conditions (Lunn et al. 2016; but see Castro de la Guardia et al. 2017).

In more recent decades polar bear research and monitoring has increased though not without challenges. Concerns over wildlife handling (e.g., immobilization, collaring, tagging, etc.) were expressed by Nunavut hunters and Inuit organizations over the past decade (Henri et al. 2010; Lunn et al. 2010; Wong et al. 2017). As a response to these apprehensions the Government of Nunavut collaborated with the University of Minnesota to develop less-invasive monitoring techniques, such as aerial surveys (Stapleton et al. 2014). Although only fairly recently applied to study polar bear abundance, aerial surveys have not only proven effective in monitoring the abundance of other wildlife species but have also become more technically advanced over the last two to three decades (e.g., through the introduction of survey methods such as distance sampling and double observer sight and re-sight methodologies) (e.g., Norton-Griffiths 1978; Caughley et al. 1976; Tracey et al. 2008; Aars et al. 2009; Stapleton et al. 2014, 2015; Obbard et al. 2015; Lee and Bond 2016). Aerial surveys have become the method of choice in Nunavut to monitor this sentinel polar bear subpopulation over the long-term to provide less invasive, less expensive, up-to-date information to decision makers and user groups (Yuccoz et al. 2001; Nichols and Williams 2006; Peters 2010; Stapleton et al. 2014). In keeping with community recommendations and previous aerial survey methods used in August 2011, we set out to up-date the status of the WH subpopulation using a distance sampling, and double observer sight re-sight method in August 2016 during the ice-free period.

## 2. METHODS

### *2.1. Study Area*

The WH polar bear subpopulation is part of the Hudson Bay complex that includes the neighboring Foxe Basin and southern Hudson Bay subpopulations (Obbard et al. 2010; Thiemann et al. 2008, Peacock et al. 2010; Figure A4.1). Although there is spatial overlap of polar bear movements from these three subpopulations apparent on the sea-ice (e.g., Stirling et al. 1999; Obbard and Middel 2012; Sahanatien et al. 2015), past capture-mark-recapture studies (Stirling et al. 1977; Derocher and Stirling 1990; Ramsay and Stirling 1990; Kolenosky et al. 1992; Taylor and Lee 1995; Derocher et al. 1997; Lunn et al. 1997, 2016), genetic studies (Paetkau et al. 1995, 1999; Crompton et al. 2008; Malenfant et al. 2016), and analyses of satellite telemetry data (Stirling et al. 1999; Sahanatien et al. 2015; Obbard and Middell 2012) support the currently accepted WH subpopulation boundary (Obbard et al. 2010).

Our study area has been well-described by Brook (2001), Dredge and Nixon (1992), Ritchie (1962), Clark and Stirling (1998), Peacock et al. (2010) and Richardson et al. (2005) and includes the areas described by Stapleton et al. (2014) and Lunn et al. (2016). The terrestrial portion of the study area stretches for approximately 1,500 km from about 35 km southeast of the Manitoba-Ontario border all the way into Nunavut (approximately 20 km south of Chesterfield). In general, the southern portion of the study area displays the characteristics of the Hudson Plains ecozone and the Coastal Hudson Bay and Hudson Bay Lowlands. The northern portion exhibits Taiga and the Southern Arctic ecozone (Ecological Framework of Canada 2016). Where trees (black spruce [*Picea mariana*], white spruce [*P. glauca*], and tamarack [*Larix laricina*]) are quite common in the southern extents, dwarf birch (*Betula nana)*, willows (*Salix* spp.), and ericaceous shrubs (*Ericaceae* spp.) are the norm to the north. The near-coastal southern areas exhibit elevated beach ridges, marshes and extensive tidal flats. There is very little relief (<200 m) with underlying continuous and semi-continuous permafrost.

Sea-ice is absent in this region generally from July to November (Stirling et al. 1999; Scott and Marshall 2010; Stern and Laidre, 2016), and biting insects are plentiful during the summer (Twinn 1950).

Polar bears of WH come ashore when sea ice levels diminish to ≤ 50% (Stirling et al. 1999; Cherry et al. 2013, 2016), which generally occurs during July (Stern and Laidre, 2016). Once on land, the bears segregate by sex, age class, and reproductive status within the study area where they exhibit fidelity to their terrestrial summer retreat areas (Stirling et al. 1977; Derocher and Stirling 1990). Adult males are generally found along the coastline, pregnant females and females accompanied by offspring are found in the interior denning area which is mostly included within Wapusk National Park, and subadults are distributed throughout the study area (Stirling et al. 1977; Derocher and Stirling, 1990; Ramsay and Stirling 1990; Clark and Stirling 1998; Clark et al. 1997; Richardson et al. 2005). When sea ice reforms during November all bears except pregnant females return to the ice. Pregnant females give birth in terrestrial dens during December and early January, and family groups generally depart their dens in March and April to return to the sea ice (Jonkel et al. 1972; Stirling et al. 1977; Ramsay and Stirling 1988).

### *2.2. Survey design*

The 2016 WH polar bear distance sampling abundance survey used double observer pairs (sight/re-sight) and was based out of the communities of Rankin Inlet and Arviat within the Nunavut Settlement Area, and Churchill and the remote camps of York Factory and Marsh Point within northern Manitoba. The comprehensive stratified aerial survey was flown between 12 and 21 August. The survey was timed to coincide with the ice-free period because; (a) all polar bears of the WH population are forced to be on land during this time, (b) any overlap with neighboring subpopulations is very likely minimal, and (c) bears are readily visible against the terrestrial landscape. In addition, females will likely not have begun to den yet and can be detected while moving towards their inland denning area (Stapleton et al. 2014). The survey was structured into two main components: 1) Pre-stratification using telemetry, past survey results and traditional, local, and ecological knowledge collected during the consultation process, and 2) Distance sampling double observer pair (sight re-sight) aerial visual survey methods using fixed and rotary wing aircraft.

The establishment of the survey area and the division of that study area into strata of individually consistent relative densities of polar bears was modeled after Stapleton et al. (2014). Modifications were based on their 2011 aerial survey results as well as previous and current telemetry findings (n = 8 collared bears in summer of 2016, A. Derocher, University of Alberta and Environment and Climate Change Canada, unpublished data; Manitoba Sustainable Development, unpublished data; Derocher and Stirling 1990; Lunn et al. 1997; Stirling et al. 2004; Richardson et al. 2005; Towns et al. 2010; Stapleton et al. 2014). In addition, we consulted coastal survey maps and den emergence information provided by Manitoba Sustainable Development.

Following a thorough review and spatial plotting of past survey observations across the WH polar bear population boundary, an in-depth round of HTO (Hunters and Trappers Organizations) and community-based consultations were undertaken in January and February of 2016. During those consultations, HTOs from the communities of Baker Lake, Rankin Inlet, Chesterfield Inlet, Whale Cove and Arviat were invited to comment on preliminary stratification of polar bear densities as well as transect placement. Comments and concerns raised during these meetings were incorporated into the survey design. The merging of past survey observations and telemetry data, with the mapped density distributions from consultations, yielded 4 survey strata that slightly varied from those used by Stapleton et al. (2014) in 2011. The 2016 survey strata included the following derived polar bear density distributions: 1) very low, 2) low, 3) moderate, and 4) high (Figure 1).

All survey transects were oriented perpendicular to the bear density to improve precision and to reduce possible bias during sampling (Buckland et al. 2001) (Figure 1). Survey effort, measured as transect spacing, was then allocated across survey strata based on the following constraints: strata with the highest estimated polar bear density for the survey period would receive the highest level of coverage with survey effort for the remaining strata being allocated proportionally to the approximate relative density of polar bears. Effective strip width varied depending on sightability, which in turn was dependent on measured covariates including cloud cover, speed, ground cover, terrain, and observer ability.

The very low density strata and transects represented the inland portions of the survey area outside of the Wapusk National Park high density stratum boundaries (Figure 1). These strata were divided further into two main areas, one north and west of the Churchill River up to the Nunavut/Manitoba boundary in the north, and the second south and east of the Nelson River bounded to the east by Cape Tatnam. The very low density strata covered only inland transects generally ending within 20 to 30 km of the Hudson Bay coastline. Transect spacing was irregular but averaged 17 km across the strata.

The low-density stratum and transects occupied the northern extents of the WH polar bear population boundary (approximately 20 km south of Chesterfield Inlet) to the Nunavut/Manitoba border (Figure 1). Modifications from Stapleton et al. (2014) included IQ-based transect extensions both over water and inland within the northern extent of this stratum. Overwater extensions within the remaining extents including 2 transects bi-secting Sentry Island were derived solely from *Inuit Qaujimajatuqangit* (IQ) reports and recommendations. Transect lines in this stratum were spaced 10 km apart, and extended up to 90 km inland, and up to 30 km into Hudson Bay beyond the coast to incorporate the many off-shore islands characterizing this coastline. The development of this stratum was largely based on local knowledge which strongly recommended the extension of coastal transects inland and across open water and coastal islands.

The moderate-density strata and transects were divided into two areas, one north and west of the Churchill River up to the Nunavut/Manitoba boundary in the north, and the second south and east of the Nelson River, approximately 60 km east into Ontario to the eastern extent of the WH polar bear population boundary. These strata primarily covered a Hudson Bay coastal strip that was approximately 20 to 30 km wide. Transect spacing within this strata was 7 km with transects extended beyond the tidal flats into open water. Recent information collected by the Manitoba Department of Sustainable Development on summer and spring polar bear habitat including denning sites, spring emergence habitat, and coastal summer retreat, led this survey effort to modify Stapleton et al. (2014) survey design to define a moderate-density stratum from Cape Tatnam east toward East Penn Island with transects extending beyond the coastal strip up to 70 km inland into known denning habitat (Figure 1).

The high-density survey stratum and transects followed those described by Stapleton et al. (2014). The stratum boundary ran between the Churchill River in the west to the coast of Hudson Bay in the east with Churchill forming the northern boundary and the Nelson River approximating the southern boundary. The core of the high density stratum included Wapusk National Park which is known to be a high density summering area, and further inland, a heavily used denning area (Lunn et al. 2016). Transects in this stratum extended up to 100 km inland and were spaced 6 km apart. As with all other survey strata, all transects were extended 5-30 km beyond the coast into Hudson Bay which enabled the survey design to include bears either in water or on the extensive tidal flats known to be occupied by bears during summer and fall periods (Dyck, 2001; Clark and Stirling 1997).

Financial and logistical constraints as well as examination of weather patterns dictated the survey window and total number of aircraft required to successfully and efficiently complete the survey without the concern over long-disance polar bear movements between survey days. One de Haviland Twin Otter fixed wing aircraft with radar altimeter, a Eurocopter (model EC135) twin engine rotary wing aircraft with radar altimeter, and a Bell Long Ranger (model L4; Bell LR4) single-engine rotary wing aircraft with pop-out floats were used to complete the August 2016 WH polar bear abundance survey. All aircraft throughout the survey maintained, as close as possible, an altitude of 400 feet above ground level (AGL) and an air speed of between 70 and 90 knots for the fixed wing, and 70 to 80 knots for the rotary wing aircraft while flying on transect. The Twin Otter fixed wing aircraft was used to complete the low density stratum within Nunavut and the very low and moderate density strata west and north of the high density stratum bounded by the Churchill River, Manitoba, in the south. The twin engine fixed wing configuration and its ability to fly on one engine was chosen to increase safety while flying over extensive water transects characteristic of the northern half of the survey study area within Nunavut.

The Eurocopter EC135 helicopter was incorporated into the survey study design as it has the ability to seat six (6) forward facing observers, four dependent observers (two on the left side of the aircraft and 2 on the right) and two non-dependent observers (a data recorder/observer on the left and a pilot/observer on the right; Appendix 1). We utilized this configuration to test the assumptions that the pilot and navigator, considered non-dedicated observers due to their additional roles that at times would impact continuous observations and associated search patterns. The goal of this configuration was to test whether these non-dedicated observer positions could observe polar bears as effectively as a dedicated observer.

The LR4 was used within the more remote extents of identified survey strata south of Churchill due to its greater fuel economy while operating out of remote fuel caches. The LR4 was configured for four (4) observers: two dedicated observers in the left and right secondary (rear) positions and a data recorder/observer in the front left primary position and a pilot/observer in the front right primary position. Both rotary wing aircraft were used to complete the remaining high, moderate, and very low density strata within the southern half of the survey study area in northern Manitoba.

### *2.2.1. Double observer pair*

The double observer pair (sight/resight) method is a variation of physical mark-recapture (Pollok and Kendall 1987). Simply, the aircraft's front and rear observers comprise two independent survey teams, visually 'marking' (i.e., front observers' sighting) and 'recapturing' (i.e., rear observers' resighting) polar bears. Observer teams must be independent to estimate detection probabilities (see Appendix 2). This resultant information provides an independent estimate of the number of bears present in the survey strip that were not observed by either team (Laake et al. 2008; Buckland et al. 2010).

The double observer pair method requires two pairs of observers on each of the left and right hand sides of the aircraft (Figure 2) (Buckland et al. 2001; Pollock and Kendall 1987). One “primary” observer sits in the front seat of the aircraft and a “secondary observer” is located behind the primary observer on the same side of the aircraft. To insure visual isolation, a barrier was installed between same side observers to remove any visual cues that could modify an observer’s ability to sight the animal (Appendix 1). Observers waited until bear groups passed before calling out the observation to ensure independence of observations. The data recorder/recorders, categorized and recorded counts of each bear (group) into “primary only”, “secondary only”, and “both”; The observers switched places approximately half way through each survey day (i.e. at lunch or during re-fueling stops) as part of the survey methods to address possible differences in sightability between the primary and secondary positions. Though the methods during all phases of the survey followed these 4 basic steps, there were differences in the methods deployment made between the three aircraft.

### *2.2.2. Fixed wing*

Within the fixed wing aircraft we utilized an 8 person platform; 4 dedicated observers, 2 data recorders (for each of the left and right primary and secondary observer pairs) and a pilot and co-pilot. Observers within the fixed wing survey crew included two experienced Hunters and Trappers Organization (HTO) observers (one from Rankin Inlet and one from Arviat), 3 experienced wildlife biologists (two from the Government of Nunavut – Department of Environment and one NTI wildlife biologist), and one experienced wildlife technician. The observers were further divided into primary and secondary teams, each isolated from the other using visual barriers between the seats as well audio barriers through the use of two independent intercom systems monitored by each of a primary data recorder/navigator and a secondary data recorder/navigator (Appendix 2). The pilot’s responsibilities were to monitor air speed and altitude while following transects pre-programmed on a Garmin 650T Geographic positioning system (GPS). The data recorder/navigators were responsible for monitoring a second and third identically programmed GPS unit for the purposes of double-checking the position as well as to record the geographic position, body condition, composition and numbers of observed polar bear groups on data sheets. The pilots, data recorders, one right side observer, and both left side observers remained consistent throughout the fixed wing portion of the survey, while one right observer position was occupied by 3 different individuals. The primary and secondary observer pairs were alternated between the front and rear positions halfway through the day during scheduled re-fueling stops.

### *2.2.3. Rotary wing*

The EC135 rotary wing platform was configured to have 6 forward facing seats with observation windows, 3 on the left side of the aircraft and 3 on the right. We utilized a 6 person configuration for the first two days of surveying and a 5 person platform for the remainder of the survey to address weight and balance issues as they pertained to extending endurance.

Within the EC135 six (6) person configuration, 4 were dedicated observers, two on the left side of the aircraft and 2 on the right. The remaining 2 positions were within the forward most seats and included a data recorder/observer on the left side and a pilot/observer on the right. Though the final population analysis utilized the observations exclusively from the 4 dedicated observers, the data recorder/observer and pilot/observer observations were also recorded to compare with the observations from respective side dedicated observers for an assessment of a non-dedicated observer's ability to sight bear groups. As only one data recorder could be accommodated using this configuration, front and rear audio isolation was not possible leading to a modification of the fixed wing configuration where the two front most observers (pilot and data recorder) waited until the observation moved to their 5 and 7 o'clock positions respectively to ensure all same side dedicated observers had ample time to independently sight the group. Additionally the primary dedicated observers waited until the bear observation passed their 4 o'clock (right) and 8 o'clock (left) position to allow the secondary observers ample opportunity to make their sighting. As in the fixed wing, the same-side dedicated observers changed between primary and secondary positions half way through the day. Only one change was made between dedicated observers over the two day period. Additionally all but one dedicated observer remained consistent over the period.

The EC135 five (5) person configuration followed the same basic configuration indicated for the 6 person configuration with the single exception of the removal of the pilot as an observer. The data recorder/observer position continued to further test the comparability between a dedicated and non-dedicated observer. All observers were experienced and remained consistent throughout the remainder of the survey. For this configuration the data recorder/observer position moved back one seat to the left primary position opposite the right primary dedicated observer. Once again primary and secondary positions were exchanged half way through the day.

The Bell LR4 only allowed for a four person configuration due to weight and balance issues while carrying full fuel as well as seating configuration. Using this configuration only the secondary observers were dedicated observers while the left primary observer seat was occupied by a data recorder/observer and the right primary position by a pilot/observer. Additionally, observers could not exchange primary and secondary positions using this configuration to determine sightability differences between seating positions. Though only two dedicated observers could be accommodated within the LR4 configuration, this study used the assessment of non-dedicated observers within the EC135 to inform on the reliability of the non-dedicated observers within the LR4. While the methods used during this study generally followed those used by Stapleton et al. (2014), it is important to note that no pooling of front and rear observers was made. All observations made during this study were independent.

### *2.2.4. Distance Sampling*

In addition to the deployment of the double observer pair method within all aircraft, we also collected observations using distance sampling. The distance sampling method followed Buckland et al. (1993, 2004, 2010) and used Program Distance, Version 6.0

(Thomas et al. 2009), to model stratified line transect observation data and estimate density and abundance for polar bears. Using the conventional distance sampling approach (CDS), we modeled the probability of detecting a group of polar bears and their densities within five delineated strata as a function of distance where the detection function represents the probability of detecting a group of polar bears, given a known distance from the transect (Buckland et al. 2001). Recognizing that other variables may affect the detection probability, density estimates were also derived using multiple covariate distance sampling (MCDS), which allowed us to model probability of detection as a function of both distance and one or more additional covariates (Buckland et al. 2004). This approach was explored in order to increase the reliability of density estimates made on subsets of the data based on terrain, vegetation, and environmental conditions, and to increase precision of the density estimates within each unique density-derived strata (Marques et al. 2007).

For the fixed wing portion of the survey only, and in addition to flying to the observed bears for position and data collection, we also used distance bins marked out with streamers and tape on the wing struts after Norton-Griffiths (1978) (Figure 4). In total, 6 distance bins were used including the following; 0-200 meters, 200-400 meters, 400-600 meters, 600-1,000 meters, 1,000-1,500 meters, and 1,500-2,000 meters. Though binned observations were not used during analysis, they did inform on the precision of binning for distance sampling platforms when compared to the actual observation waypoint recorded.

### *2.2.5. Observations*

Polar bears observed while flying along a transect line were considered on-transect while those observed while ferrying to, from, or between transects, or to bear and/or wildlife sightings, where considered off-transect. Because polar bears are often found in groups, each observation (whether individual or group) represented a group of polar bears. In this work a group of polar bears was defined as one or more individuals within a visually estimated 100 meter radius of one another. All observations were investigated by moving off the transect line to the center of the group as they were initially observed, to record the location, group size, sex/age classes, body condition, and activity. Additional covariates including topography, habitat, visibility, cloud cover, and ground speed were also recorded for each observation. Observation times were kept to a minimum to reduce disturbance and stress. All distances to the observations were measured perpendicularly ($90^0$) from the transect line to the center of the observation, and recorded along with the observation's date and time of day.

We determined gender and body condition, to the extent possible, from approximately 30 meters altitude. A general, relatively robust though subjective fat index has been successfully used in past studies to assess body condition of polar bears (Stirling et al. 2008; SWG 2016; Government of Nunavut, unpublished data). Gender of bears was determined based on body size, the presence of morphometric characteristics (e.g., such as scars, large head, thick neck, long fur on front legs, vulva patch and urine stains) and behavior when encountered (SWG 2016). Age class assessment from the air can be accomplished reliably for adult males, pregnant females, and members of family groups (Government of Nunavut, unpublished data; SWG 2016). Based on these methods, polar bears were classified as male or female, and as adult males (6+ years), adult females (5+ years), sub-adult males (2 to 5 years), sub-adult females (2 to 4 years), yearlings (>1 and < 2 years), and cubs of the year (<1 year). Standardized body condition indices [i.e., poor (1), fair (2), good (3), excellent (4) and obese (5)] were scored for each individual bear (Stirling et al. 2008) as was the activity at the time of observation (i.e., either laying down, sitting, walking, running or swimming). Each aircraft had at least one experienced biologist on board that could identify age classes and body conditions of observed bears with confidence.

For each observation, habitat structure and topography were recorded as covariates as well as cloud cover, visibility and ground speed. Habitat structure was recorded as rocky (1), boulders (2), trees (3), high shrubs (4), grassland (5), sand/mudflats (6), open water (7) and lichen tundra (8). Topography was broken down into an index for slope measured as flat (1), moderate (2) or steep (3), and an index for terrain measured as flat (1), rolling (2) and mountainous (3). By way of example a moderate slope within a rolling terrain would receive a score of 2/2. Visibility of 100%

was indexed as excellent (1), moderate or 75% to 100% (2), and poor or less than 25% (3). All aircraft deployed the distance sampling methods and collection of covariate data consistently across the study.

### *2.3 Analyses*

#### *2.3.1. Data screening and truncation*

Data were initially screened for outlier observations that occurred at far distances therefore creating a tail on the detection function that can be difficult to fit. A right truncation distance that eliminated the upper 5% of observations was considered to minimize the influence of these observations (Buckland et al. 1993, Stapleton et al. 2014). Unlike the previous survey (Stapleton et al. 2014) we left-truncated both the front (pilot and data recorder) observations from the Bell helicopter rather than only left truncating the rear observations. The rationale for this was that we wanted to keep the data sets as similar as possible for the double observer analysis. There were 3 observations of 7 bears that were only observed in the rear observer blind spot by the front observers in the Bell helicopter. Therefore, the degree of reduction due to left truncation of the Bell helicopter data was not large.

The blind spot under each aircraft was estimated using geometric formulas. From this, left truncation distances were estimated for the twin otter as 98.9m, 67.2m for the EC135 helicopter, and 73.5 m for the Bell L-4 helicopter. Adjusted distance from the transect line was then estimated as the distance from the transect line minus the left truncation distance for each aircraft.

#### *2.3.2. Co-variates*

Covariates that affected bear sightability were considered that included environmental, observer and survey factors (Table 1). These covariates included group size, aircraft type, observer, and visibility. Visibility was reasonably good during the survey where only 15 of 178 observations were recorded as non-optimal conditions. Therefore, visibility was reduced to a binary covariate as was done in previous analyses (Stapleton et al. 2014).

A habitat (*hab*) category based on classification by observers was derived from field observations. This classification included open, shore, shrub, tree, and water habitat classes. A shrub habitat category was also initially considered, however, the number of observations was low and the distribution of observations was disjoint. Therefore, this category was pooled with shore category for observations that occurred on the shore and tree for inland observations.

A remote sensing based covariate (*RSveg*) based on LANDSAT 8 vegetation classification was also considered (Figure 5). The rationale behind this covariate was that it would systematically index dominant vegetation types in the proximity of observations therefore providing the best comparison of habitat and potential obstruction of observations across all observations. Remote sensing covariates based upon the habitat class of the pixel ($625m^2$) where the observation occurred as well as the dominant habitat class within a 90X90m and 150X150m area around the observation were used. The main categories in Figure 5 that were present in the study area were gravel, shrub, trees, low vegetation, and water.

A combination of remote sensing and observer-based habitat scores was also considered (*RSveg-hab*) which re-classified the *RSveg* water category based upon observer habitat scores. For this category *RSveg* that were classified as water were reassigned to gravel (habitat class shore or habitat class water), low-vegetation (habitat class open), shrub (habitat class shrub), and tree (habitat class tree).

All of the survey aircraft except the Bell LR4 (and 3 survey days in the EC135 with only 3 dedicated observers and one observer-recorder on the left hand side) helicopter had 2 dedicated observers per side. The Bell LR4 had 2 dedicated surveyors in the back seat of the helicopter and the pilot and data recorder/navigator as observers in the front. The pilot and data-recorder did not have the same view as the observers, and were distracted by piloting the helicopter and navigating/data recording. Therefore, special covariates were formulated for the pilot and data recorder/observers in this aircraft.

We also noted that the angle of the sun in the afternoon affected our ability to sight bears given that cloud cover was minimal during the survey. This occurred when the sun was lower on the horizon and was directed towards the observers reflecting of the many lakes and ponds characteristic of the survey area. To test for this effect we calculated sun azimuth (e.g., the direction of the sun in the sky) and altitude relative to the path of the survey aircraft. From this we were able to determine when the sun was directed towards the observers (based on sun azimuth relative to flight path) and sun altitude based on time of day. Using this information we constructed a sun covariate which was only considered if the sun was facing the observers. If the sun was facing the observers then sun altitude relative to the horizon was tested as a sightability covariate with the expectation that sightability would be lower at lower sun angles.

*2.3.3. Models and modeling approach*

Mark-recapture distance sampling methods were applied to the survey data (Buckland et al. 2004, Laake et al. 2008a, Laake et al. 2008b, Buckland et al. 2010, Laake et al. 2012). A mark-recapture/distance sampling model assuming point independence was used which allows estimation of the detection probabilities at the transect line (or left truncation distance) using independent double observer pair methods with distance sampling methods used to model the decline in sighting probabilities as a function of distance from the survey line.

A sequential process was used for model building. First, parsimonious distance sampling models were formulated using a mark recapture model with constant detection probabilities. Once the most supported distance model was determined, parsimonious mark-recapture models were formulated using the most supported distance model as a base model in the mark-recapture model analysis. As a final step, optimal distance and mark-recapture models were combined and assessed for goodness of fit and overall parsimony. Information theoretic methods (Burnham and Anderson 1992) were used to assess relative model fit. More exactly, Akaike Information Criterion (AIC) were used as an index of model parsimony with lower scores indicating a model that explained the most variation in the data set with the least number of parameters. The difference between the most supported model and given model was evaluated ($\Delta$AIC) to indicate relative support with models at ∆AIC values of less than 2 being of interest. Akaike weights were used to estimate proportional support of models. Models were averaged based on AICc weights using the *AICcmodavg* (Mazerolle 2016) package in program R (R Development Core Team 2009). The AIC score indexes relative fit but does not provide a test of overall goodness-of-fit. Goodness-of-fit tests incorporated in program DISTANCE were used to further evaluate fit of the most supported models.

The 2016 data set was also analyzed using only distance sampling methods to assess if estimates were significantly different when mark-recapture double observer methods were used given that previous surveys did not use the mark-recapture method.

One of the primary objectives of the analysis was to compare the 2011 and 2016 distance survey estimates given that the field sampling designs for the 2 surveys were nearly identical. To ensure that estimates were comparable, the 2011 data set was re-analyzed with the remote sensing based *RSveg* habitat classes to assess whether inclusion of this covariate would influence abundance estimates compared to the structure covariate used in the 2011 analysis (Stapleton et al. 2014). A t-test was used to compare estimates with degrees of freedom estimated using the formulas of Gasaway et al. (1986).

Analyses were conducted using program DISTANCE 7.0 (Thomas et al. 2009) for initial model input and fitting with additional analyses conducted in the *mrds v2.1.1.17* (Laake et al. 2012) R package version 3.3.3 (R Development Core Team 2009). Data were explored graphically using the *ggplot2 R* package v 2.2.1 (Wickham 2009) and QGIS program (QGIS Foundation 2015).

## 3. RESULTS

### *3.1. Sightings, Habitat, and Detection*

The WH polar bear survey was flown between August 12 and 21, 2016. Survey strata flown between Chesterfield Inlet and Churchill with the Twin Otter took 4 days to complete. The remainder of the study area was completed utilizing 2 rotary wing aircraft in 5 days. During the survey we flew approximately 35 hrs with the Twin Otter and 80 hrs total with the two rotary wing aircraft for an estimated total distance of approximately 17,100 km, including ferry time.

In total, 339 bears were observed during the survey (Table 2). Of these observations, 17 were in the blind spot of the plane and 25 were beyond the right truncation distance. The remaining 297 bears were in the survey strip, however, 280 of these were seen by one or both of the dedicated observers and only 17 were observed by non-dedicated observers including the data recorder/observers and pilot/observers.

Graphical illustration of the distribution of observations revealed differences for our initially selected habitat types. More distant observations occurred within coastal as well as more open habitats whereas reduced detections and detection distances were observed for the water and tree habitat categories (Figure 6). The majority of observations occurred at distances of less than 2700 meters from survey aircraft (Figure 7). The 95$^{th}$ percentile of this observation data was within 2250 meters of the aircraft and therefore the data was right truncated to this distance value. Sensitivity analyses were conducted at a later stage of the analysis to determine if estimates were sensitive to both left and right truncation distances.

The distribution of LANDSAT remote sensing categories (*RSveg* covariate) revealed a broad distribution for the gravel category with sparse distributions of low vegetation (Figure 8). The tree category had most observations close to the survey line suggesting lower sightability, while the shrub distribution suggests moderate sightability. In contrast to the observation-based habitat water classification (Figure 6), the LANDSAT classification of water in Figure 8 reflected habitat in and around water as opposed to water alone as indicated by the presence of non-water habitat class observations, such as shore, in the water *RSveg* class. As a result, the water category had higher sightability with more observations further from the survey line than the water observation-based habitat class. Most of the gravel category corresponded to observations that occurred on the shore line with mixed distributions of habitat categories for the other *RSveg* classes. The distribution of the low vegetation class was potentially problematic due to few observations close to the survey line. This issue, which was most likely due to sparse data, was alleviated by pooling the shrub and low vegetation classes (Figure 9). This new pooled covariate class was called *RSveg2*.

Distributions of detections for aircraft type were relatively similar with relatively similar ranges of distance for observations (Figure 10). The main difference was the relative number of observations for each aircraft which created distributions that were more disjoint when the number of observations was lower.

Twelve observers were used during the survey of which 2 also were data recorders for at least part of the survey (Table 3). Naïve detection probabilities were estimated as the total number of times a bear was detected when an observer was active divided by the total number of observation event/trials. This is a naïve estimate given that other factors such as distance from the aircraft of the bear is not considered and therefore this probability will underestimate the detection probability on the survey line for any observer. In addition, the actual probability of detection on any side of the aircraft is based on 2 observers and will be higher than a single observer detection probability. Regardless, the average naïve detection probability for an observer was 0.77. Of most interest were detection probabilities below this amount. The Bell LR4 pilot and recorder both had lower detection probabilities and were therefore considered in detail in subsequent analyses.

We observed 39 cubs of the year (COY), and 10 yearlings (YRLG), which resulted in a mean COY and YRLG litter size of 1.63 (SD: 0.49; n = 24) and 1.25 (SD: 0.46; n = 8), respectively. COYS and YRLGs represented 11.5% and 2.9% of the entire observed sample of 339 bears. Approximately 53% of all observations were adult males (Table 4).

### *3.2. Distribution*

A break-down of observed bears by strata, and across the study area is shown in Figure 11 and Table 2. The distribution of bears within the study area during August 2016 was not uniform. The majority (93.5%) of observations occurred in the high and moderate density strata. When the WH polar bear population study area was broken down into areas according to Lunn et al. (2016), Nunavut (their area A or our low density strata) exhibited the lowest bear density whereas area C (i.e., the high density area) contained 50% of all observed bears (Table 4). Area D (or the area east of the high density area) had the highest density of adult males. We only report the pooled mean ± SD distance from coast for areas C and D since these are the areas with the highest sample size. In general, adult males were found near the coast (1.3 ± 1.8 km; range: 0.02 – 12.1 km), whereas adult females were found an average of 25.5 ± 23.4 km (range: 0.5 – 84.3 km) from the coastal areas. For family groups, the mean distance from shore was 11.5 ± 16.2 km (range: 0.1 – 54.2 km).

## *3.3. Distance/Mark-recapture analyses*

### *3.3.1. Distance analysis*

The distance component of the analysis used a constant mark-recapture model probability which basically assumed that detection at the left truncation distance did not vary (but was less than 1). Initial fitting revealed that both the hazard rate and half normal models showed some support from the data with a tendency of the hazard rate to be supported when covariates were not used (Table 5, model 13). Of covariates considered, models with group size (*size*), habitat (*hab*), remote sensing veg (*RSveg2*) and visibility (*vis*) were more supported than constant models. Of all models considered, a model with a hazard rate detection function with sightability varying by *RSveg2* and *size* was most supported. However, models with just *RSveg2* as well as models with the half normal detection function with habitat and visibility as covariates (model 3) also showed some support as indicated by ∆AICc values of less than 2. Therefore, these models were considered further in the joint distance/mark-recapture phase of the analysis.

The most supported hazard rate (*RSveg2*+*size*) model was used for the mark-recapture analysis phase. Estimated abundance varied between 770 and 966 for models with abundance around 850 for the more supported models in the analysis (Table 5).

### *3.3.2. Mark-recapture analysis*

The most supported distance model (HR (*RSveg2+size*) was then used as a baseline distance model for the mark-recapture component of the analysis (Table 6). Of covariates considered, *group size, aircraft type, sun*, and *observers* were more supported than a constant model (model 12). Of the observer models, a model with unique detection probabilities for the Bell LR4 pilot (*Bellp*) and data recorder/navigator (*Bellr*) and equal probabilities for all other observers (model 4) was more supported than a model with all observer detection probabilities being different (model 6). Overall, a model with the Bell pilot, Bell recorder, sun, and group size was most supported (model 1). A model without group size included (model 2) also had marginal support as indicated by ∆AICc values of less than 2.

### *3.3.3. Distance/mark-recapture analysis*

The most supported covariates for distance sampling (Remote sensing vegetation (*RSveg2*), observer-based habitat class (*hab*), visibility (*vis*), and group size (*size*)) and mark-recapture (group size (*size),* Bell pilot *(Bellp),* Bell recorder *(Bellr), and sun angel (sun)*) were considered in the joint distance/mark-recapture analysis. Of the models considered, a model with the most supported stand-alone distance sampling covariates (Table 7; *RSveg2+size*) and most supported mark-recapture covariates (Table 5; (*Bellp +Bellr+sun+size*) was most supported (Table 7; model 1). Other models that did not include group size for distance (model 2), used a half-normal detection function with habitat visibility (model 3) as well as other combinations of covariates with a hazard rate detection function (models 4-6) were supported as indicated by ∆AICc values of less than 2. Estimates from the most supported models were close ranging from 774 to 896 with reasonable levels of precision for all models.

### *3.3.4. Goodness of fit*

Goodness of fit for the most supported model (Table 7) revealed acceptable fit for the distance component ($\chi^2$=4.33,df=2, p=0.11) with 250meter bin intervals and the mark-recapture component ($\chi^2$=12.4,df=13, p=0.49) leading to an overall acceptable goodness of fit score of ($\chi^2$=16.7,df=15, p=0.34). Kolmogorov-Smirnov tests (0.045, p=0.91) and Cramer-Von-Mises tests (0.035, p=0.89) also suggested reasonable fit.

Predictions for various combinations of distance sampling and mark-recapture covariates were plotted to explore the effect of covariates on detection probabilities as well as assess fit to the main *RSveg2* classes (Figure 12). If model fit is adequate then the general pattern of points should parallel the histogram bars. The size of each data point was proportional to group size with larger groups having larger symbols. Larger groups had higher detection probabilities than smaller groups which created the most scatter in the observation points at different distance intervals. In addition, observations that were most affected by sun altitude (as indicated by a sun altitude of less than 30 degrees) are denoted as red dots with yellow dots representing situations where the sun was facing the observer but was higher in altitude (with less of an estimated effect on detection probabilities). Finally, black dots indicate when the sun was behind the observer therefore not affecting detection probabilities. A few patterns arise from Figure 12. First, the fit of the data to each *RSveg2* class is reasonable with the general pattern of observations following the shape of the histograms. Most notably, the tree observations decline steeply with distance with moderate declines in vegetation-shrub, lesser declines in habitat areas in and around water, and minimal decline in the gravel categories. Larger group sizes of bears show a less substantial decline compared to smaller group sizes with some large groups having higher sighting probabilities at further distances from the survey aircraft. However, observations that were affected by the sun (denoted by red points) have lower detection probabilities than other observations at similar distances and group sizes.

The other factor affecting sightability was reduced sightability near the line for the Bell helicopter recorder and pilot. This basically reduced the y-intercept of the detection probability to be lower than one; an effect that is most noticeable when group size is smaller (Figure 13). A plot of pooled detection probabilities superimposed on the detection frequencies also suggests reasonable fit (Figure 14). The points on Figure 14 are for each observation whose probability will vary by covariates such as habitat, visibility, group size, and observer as described in Figures 12 and 13.

Average front observer detection probabilities for the front and rear observer was 0.63 and 0.76 which resulted in a combined double observer detection probability of 0.90 at the survey line (Figure 15). Plots of detections by front (observer=1) and rear observer (observer=2) reveal similar detection function shapes for situations when a bear was only detected by a single observer as well as both observers (duplicate detections) (Figure15). The conditional detection probabilities were similar with distance for observer 1 given detection by observer 2 but slightly higher for observer 2 when detected by observer 1 at further distances. This could be due to cueing or more time for the rear observer to spot animals at further distances.

### *3.3.5. Abundance estimates*

A model averaged estimate of abundance that considered all of the candidate models in the analyses (Tables 5-7) was 842 bears (SE=142.6, CV=16.9%, CI-562-1121) during August 2016. This estimate was very close to the most supported model estimate of 831 (Table 7). The corresponding model averaged estimate of density is 9.9 bears per 1000 km$^2$ (SE=1.67, CI=6.62 -13.18).

Abundance estimates are given by strata for the most supported model (model 1) in Table 7. One issue we encountered was that only one observation of 8 bears occurred in the very low strata leading to very imprecise estimates. The low and very low could be pooled into a single strata to confront this issue. However, the actual estimates will not be affected greatly (Table 8).

### *3.3.6. Sensitivity of estimates to truncation*

The most supported model (model 1, Table 7) was rerun at various right truncation distances to determine the overall sensitivity of estimates to deletion of observations that occurred far from the transect line. Decreasing the right truncation distance to 1800 meters which is closer to the data limit by the previous survey (Stapleton et al. 2014) decreased the estimate slightly to 826 bears whereas increasing the right truncation distance to 2700 m include further observations (Figure 7) decreased the estimate by 6 bears. Overall, the effect of truncation was minimal on estimates (Table 9).

### *3.3.7. Analysis of the 2016 data set using only distance sampling methods*

The data were also run through the most supported distance model (HR(*RSveg2*+size) to assess estimates if data observed by non-dedicated observers was included but with sightability assumed to be 1 on the survey line. For this analysis the 17 bears that were not observed by the 2 dedicated observers were included in the analysis given that they were observed from the aircraft by data recorders or pilots . Of the 17 bears not seen by the dedicated observers, 7 were observed by the front left data recorder at 696 meters on the EC135, 7 were observed on the twin otter by the front right data recorder, and 3 were observed by the front left pilot on the twin otter. All of these bears were within the survey strip.

The HR (*RSveg2*+size) displayed adequate fit to the data ($\chi 2=7.71$,df=6, p=0.26). Kolmogorov-Smirnov tests (0.041, p=0.95) and Cramer-Von-Mises tests (0.032, p=0.97) also suggested reasonable fit. The resulting abundance estimate was 843 bears (SE=104.2, CV=16.8%, CI=607-1170) which is very close to the mark-recapture/distance sampling estimate of 831 (Table 8).

### *3.3.8. Additional analyses*

We conducted additional analyses with the main objective of comparing abundance estimates from the 2011 and 2016 surveys to allow a robust estimate of trend. The rationale behind these analyses was to ensure similar modelling and analysis methods were used in each survey year therefore allowing direct comparison of the estimates.

#### 3.3.8.1. Re-analysis of 2011 data set using LANDSAT covariates

We re-analyzed the 2011 data set using the remote sensing (LANDSAT) based habitat classification scheme to determine if this covariate was also supported as a detection function covariate for the 2011 data set, and to assess any change in estimates with this covariate. A full suite of models were considered including those from the original analysis (Stapleton et al 2014). A model with the LANDSAT covariate (along with visibility and habitat structure) with a hazard rate detection function was most supported. The model averaged estimate of abundance from this analysis was 949 bears, (SE=168.9, CI=618-1280, CV=17.7%). This analysis is detailed in Supplemental Material 1.

#### 3.3.8.2. Trend analysis based on distance sampling and coastal surveys

The 2011 estimate of 949 derived from the LANDSAT covariate analysis was used to estimate trend between the two surveys with the rationale that the most comparable estimates would be obtained by models that used the same covariates for sightability and employed similar survey methodologies. We note that another estimate of abundance of 1030 that combined coastal surveys and inland samples was produced for the 2011 data set (Stapleton et al 2014). Coastal surveys were not conducted in unison with distance sampling in 2016 and therefore this type of estimate could not be derived for 2016. Therefore, the most comparable estimates in terms of assessing trends are the distance sampling only estimates from the two years which used similar methodologies and detection function covariates.

A comparison of model averaged abundance estimates from 2011 using the LANDSAT covariate of 949 bears (SE=168.9, CI=618-1280, CV=17.7%) and the 2016 estimate of 842 bears bears (SE=142.6, CV=16.9%, CI-562-1121) using t-tests suggested the difference between the 2 estimates was not significant (t=0.48, df=452,p=0.63). The ratio of the 2 estimates resulted in a 5-year change of 0.89 which translates to an annual change ($\lambda$) of 0.98 (0.89-1.07). The $\lambda$ estimate in this case suggests a very slight annual decline in abundance, however, the confidence intervals overlap 1 and therefore this decrease is not significant.

We also performed a trend analysis that used coastal survey data collected by the government of Manitoba and compared trend estimates from these surveys to trend based on the ratio of the distance sampling estimates. Estimates of trend based on coastal surveys from 2011 to 2016 suggested a non-significant annual increase ($\lambda$=1.06, CI=0.98-1.14) in abundance based on coastal surveys.

One relevant question was whether changes in abundance were apparent in adult male and adult female bears. To explore this we conducted a post-stratified analysis with age-sex groups defined by adult males and adult females (lone and with offspring). Subadults and unknown bears, for which classification is less certain, were excluded from this analysis. The 2011 and 2016 distance sampling estimates were post-stratified to produce estimates for each age-sex group. In addition, trend analyses were conducted for coastal surveys based on these 2 groups.

Results from both the distance sampling and coastal survey analyses suggest a stable to declining adult female segment of the population and an increasing adult male segment. While trends are apparent in both data sets, neither are statistically significant. These results suggest that any apparent increase in abundance may be more based upon increase in adult males compared to adult females. The details of this analysis are described in Supplementary Material 2.

## 4. DISCUSSION

### *4.1. Distribution*

As with the previous 2011 aerial survey (Stapleton et al. 2014), the 2016 data provide a comprehensive and detailed overview of summer polar bear distribution across the entire study area. The recent data suggest that, at least during the summer, the majority of WH polar bears reside in Manitoba; only about 5.3% of the sightings occurred in Nunavut. These findings are consistent with previous studies (Stapleton et al. 2014, Peacock and Taylor 2007) but are in contrast to local knowledge where communities along the Nunavut coastline report increasing numbers of polar bears (Tyrell 2006, 2009; Kotierk 2012). Kotierk (2012) suggested that Inuit see more bears in coastal areas than they ever have and that this creates a number of public safety concerns. However, that report is not specific about the time of year. It is generally understood that more bears frequent the Nunavut coastline during fall before freeze-up when compared to summer, but more empirical or traditional data should be collected to verify the timing.

With the exception of the high density strata, bears generally occupied a narrow strip along the coastline (Figure 11), rarely farther inland than 20 km. Most adult males were observed < 10 km from the coastline. Polar bears are sexually dimorphic with males being about twice as large as females (Derocher et al. 2005, 2010). Being near the coastline likely offers opportunities to reduce thermal stress, and may also be beneficial in reducing attacks by biting insects due to the cooler temperature and ability to enter the water. In the high density stratum (or area C in Lunn et al. 2016) bears were distributed throughout the general area with distances ranging up to > 80 km from the coastline for solitary adult females. Sexual segregation became most apparent in this stratum, which has been reported in previous studies (Derocher and Stirling 1990; Jonkel et al. 1972; Stirling et al. 1977).

### *4.2. Abundance*

As in 2011, the 2016 WH polar bear study represents a systematic and geographically comprehensive survey of the WH polar bear population (Stapleton et al. 2014). Thus, we provide an updated abundance estimate for the WH polar bear population as well as a comparison between the two aerial study results. Additionally the current study's methods parallel those of Obbard et al. (2015) who also used a distance mark-recapture sampling method to estimate polar bears in southern Hudson Bay.

Stapleton et al. (2014) produced two population estimates. An estimate of 1030 bears was derived that combined coastal surveys and inland transect observations for the 2011 data set (Stapleton et al 2014). In 2016, because two helicopters were utilized to conduct a systematic transect survey to cover the entire study area, a separate coastal strip survey was not required. Therefore, we used estimates that were the most comparable between 2011 and 2016 to assess trend. In general it is challenging to detect declines in abundance between two surveys unless the change is quite large (Gerrodette 1987, Thompson et al. 1998). In addition, comparison of two survey estimates does not allow separation of sampling variance from natural "process" variance in the population (Buckland et al 2004). For this reason we also considered annual coastal survey trend estimates (conducted by Manitoba) as well as an estimation of age-sex group specific trends to allow further inference on overall population trend and demography. Coastal surveys assume that similar proportions of the population occur on the coast during the survey each year. This assumption needs to be vigorously investigated prior to validation of this key assumption. For example, documented long range movements of male bears suggest that their aggregation points and localized movement rates may not be consistent and less predictable. A comparison of counts of adult males in coastal surveys suggest a larger degree of annual variation compared to females with offspring (as detailed in Supplementary Material). Despite these differences, the coastal surveys and distance sampling surveys suggest similar trends with the adult male segment increasing and adult females (with offspring) stable to decreasing from 2011– 2016.

Very few bears were observed in Nunavut, and a substantial proportion of bears, mostly adult males, were encountered in the south-east section of the study area towards the Manitoba-Ontario border. Cubs and yearlings comprised a small proportion of the sample size, which was also observed during previous studies. This suggests that reproductive performance is low for this subpopulation but this was not a specific objective of this study (Table 10). These findings are consistent with previous mark-recapture studies (Regehr et al. 2007). Of three polar bear subpopulations that inhabit the Hudson Bay complex, WH had the lowest reproductive performance values (Table 10). Whether this phenomenon is linked to a reduction in sea ice (e.g., Stirling et al. 1999), high intra-species offspring predation due to a high proportion of adult males in the population (Table 4), or a combination would require further examination. Until recently, the neighboring southern Hudson Bay (SH) polar bear subpopulation has exhibited a relatively healthy reproductive performance despite observed long-term changes in sea-ice conditions in the area (Gagnon and Gough 2005, Etkin 1991, Hochheim and Barber 2014, Stern and Laidre 2016, Obbard et al. 2016).

Southern Hudson Bay polar bears have been experiencing a significant decline in body condition between 1984 and 2009 that was linked to a later sea ice freeze-up (Obbard et al. 2016). The decline in body condition for cubs, however, was less than for adult males, suggesting that adult females may be allocating a greater amount of energy to their dependent offspring at an energetic cost to themselves. Obbard et al.

(2016) argue that declines in reproductive success are likely in the future if body condition of reproductive-age females continues to decrease.

Aerial surveys (e.g., distance sampling methods) rely on techniques that minimize heterogeneity of sighting conditions with one of the assumptions that similar sighting probabilities exist by a given observer for all encountered animals or animal groups. Sightability may also be affected by internal factors (e.g., observer fatigue, observer skill, and/or aircraft type), external factors such as animal behavior, group size, and distance from observer, and environmental factors (e.g., cloud cover, topography, vegetation cover, sun angle, etc.) (Ransom 2012, Fleming and Tracey 2008, Lubow and Ransom 2016). The 2016 WH survey protocol and analyses included several topographical and vegetation indices, and land classification studies (including post-survey inclusion of LANDSAT imagery), sun angle and position, and observer position and function as covariates which were most supported through our modeling approach (Tables 1, 3, 5-7).

It has been assumed that there was little difference between a dedicated and non-dedicated observer's ability to observe and detect wildlife during an aerial survey, meaning that sightability is equal. We were able to demonstrate for this survey that the ability of the pilot and data recorder for all aircraft to detect animals appeared to be influenced by their primary responsibilities (e.g. flying the aircraft and observing weather conditions and aircraft equipment, and recording observation data and monitoring transects and survey equipment, respectively). Even when animals are conspicuous against their background and environment (e.g., polar bears during the summer against a white/green environment), we recommend individually assessing the detection ability of animals by all dedicated and non-dedicated observers, so that the option to include observer performance as a co-variate into final models remains open and some assurances that model assumptions are not being violated.

We included sun angle and position into our modeling approach because observers found that this factor reduced sightability. When facing the sun during aerial surveys, additional glare is created on lighter-coloured background (e.g., lichen, water body surfaces) that makes the detection of animals more difficult, which can subsequently lead to missed observations, even within a double observer pair platform.

### *4.3. Assumptions and potential biases*

One assumption during aerial surveys is that animals are detected at their initial location (Buckland et al. 2001). During the 2016 WH survey, behavioral response to survey aircraft varied depending on age and sex class and distance from aircraft. Adult males appeared to be the least affected by aircraft, while other age and sex classes appeared to react more strongly to aircraft when groups were approached that were close to transect lines or being overflown by survey aircraft to record detailed group and animal observational data. The majority (approximately 88%) of bears when first observed from survey transects were either laying down, sitting, standing, or swimming. Given an aircraft speed of 130 to 148 km per hour, any movement that may have occurred prior to detecting the bears further away from transects was minimal (Buckland et al. 1993, 2001). Bears did, however, display greater avoidance behaviors when aircraft broke off transect and flew to the observed group for age and sex determination. In many cases and depending on proximal habitat, bears fled into water in order to avoid the aircraft while some moved into thick shrub to hide from the oncoming aircraft. Large mature males appeared to be the least disrupted upon initial approach of the aircraft, with some exceptions.

The analysis also assumed that the distance from the survey line was measured accurately and that detections were independent of each other. Each observation was marked at the exact point at which the group was observed from transect even in the instance where bears had moved off that location assuring accurate off transect measurements. We used groups to define observations and ensured that observers did not search for additional bears while flying to observed groups to waypoint and classify the animals, therefore ensuring independence of observations. Additionally, observers on the same side were at all times visually separated by a screen therefore ensuring that detections were independent between observers.

It is possible that some bears were missed during the survey because they were unavailable for observations when in a den or visually obscured by vegetation. Dens are used quite frequently during the ice-free period by WH polar bears, at times as early as mid-to-late August, where pregnant adult females are more likely to be missed if inside a den (Stirling et al. 1977, Clark et al. 1997, Clark and Stirling 1998, Richardson et al. 2005, Jonkel et al. 1972). We encountered several freshly constructed dens excavated into peat. In several instances the bear was standing near the den entrance and could be observed. Moreover, our methods allowed for aerial inspection of any den to check for bear presence. Most freshly excavated dens that were observed during the 2016 survey effort also observed a polar bear and/or polar bear group in the vicinity. Therefore, the number of bears hidden from sight inside dens was low.

Habitats within the 2016 survey study area are diverse ranging from both coastal and fresh water shoreline, open tundra, to densely vegetated areas of shrubs and trees farther inland, where the detection of bears becomes challenging (Appendix 3). Including vegetation as a covariate into our modeling approach was important to capture the variation of detection among these varying habitats (Figure 9). Detection distances were reduced in treed habitat when compared to the other habitat types.

The point independence mark-recapture distance sampling model that we used in our analysis assumes that sightability at the left truncation distance (closest distance to the plane) is in part accounted for by covariates. However, variation in sightability due to vegetation and other factors away from the survey line can occur with minimal effect on estimates (Laake et al. 2008, Burt et al. 2014). Similar to Obbard et al. (2015) we found that sightability at the left truncation distance was not exact (or 1). Through the use of covariates in our analysis, factors influencing sightability both on the survey line as well as the shape of the detection functions were utilized to account for these potential biases to produce more robust abundance and density estimates.

## 5. CONCLUSION

The WH polar bear population has been subjected to changes in sea ice conditions reported in other studies resulting in reductions of body condition and vital rates (Gagnon and Gough 2005, Scott and Marshall 2010, Regehr et al. 2007, Stirling et al. 1999, Lunn et al. 2016). Under such conditions, and in order to provide goal-oriented conservation and management recommendations, up-dated information is needed in regular monitoring intervals. Traditional capture-mark-recapture studies are logistically challenging, locally unpopular, and they are time-consuming until results are disseminated. Comprehensive aerial surveys have become a useful monitoring tool for this subpopulation especially in response to the apprehension by Inuit toward intrusive physical handling of wildlife. As with any research methods, aerial surveys have their own limitations in terms of the scientific information that they can provide. Nevertheless, they have been proven to be an additional tool that can provide quick and updated information on the abundance, trend, distribution, and insights into reproductive success of a population.

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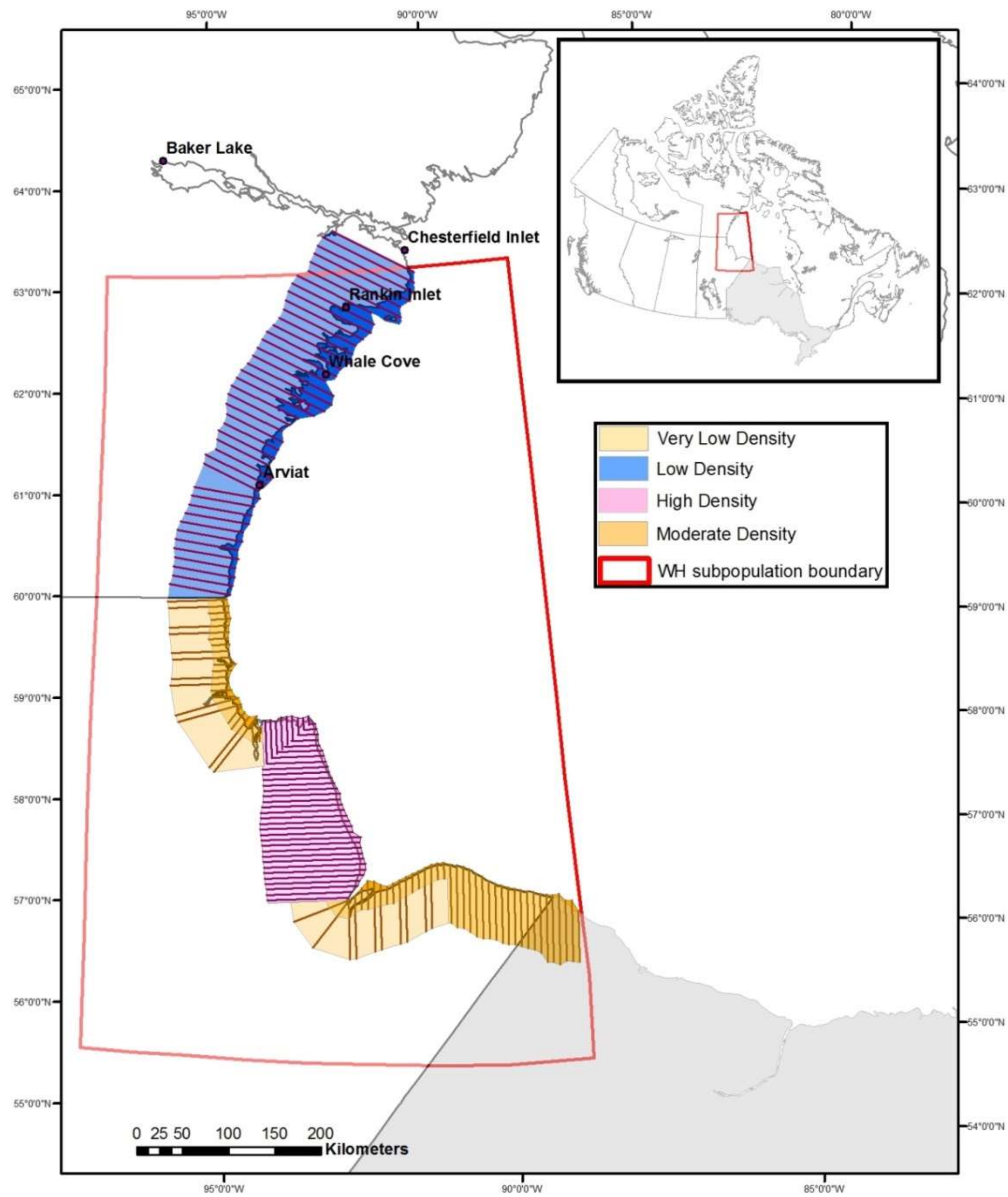



**Figure 1. The August 2016 western Hudson Bay (WH) polar bear abundance survey strata and transects. All transects were run perpendicular to known polar bear densities. Extension of transects outside of the delineated WH polar bear population boundaries were based on Inuit knowledge of the area.**

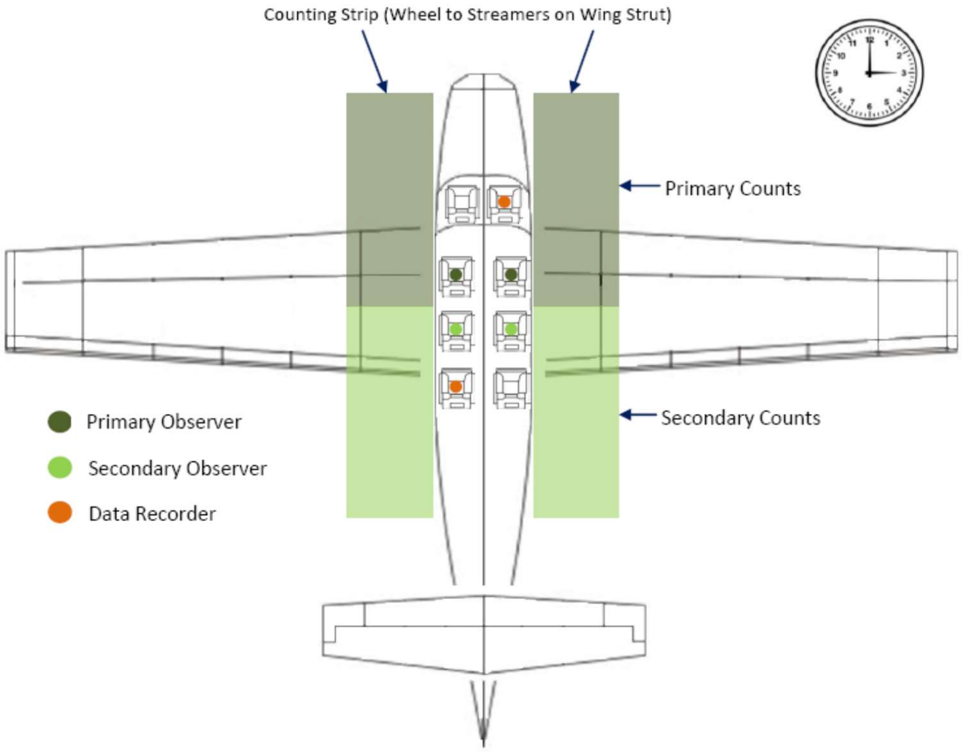



**Figure 2.** **Observer position for the double observer method employed on this survey. The secondary observer calls polar bears not seen by the primary observer after the polar bear/bears have passed the main field of vision of the primary observer at a point half way between same side primary and secondary observers. The small hand on a clock is used to reference relative locations of polar bear groups (e.g. "Polar bear group at 3 o'clock" would suggest a polar bear group 90o to the right of the aircrafts longitudinal axis.).**

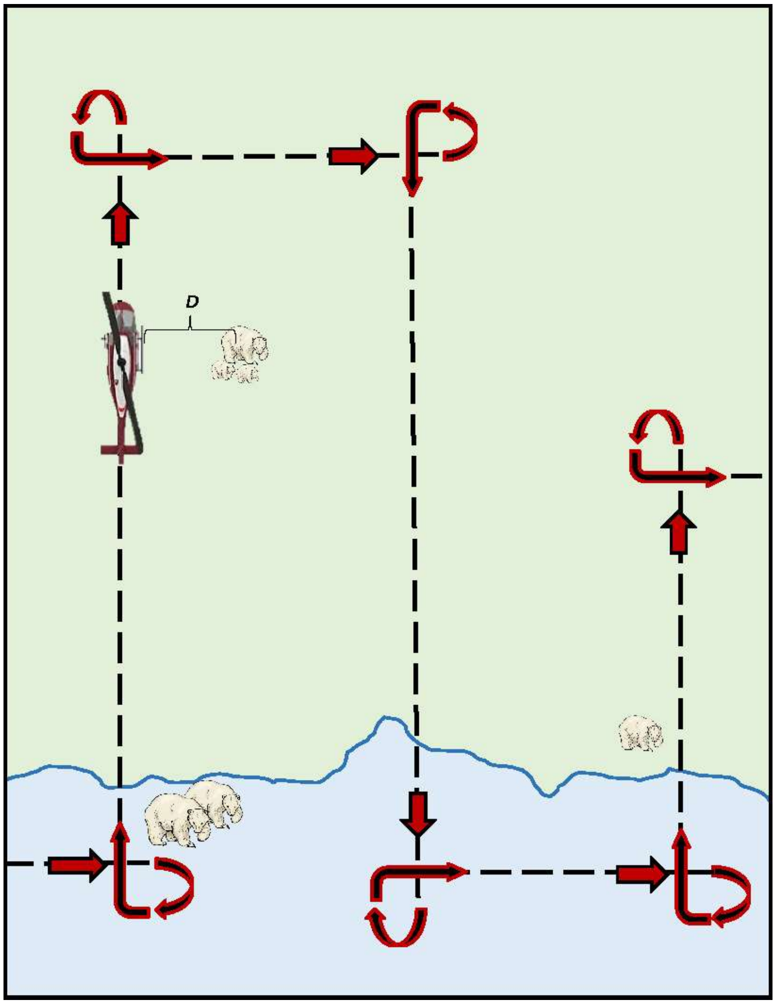
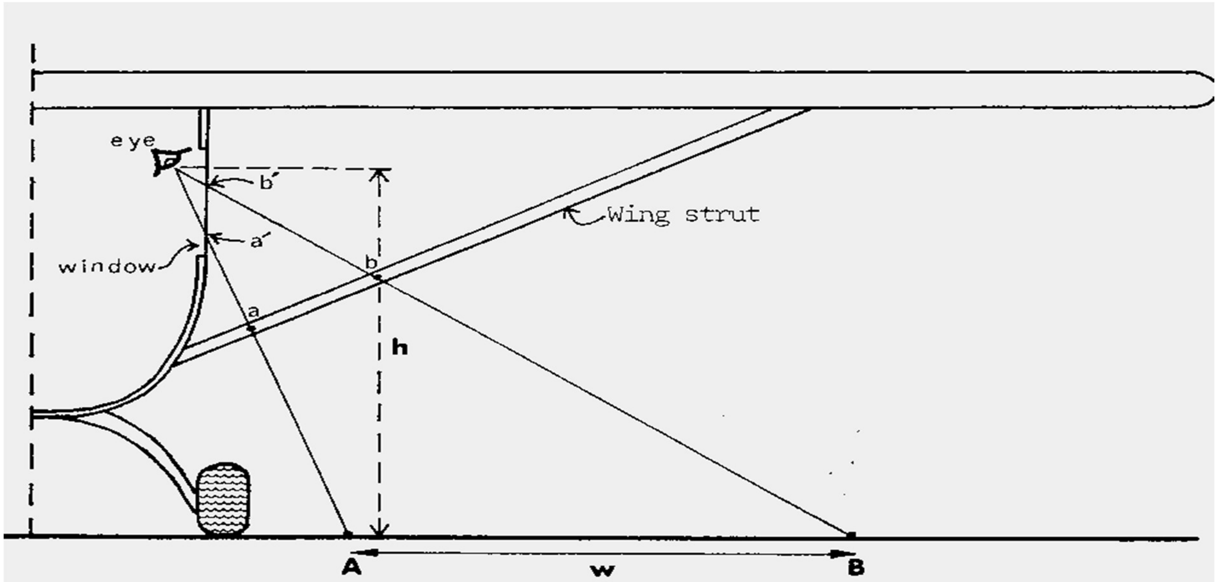



**Figure 3. Application of the distance sampling method during the August 2016 polar bear aerial survey in western Hudson Bay. Once observed the aircraft would move off the transect to the center of the observation to record location via a GPS, and assess and record field age, sex, and body condition for all individuals within the group as well as environmental covariate information (Note: D = the distance as measured 900 from the transect to the center of the observation/group).**




*w = W * h/H*

*<u>Where</u>:*

***W** = the required strip width**;***

***h** = the height of the observer's eye from the tarmac; and*

***H** = the required flying height*

**Figure 4. Schematic diagram of aircraft configuration for strip width sampling (Norton-Griffiths, 1978). W is marked out on the tarmac, and the two lines of sight a' – a – A and b' – b – B established. The streamers are attached to the struts at a and b, whereas a' and b' are the window marks.**

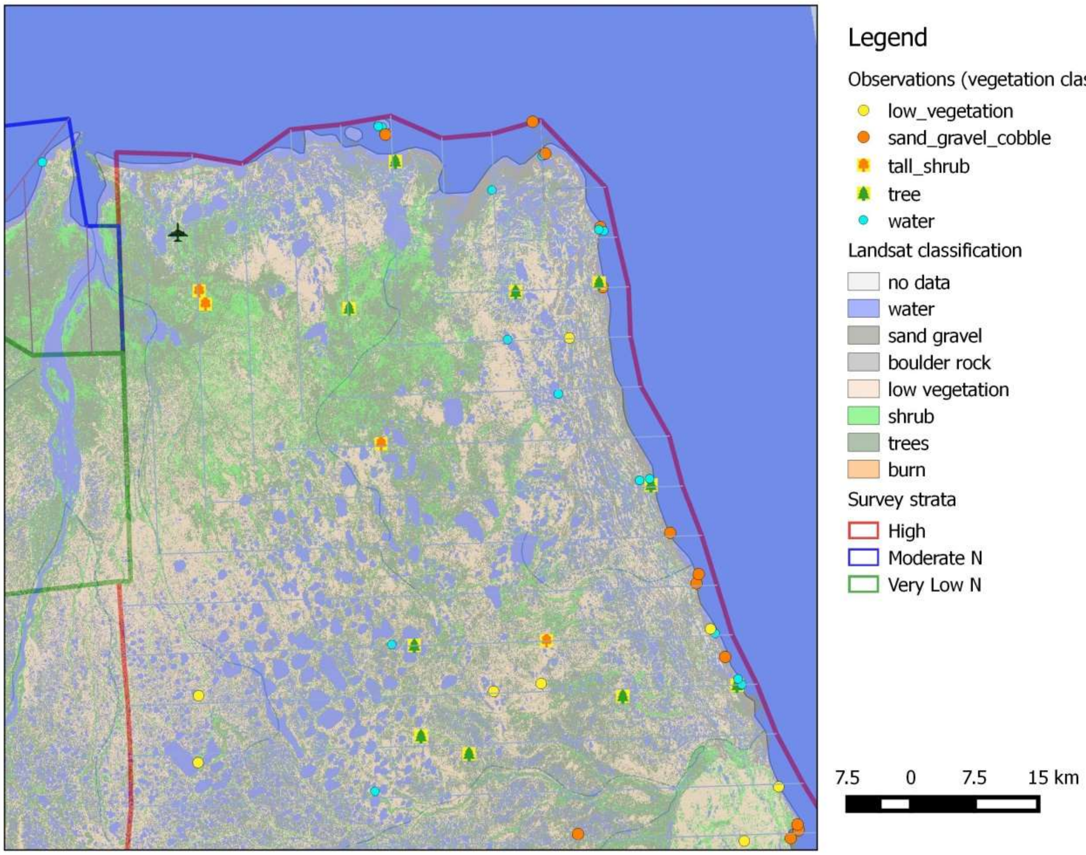



**Figure 5: Landsat habitat classification and observations for a section of the high-density stratum of the 2016 study area.**

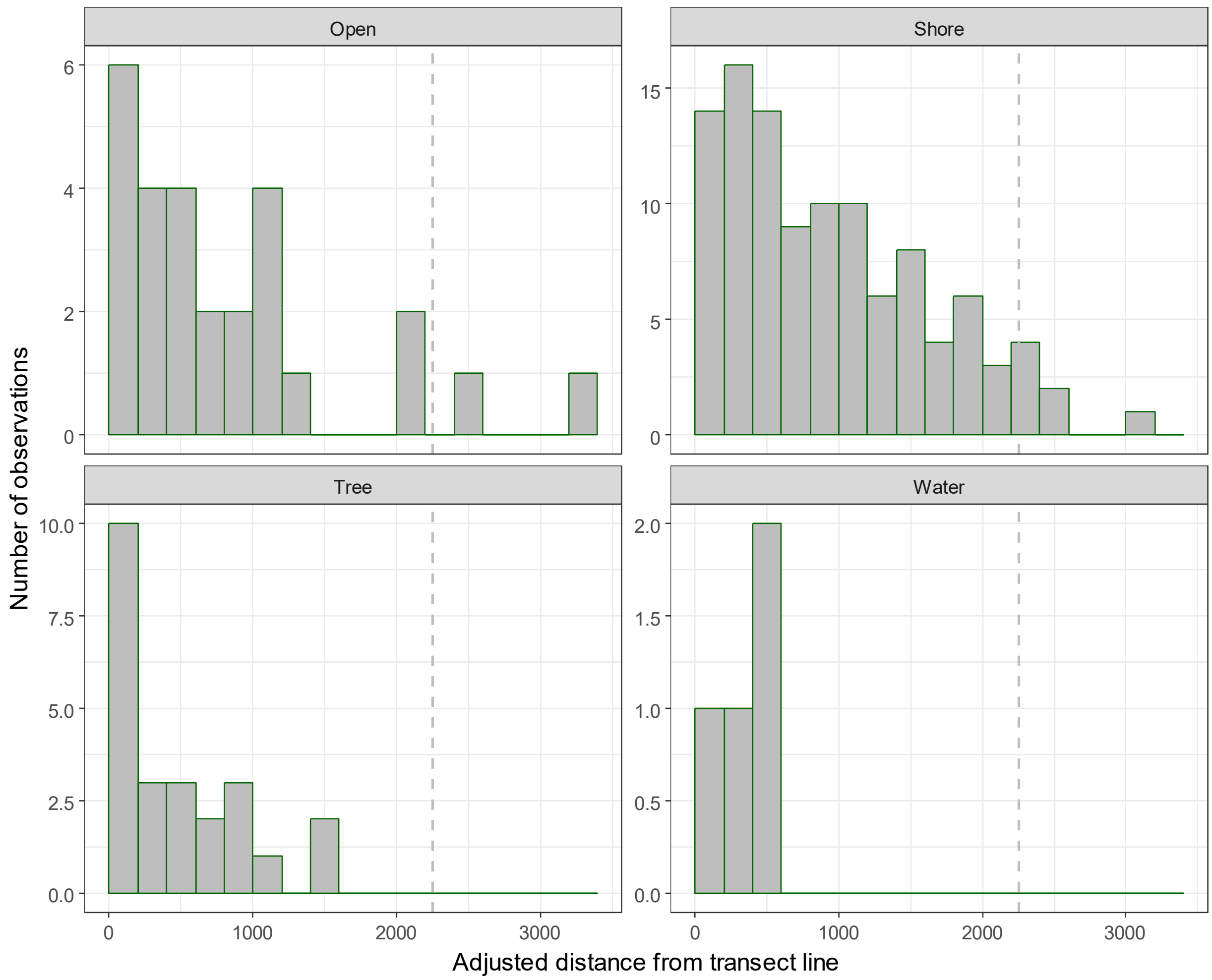



**Figure 6. Distributions of detections for habitat classes.**

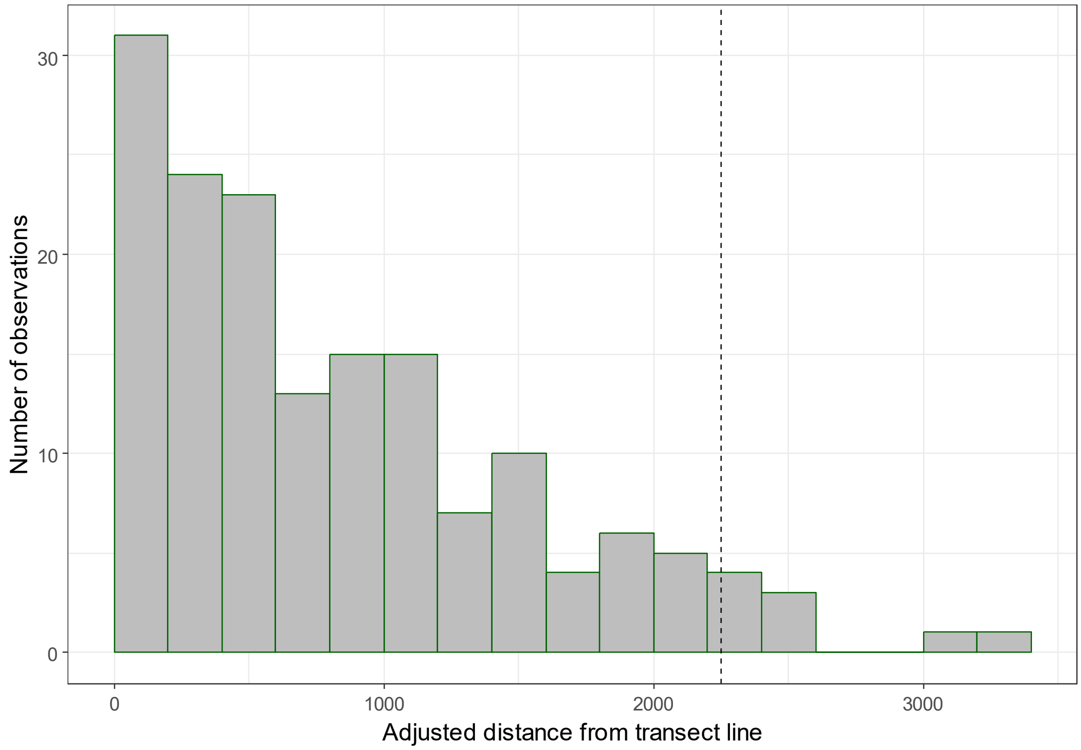



**Figure 7. The distribution of observations relative to adjusted distance from the survey line (Distance from transect line-blind spot distance for each aircraft). The right truncation distance of 2250 meters used in the analysis is shown as a vertical line.**

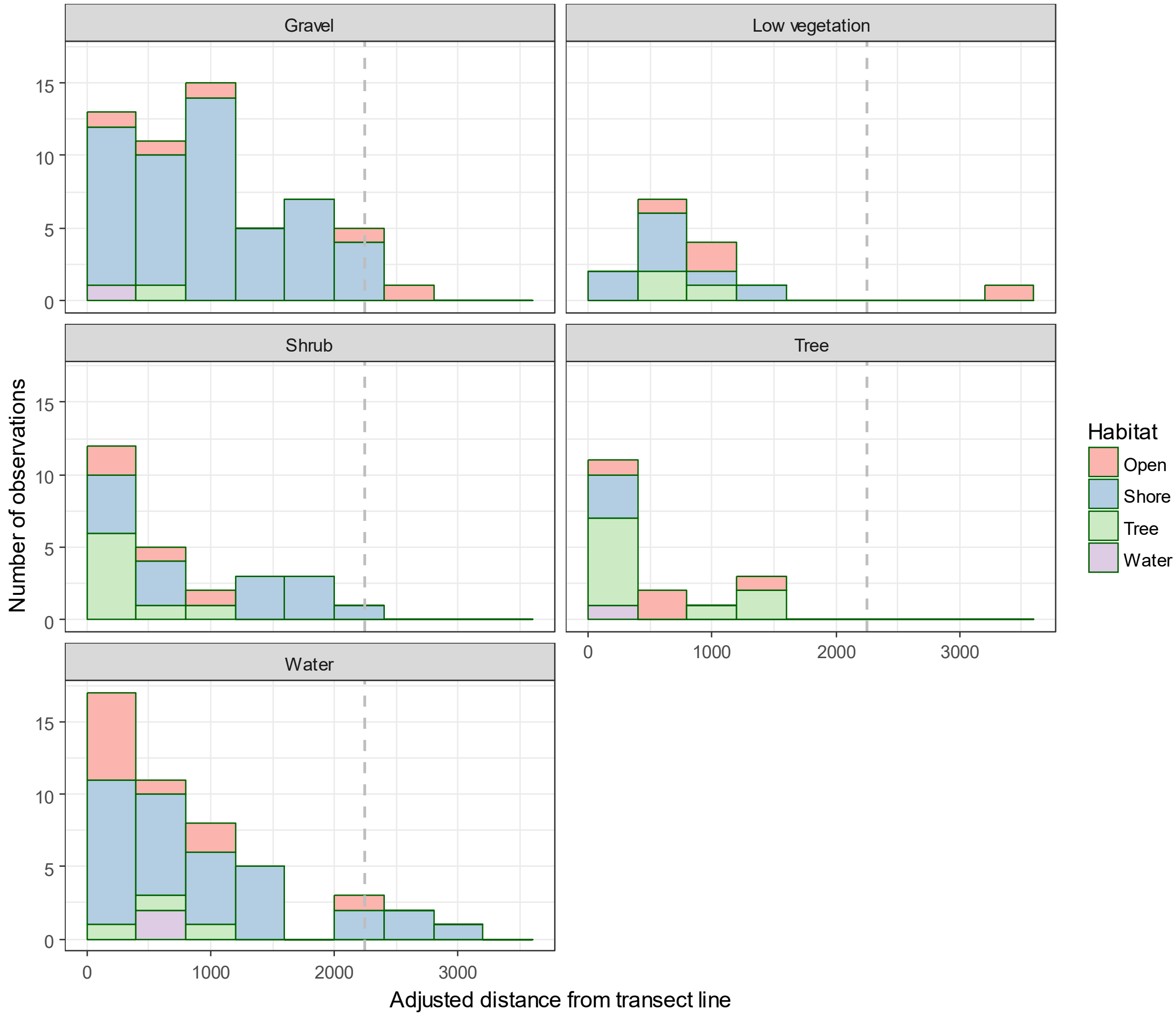



**Figure 8. Distributions of detections for Landsat remote sensing-based covariates with observer-based habitat classes shown as sub-bars to allow comparison of the 2 methods of habitat classification.**

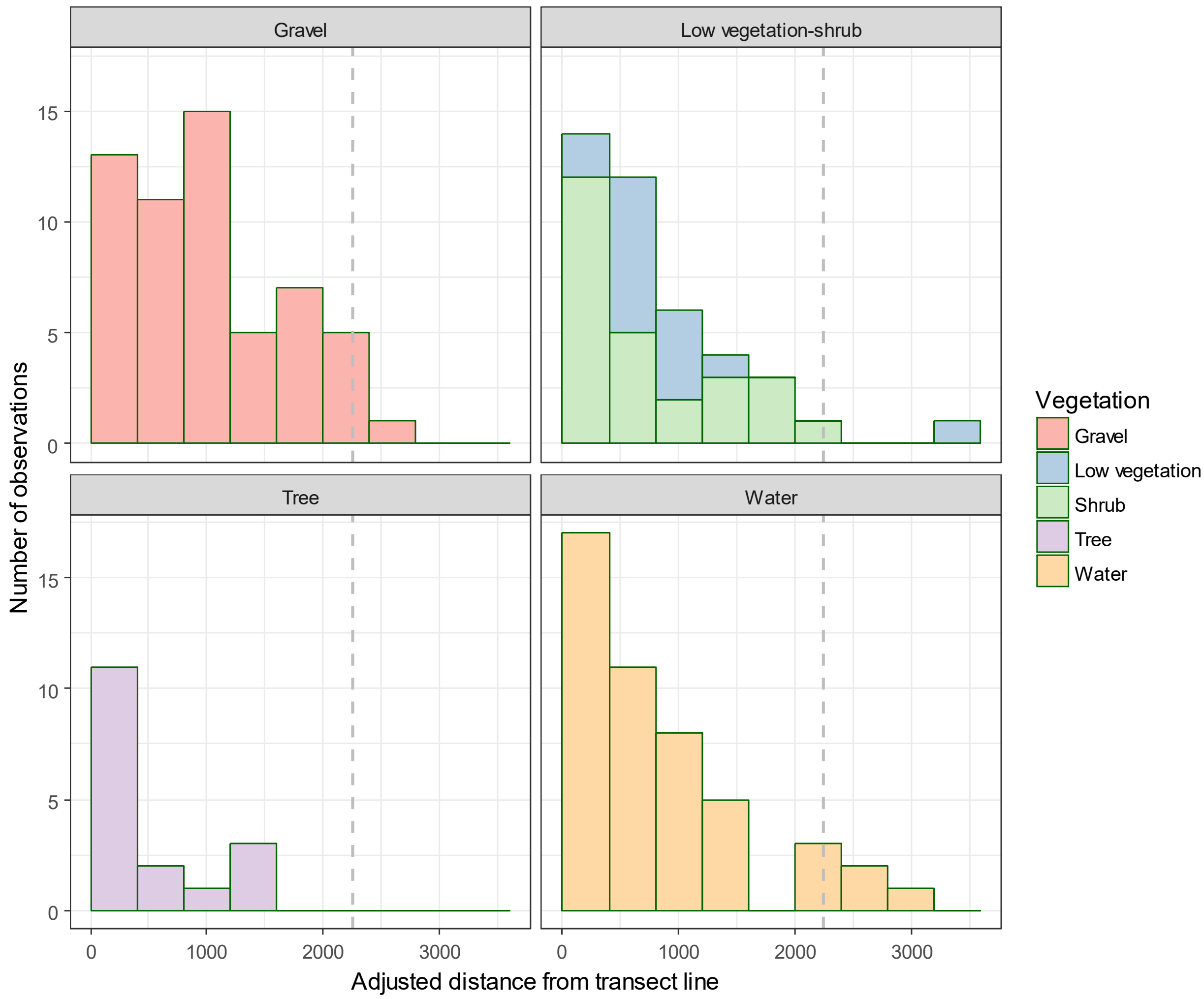



**Figure 9.** **Remote sensing vegetation classes with the shrub and low vegetation category pooled. This covariate was termed RSveg2.**

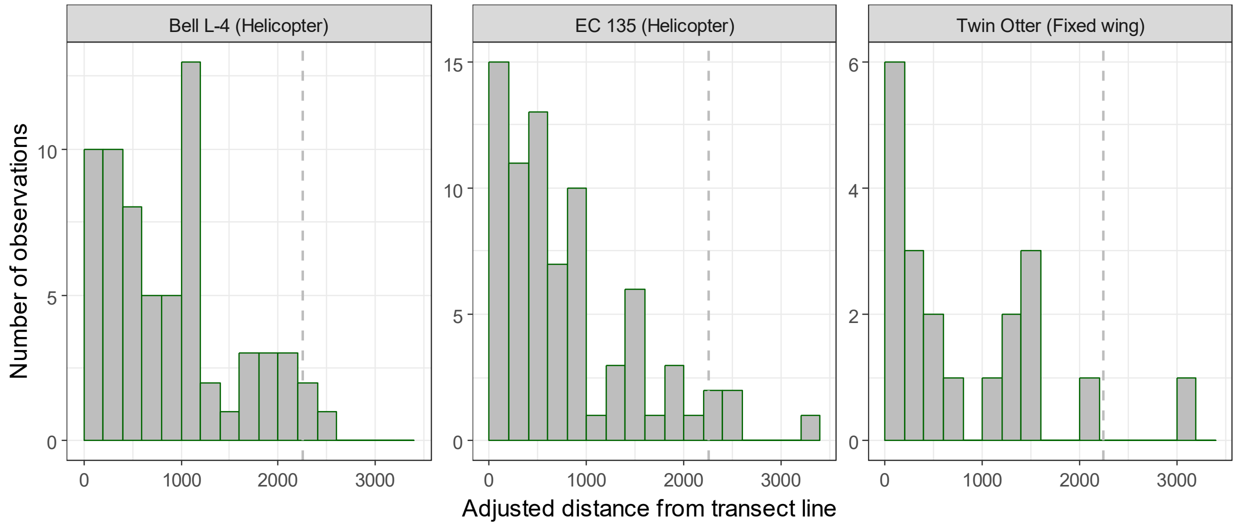



**Figure 10. Distributions of detection for aircraft type.**

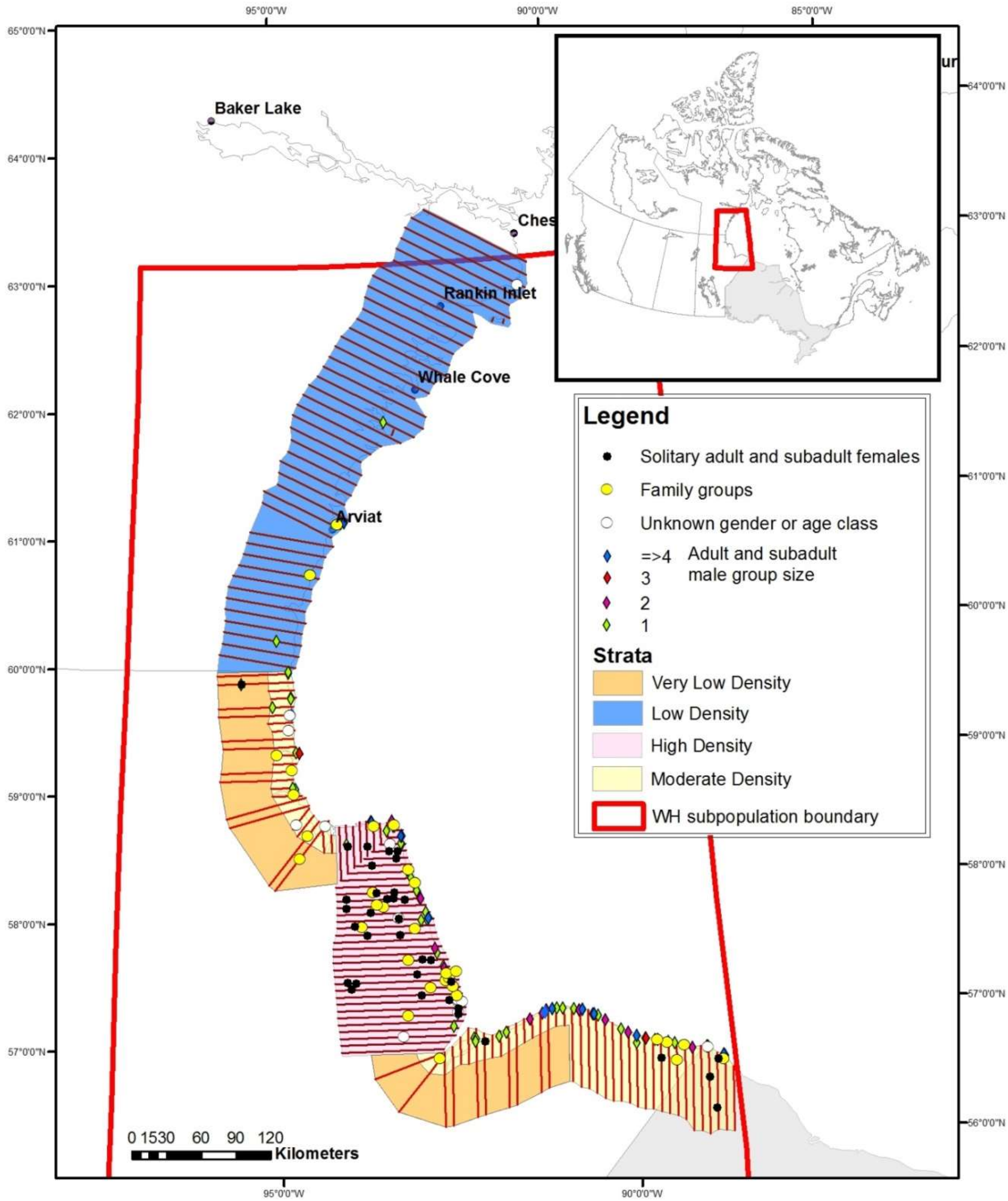



**Figure 11. Distribution of polar bear group observations by age/sex class and strata within the study area during the 2016 western Hudson Bay aerial survey. Note that classifications of bears are based on aerial inspection.**

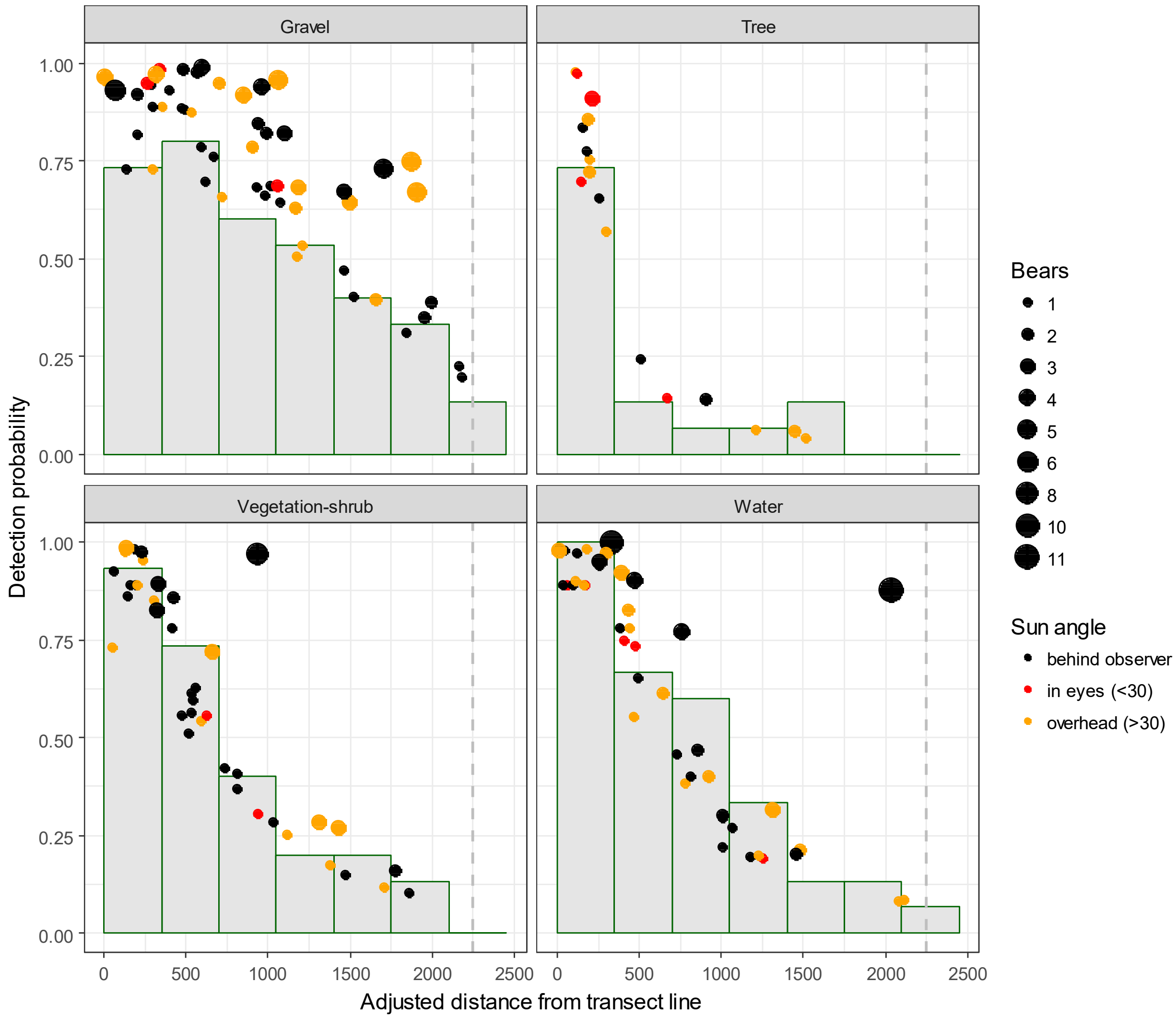



**Figure12. Comparison of the observed detection distributions with predicted detection probabilities as a function of remote sensing vegetation classes (RSveg2) , group size (Bears), and angle of the sun from model 1 (Table 6).**

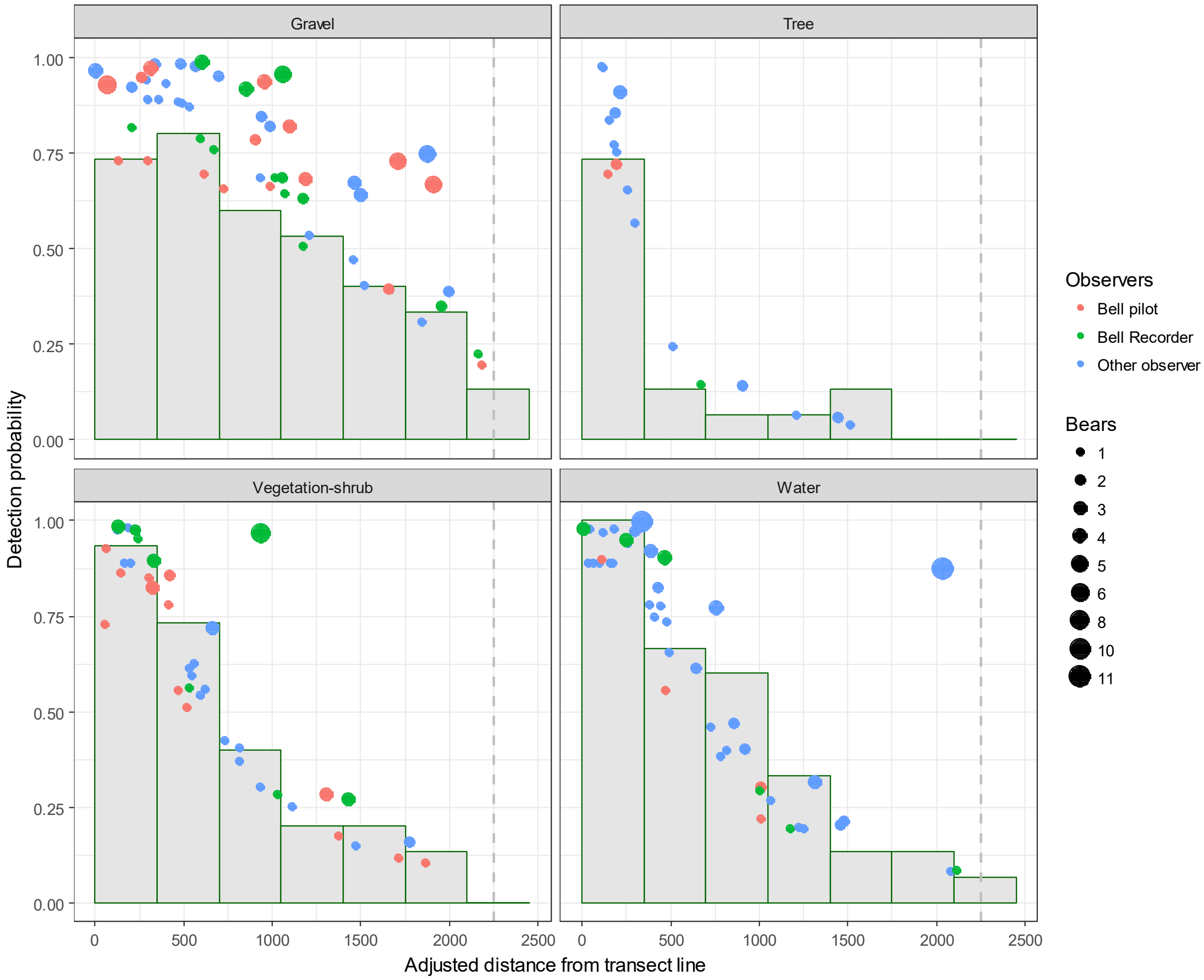



**Figure 13.** **Comparison of the observed detection distributions with predicted detection probabilities as a function of RSveg2 class, group size (Bears), and observer type from model 1 (Table 6).**

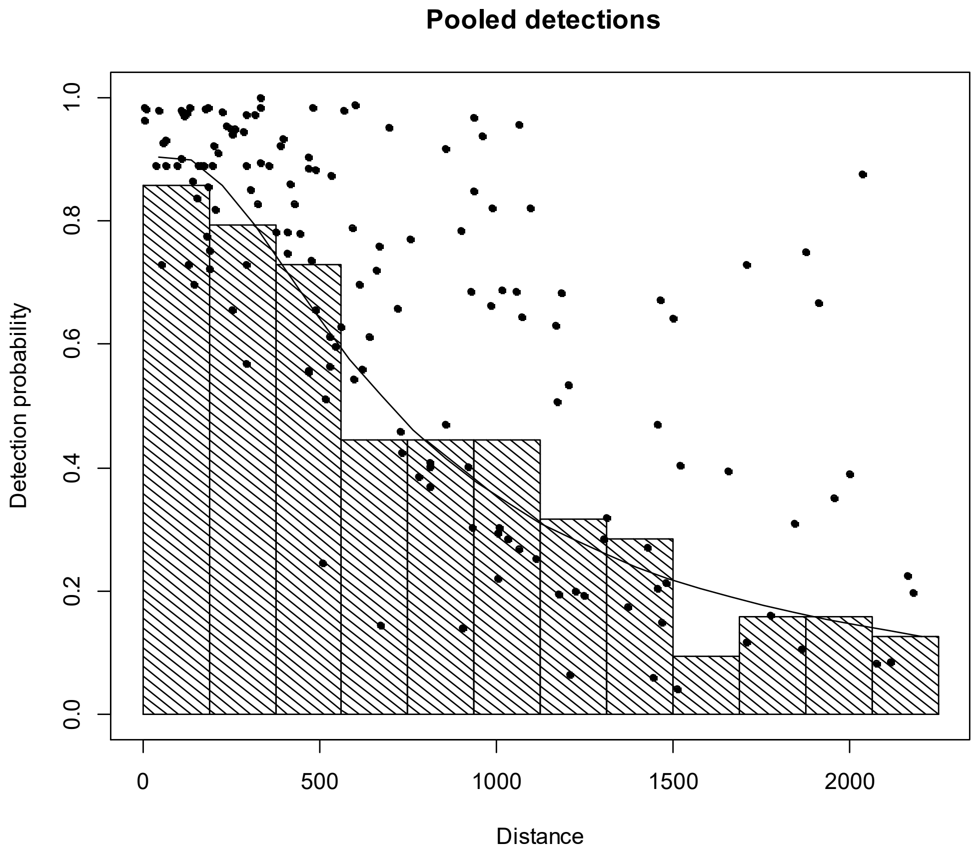



**Figure 14. Predicted double observed detection probabilities (points) and mean detection (line) superimposed on detection frequencies for model 1 (Table 6).**

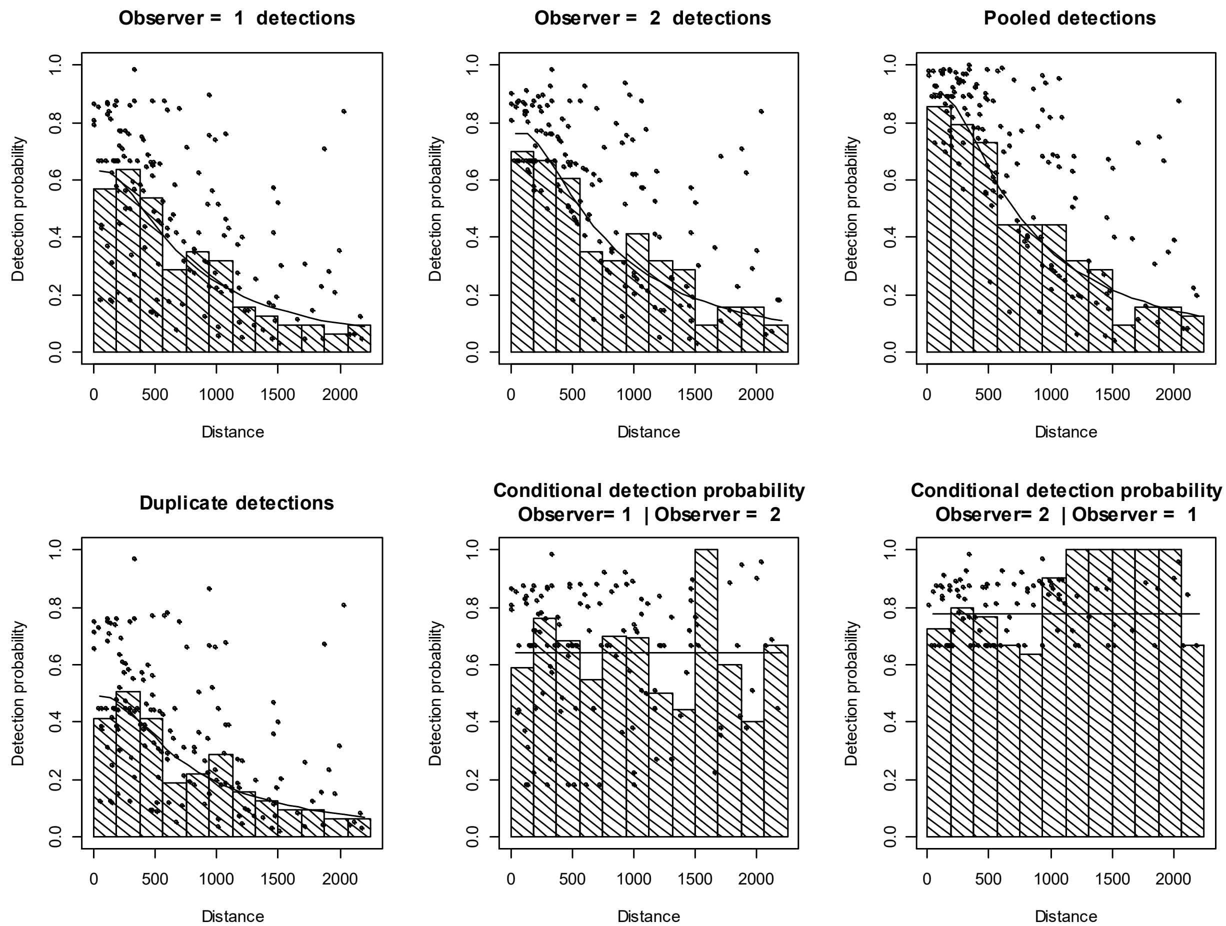



**Figure 15. Detection plots for the front observer (1) and rear observer (2), pooled observers and duplicate observations (where both observers saw a bear. Conditional probabilities are also given for detection of bear by observer 1 given detection by observer 2 and vice versa. All estimates are from model 1 in Table 6.**

**Table 1. Covariates considered in the mark-recapture/distance sampling analysis. The primary use of the covariate for distance sampling analysis (DS) and mark-recapture analysis (MR) is denoted.**

| Covariate | Type | DS | MR | description |
|---|---|---|---|---|
| **size** | continuous | x | x | group size |
| **aircraft** | categorical | x | x | aircraft (Twin Otter, Bell, or EC135) |
| **heli** | binary | x | x | helicopter or airplane |
| **Bell** | binary | x | x | Bell helicopter |
| **Bellp** | binary | x | x | Pilot of Bell helicopter |
| **Bellr** | binary | x | x | Recorder/Navigator of Bell helicopter. |
| **hab** | categorical | x | x | habitat within 30m of observation as classified by observers (Open, Water, Shore, and Tree) |
| **RSveg** | categorical | x | x | Landsat habitat (Gravel,Low vegetation, Shrub, Tree, and water) at pixel (625 $m^2$) scale |
| **RSveg2** | categorical | x | x | RSveg habitat category with the Low vegetation and shrub category pooled. |
| **RSveg90** | categorical | x | x | RSveg at 90X90m scale |
| **RSveg150** | categorical | x | x | RSveg at 150X150m scale |
| **RSveg-hab** | categorical | x | x | RSveg water class re-assigned based on habitat classes. |
| **vis** | binary | x | x | ideal (163) or marginal (15 observations) |
| **obs** | categorical | | x | Observers (12) |
| **Sun** | continuous | x | x | Sun altitude; only in equation if sun was facing observer |
| **pilot** | binary | x | x | if observer was a pilot |
| **rec** | binary | x | x | if observer was a data recorder |

**Table 2. Summary of observations by strata. Mean group sizes and numbers of bears by distance category are shown. LT (Blind spot) observations occurred under the planes and were usually only seen by the pilot and front seat navigator. Bears in the survey strip were observed by at least one of the 2 observers, or only seen by data recorders or non-observer personnel.**

| Strata | | Group size | | | | Numbers of bears by distance category | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | mean | std | min | max | LT (Blind spot) | Observed | Not observed | RT >2250m | Total |
| **High** | 98 | 1.72 | 1.17 | 1 | 7 | 5 | 150 | 7 | 7 | 169 |
| **Low** | 8 | 2.25 | 2.12 | 1 | 7 | 1 | 6 | 4 | 7 | 18 |
| **Moderate** | 69 | 2.14 | 1.98 | 1 | 11 | 8 | 123 | 6 | 11 | 148 |
| **Very Low** | 3 | 1.33 | 0.58 | 1 | 2 | 3 | 1 | 0 | 0 | 4 |
| **Totals** | 178 | | | | | 17 | 280 | 17 | 25 | 339 |

**Table 3. Summary of observer data during the Hudson Bay polar bear survey. The naïve probability is the number of detections divided by the total trials. The Bell pilot had the lowest probability.**

| Individual | Role | Bear observations | | | Naïve probability |
|---|---|---|---|---|---|
| | | Not detected | detected | Total trials | |
| **1** | observer | 2 | 22 | 24 | 0.92 |
| **2** | observer | 3 | 28 | 31 | 0.90 |
| **3** | Bell recorder | 11 | 20 | 31 | 0.65 |
| **4** | observer | 6 | 16 | 22 | 0.73 |
| **5** | observer | 4 | 10 | 14 | 0.71 |
| **6** | observer | 1 | 6 | 7 | 0.86 |
| **7** | observer | 5 | 15 | 20 | 0.75 |
| **8** | observer | 12 | 35 | 47 | 0.74 |
| **9** | Recorder | 1 | 14 | 15 | 0.93 |
| **10** | observer | 3 | 37 | 40 | 0.93 |
| **11** | Bell pilot | 22 | 13 | 35 | 0.37 |
| **12** | observer | 4 | 34 | 38 | 0.89 |
| | | 74 | 250 | 324 | 0.77 |

**Table 4. Overview of observed polar bears during the western Hudson Bay aerial survey, August 2016, by field age class and spatial occurrence. Areas A-D are defined as in Lunn et al. (2016).**

| Age Class[§ 1] | Area | | | | | |
|---|---|---|---|---|---|---|
| | NU (A) | MB (B) | MB/WNP (C) | MB EAST (D) | Total (bears or km) | PPN |
| ADF+1COY | 0 | 2 | 7 | 0 | 18 | 0.053 |
| ADF+2COY | 2 | 2 | 7 | 4 | 45 | 0.132 |
| ADF+1YRLG | 0 | 1 | 4 | 1 | 12 | 0.035 |
| ADF+2YRLG | 0 | 0 | 2 | 0 | 6 | 0.018 |
| ADF+1 2-yr old | 0 | 0 | 1 | 0 | 2 | 0.006 |
| ADF | 0 | 1 | 27 | 5 | 33 | 0.097 |
| ADM | 11 | 23 | 63 | 84 | 181 | 0.532 |
| SAM | 0 | 0 | 21 | 4 | 25 | 0.074 |
| SAF | 0 | 0 | 2 | 0 | 2 | |
| U | 1 | 5 | 9 | 1 | 16 | 0.047 |
| Flown distance (km) | 4 900 | 1 870 | 6 200 | 4 300 | 17 270 | |
| Transect flights (km) | 3 511 | 1 053 | 2 881 | 2 237 | 9 682 | |
| TOTAL bears observed | 18 | 41 | 173 | 108 | 340 | |
| PPN | 0.053 | 0.121 | 0.509 | 0.318 | | |

[§] ADF=adult female; COY=cub-of-the-year; ADM=adult male; SAM=subadult male; SAF=subadult female; U=unknown; YRLG=yearling; 2-yr=2-year old.
[1] all classifications are based on aerial assessments from helicopters

**Table 5. Model selection results for distance sampling analysis. The mark-recapture component of the MRDS model was set at constant for this analysis step. Covariates are listed in Table 1. Estimated abundance is given for reference purposes. Constant models are shaded. Akaike information criterion (AIC), the differences between AIC of the given model and most supported model ΔAIC, Akaike weight (wi), and Log-likelihood of each model is also shown.**

| No | DF | Distance | AIC | ΔAIC | $w_i$ | K | LogL | N | Conf. int | | CV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HR | Rsveg2 +size | 2611.6 | 0.00 | 0.22 | 7 | -1298.8 | 836 | 602 | 1160 | 16.7% |
| 2 | HR | Rsveg2 | 2612.3 | 0.78 | 0.15 | 6 | -1300.2 | 908 | 644 | 1279 | 17.5% |
| 3 | HN | hab+vis | 2612.9 | 1.31 | 0.12 | 6 | -1300.4 | 816 | 625 | 1067 | 13.6% |
| 4 | HR | RSveg2+size+vis | 2613.2 | 1.67 | 0.10 | 8 | -1298.6 | 833 | 603 | 1152 | 16.5% |
| 5 | HN | hab+vis+size | 2613.5 | 2.00 | 0.08 | 7 | -1299.8 | 779 | 588 | 1033 | 14.4% |
| 6 | HR | RSveg-hab | 2613.7 | 2.14 | 0.08 | 6 | -1300.8 | 900 | 643 | 1262 | 17.2% |
| 7 | HR | Rsveg2+vis | 2613.7 | 2.19 | 0.07 | 7 | -1299.9 | 898 | 641 | 1258 | 17.2% |
| 8 | HN | hab | 2613.8 | 2.26 | 0.07 | 5 | -1301.9 | 813 | 622 | 1065 | 13.7% |
| 9 | HN | hab+size | 2614.0 | 2.46 | 0.06 | 6 | -1301.0 | 770 | 581 | 1019 | 14.3% |
| 10 | HR | hab+vis | 2617.0 | 5.48 | 0.01 | 7 | -1301.5 | 862 | 633 | 1173 | 15.7% |
| 11 | HR | size | 2617.4 | 5.82 | 0.01 | 4 | -1304.7 | 773 | 578 | 1035 | 14.9% |
| 12 | HN | vis | 2619.2 | 7.68 | 0.00 | 3 | -1306.6 | 800 | 615 | 1040 | 13.4% |
| 13 | HR | Constant | 2619.9 | 8.33 | 0.00 | 3 | -1306.9 | 931 | 658 | 1316 | 17.7% |
| 14 | HR | RSveg90m | 2619.9 | 8.33 | 0.00 | 7 | -1302.9 | 966 | 675 | 1381 | 18.3% |
| 15 | HR | RSveg150m | 2620.0 | 8.42 | 0.00 | 7 | -1303.0 | 955 | 670 | 1362 | 18.2% |
| 16 | HR | bellheli | 2620.5 | 8.91 | 0.00 | 4 | -1306.2 | 904 | 644 | 1269 | 17.3% |
| 17 | HN | Constant | 2620.6 | 9.05 | 0.00 | 2 | -1308.3 | 799 | 614 | 1040 | 13.4% |
| 18 | HR | bellpilot+bellrec | 2621.4 | 9.80 | 0.00 | 5 | -1305.7 | 922 | 652 | 1302 | 17.7% |
| 19 | HR | Sun | 2621.6 | 10.04 | 0.00 | 4 | -1306.8 | 939 | 661 | 1333 | 18.0% |
| 20 | HR | vis | 2621.7 | 10.17 | 0.00 | 4 | -1306.9 | 917 | 652 | 1290 | 17.5% |
| 21 | HR | aircraft | 2622.1 | 10.59 | 0.00 | 5 | -1306.1 | 944 | 661 | 1348 | 18.2% |

**Table 6. Model selection results for mark-recapture analyses. The most supported distance model (HR(RSveg2+size)) was used in all the models in this analysis. Covariates are listed in Table 1. Estimated abundance is given for reference purposes. . Akaike information criterion (AIC), the differences between AIC of the given model and most supported model ΔAIC, Akaike weight (wi), and Log-likelihood of each model is also shown.**

| No | Mark-recapture model | AIC | ΔAIC | $w_i$ | K | LogL | N | Conf. Limit | | N CV |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bellp+Bellr+sun+size | 2575.5 | 0.00 | 0.65 | 11 | -1278.1 | 896 | 638 | 1258 | 17.4% |
| **2** | Bellp+Bellr+sun | 2577.0 | 1.48 | 0.31 | 10 | -1279.9 | 911 | 647 | 1282 | 17.5% |
| **3** | Bellp+Bellr+size | 2582.2 | 6.70 | 0.02 | 10 | -1282.5 | 884 | 630 | 1240 | 17.3% |
| **4** | Bellp+Bellr | 2584.0 | 8.52 | 0.01 | 9 | -1284.4 | 897 | 638 | 1260 | 17.4% |
| **5** | aircraft+Bellp+Bellr | 2585.1 | 9.61 | 0.01 | 11 | -1282.9 | 893 | 634 | 1256 | 17.5% |
| **6** | observers | 2591.9 | 16.47 | 0.00 | 18 | -1279.4 | 891 | 633 | 1255 | 17.5% |
| **7** | sun | 2605.1 | 29.64 | 0.00 | 8 | -1295.9 | 922 | 654 | 1301 | 17.6% |
| **8** | aircraft | 2605.6 | 30.08 | 0.00 | 9 | -1295.2 | 926 | 658 | 1304 | 17.5% |
| **9** | heli | 2607.9 | 32.37 | 0.00 | 8 | -1297.3 | 914 | 648 | 1288 | 17.5% |
| **10** | size | 2611.2 | 35.75 | 0.00 | 8 | -1299.0 | 896 | 637 | 1259 | 17.4% |
| **11** | constant | 2611.6 | 36.08 | 0.00 | 7 | -1300.2 | 908 | 644 | 1279 | 17.5% |
| **12** | vis | 2612.2 | 36.72 | 0.00 | 8 | -1299.5 | 908 | 645 | 1279 | 17.5% |
| **13** | pilot | 2612.2 | 36.73 | 0.00 | 8 | -1299.5 | 908 | 645 | 1279 | 17.5% |
| **14** | hab | 2613.2 | 37.71 | 0.00 | 10 | -1298.0 | 921 | 652 | 1300 | 17.7% |
| **15** | recorder | 2613.5 | 38.06 | 0.00 | 8 | -1300.2 | 908 | 644 | 1279 | 17.5% |
| **16** | distance | 2613.5 | 38.06 | 0.00 | 8 | -1300.2 | 908 | 644 | 1279 | 17.5% |
| **17** | Rsveg | 2617.0 | 41.55 | 0.00 | 11 | -1298.9 | 915 | 648 | 1292 | 17.7% |

**Table 7. Model selection results for the combined distance and mark-recapture analysis. The most supported distance model and mark-recapture models given in Tables 4 and 5 were considered in this analysis. Covariates are listed in Table 1. Estimated abundance is given for reference purposes. Akaike information criterion (AIC), the differences between AIC of the given model and most supported model ΔAIC, Akaike weight (wi), and Log-likelihood of each model is also shown.**

| No | DF | Distance | MR | AIC | ΔAIC | wi | K | LogL | N | Conf. Limit | | N CV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HR | Rsveg2+size | Bellp+Bellr+sun+size | 2575.5 | 0.00 | 0.22 | 11 | -1276.7 | 831 | 599 | 1151 | 16.7% |
| 2 | HR | Rsveg2 | Bellp+Bellr+sun+size | 2576.3 | 0.78 | 0.15 | 10 | -1278.1 | 896 | 638 | 1258 | 17.4% |
| 3 | HN | Hab+vis | Bellp+Bellr+sun+size | 2576.8 | 1.30 | 0.11 | 10 | -1278.4 | 808 | 619 | 1056 | 13.6% |
| 4 | HR | Rsveg2+size | Bellp+Bellr+sun | 2577.0 | 1.48 | 0.10 | 10 | -1278.5 | 840 | 605 | 1165 | 16.7% |
| 5 | HR | Rsveg2+size+vis | Bellp+Bellr+sun+size | 2577.1 | 1.67 | 0.10 | 12 | -1276.6 | 828 | 600 | 1143 | 16.5% |
| 6 | HN | Hab+vis+size | Bellp+Bellr+sun+size | 2577.5 | 2.00 | 0.08 | 11 | -1277.7 | 774 | 585 | 1024 | 14.3% |
| 7 | HR | Rsveg2+vis | Bellp+Bellr+sun+size | 2577.7 | 2.19 | 0.07 | 11 | -1277.8 | 887 | 635 | 1238 | 17.1% |
| 8 | HR | RSveg2 | Bellp+Bellr+sun | 2577.7 | 2.26 | 0.07 | 9 | -1279.9 | 911 | 647 | 1282 | 17.5% |
| 9 | HN | Hab+vis | Bellp+Bellr+sun | 2578.3 | 2.78 | 0.05 | 9 | -1280.1 | 823 | 627 | 1079 | 13.8% |
| 10 | HN | Hab+vis+size | Bellp+Bellr+sun | 2578.9 | 3.47 | 0.04 | 10 | -1279.5 | 785 | 590 | 1045 | 14.6% |

**Table 8. Strata-specific and total estimates of abundance for model 1 (Table 6).**

| Strata | Individuals | N | SE | CV | Conf. Limit | |
|---|---|---|---|---|---|---|
| **High** | 150 | 471 | 103.0 | 21.9% | 307 | 723 |
| **Low** | 6 | 27 | 13.8 | 50.8% | 10 | 71 |
| **Moderate** | 123 | 323 | 63.4 | 19.6% | 220 | 475 |
| **Very Low** | 1 | 9 | 9.7 | 102.2% | 2 | 54 |
| **Total** | 280 | 831 | 138.5 | 16.7% | 599 | 1151 |

**Table 9. Sensitivity of MRDS models to left and right truncation. The most supported MRDS model from Table 6 was used for estimates.**

| Right Truncation | N | CV | Conf. Limit | |
|---|---|---|---|---|
| **2250** | 831 | 16.7% | 599 | 1,151 |
| **2700** | 825 | 16.4% | 599 | 1,136 |
| **1800** | 826 | 17.9% | 581 | 1,173 |

**Table 10. Mean (standard error) polar bear cub-of-the-year (COY) and yearling (YRLG) litter sizes of populations that inhabit the Hudson Bay complex, also presented as proportion of total observations during the respective studies.**

| Subpopulation | Litter size | | Proportion of total observations | | Source |
|---|---|---|---|---|---|
| | COY | YRLG | COY | YRLG | |
| Western Hudson Bay (2016) | 1.63 (0.10) | 1.25 (0.16) | 0.11 | 0.03 | GN (unpublished data) |
| Western Hudson Bay (2011) | 1.43 (0.08) | 1.22 (0.10) | 0.07 | 0.03 | Stapleton et al. (2014) |
| Southern Hudson Bay (2011) | 1.56 (0.06) | 1.49 (0.08) | 0.16 | 0.12 | Obbard et al. 2015 |
| Foxe Basin (2009-2010) | 1.54 (0.04) | 1.48 (0.05) | 0.13 | 0.10 | Stapleton et al. (2015) |

## Appendix 1

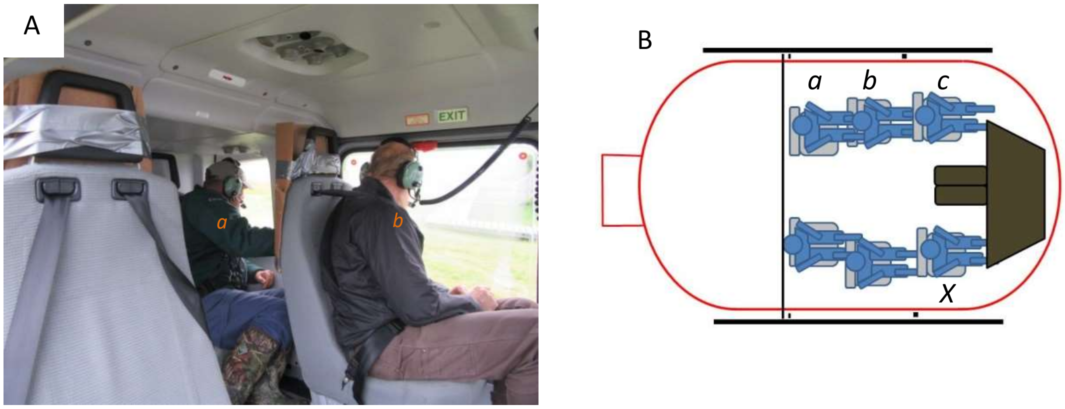



Figure A1: Overview of the EC135 rotary wing seat/observer configuration with separation wall set-up. Left photograph (A) depicts position *a* and *b* in the schematic diagram (right panel, B; *c* not shown in photograph A, *X* denotes pilot).

## Appendix 2


Figure A2. Depicted are the front observers (local members of the Rankin Inlet and Arviat Hunters and Trappers Association) in a Twin Otter fixed-wing survey platform, separated by a cardboard barrier from the rear observers. Not shown are the recorders.

## Appendix 3

Figure A3.1. Extended tidal flats in the western Hudson Bay study area. Red circle indicates 2 polar bears near boulders observed during the August 2016 aerial survey.

Figure A3.2 Boreal forest several kilometers inland interspersed with ponds and lakes. Red circle indicates a swimming polar bear seen during the August 2016 aerial survey.

Figure A3.3 View of the coastal plains interspersed with lichen/peat tundra and pond/lakes. Red circle indicates a polar bear seen resting next to a pond during the August 2016 aerial survey.

Figure A3.4 Polar bear (red circle) seen near the shore in the water at high tide during the August 2016 aerial survey in western Hudson Bay.

# Appendix 4

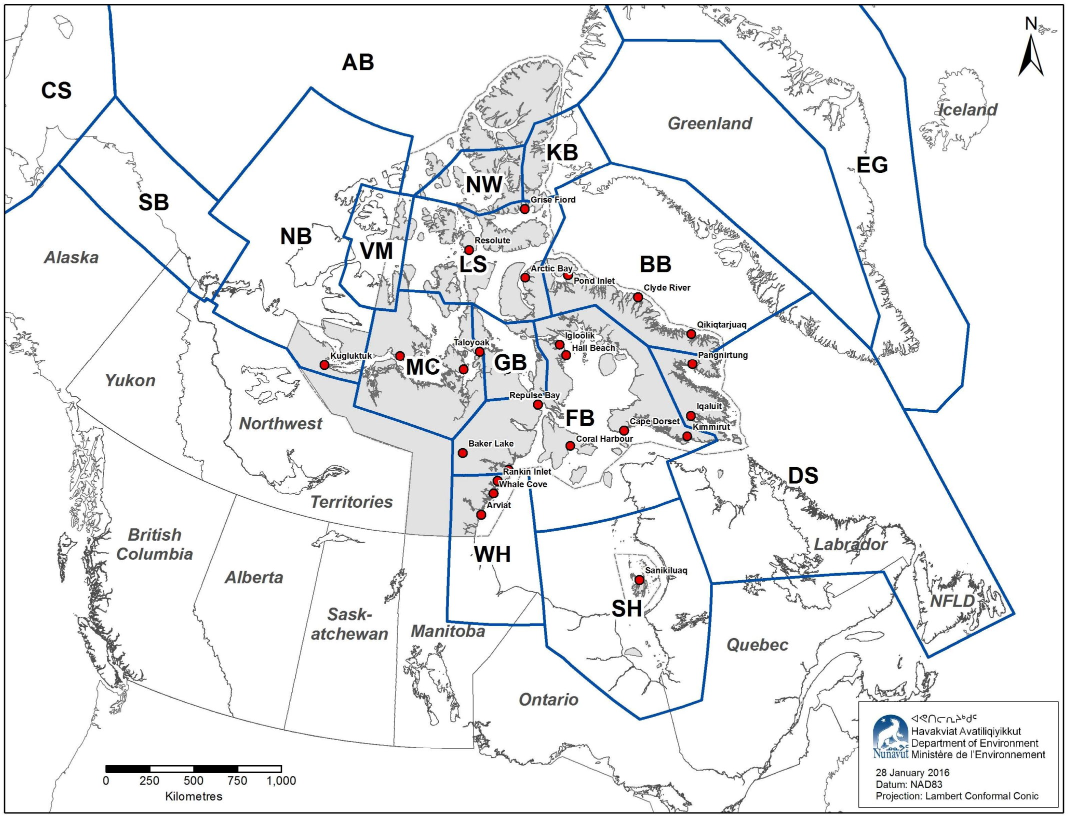



Figure A4.1. Canadian and Nunavut (dark grey) polar bear subpopulations [BB = Baffin Bay; DS = Davis Strait; SH = Southern Hudson Bay; WH = Western Hudson Bay; FB = Foxe Basin; GB = Gulf of Boothia; MC = M'Clintock Channel; LS = Lancaster Sound; KB = Kane Basin; NW = Norwegian Bay; VM = Viscount Melville Sound; NB = Northern Beaufort Sea; SB = Southern Beaufort Sea.

# SUPPLEMENTARY MATERIAL 1 TO THE WESTERN HUDSON BAY POLAR BEAR AERIAL SURVEY REPORT

## Analysis of the 2011 data set using the LANDSAT habitat covariate

Comparison of the distribution of detections from 2011 and 2016 revealed a larger range of detections at further distances in 2016 compared to 2011. One potential reason for this was likely the lower visibility in 2011 as indicated by 68% (n=100 of 147 observations) of observations with a visibility rating of 1 indicating “fair” visibility. In contrast, only 8.4% (15 of 178) observations had a fair visibility rating in 2016 (Figure SM1.1). We right truncated the 2011 distance at 1800 meters as was done in previous analyses (Stapleton et al. 2014).

The distribution of *RSveg* remote sensing habitat classes was well distributed for all 5 habitat classes with more observations closer to the transect line for all categories. For this reason the full *RSveg* habitat class was considered in addition to the *RSveg2* class (which pooled shrub and low vegetation), used in the 2016 analysis, which pooled the shrub and low vegetation class (Figure SM1.2). The 2011 survey used a “structure” covariate to describe sightability rather than habitat classes with 0 indicating no obstruction and 1 indicating obstruction by vegetation. There was a slight pattern where most of the obstructed observations occurred in the low vegetation and shrub category. There were less observations for the tree category which may have been due to reduced visibility in these areas. The gravel category had few observations with obstruction. Models were considered which had both the *RSveg* and *structure* covariates under the assumption that each covariate was describing different factors influencing sightability. For example, it is possible that the structure covariate was describing small-scale factors influencing sightability whereas the *RSveg* class was describing large scale factors.

Model selection results suggested support for a model with *RSveg2* habitat covariate, visibility, and the structure covariate with a hazard rate detection function (Table SM1.1, model 1). Also supported was a model with the full *RSveg* categories (shrub and low vegetation not pooled) with structure and visibility. This model was more supported than a half normal model with structure and visibility which was supported in the previous analysis (Stapleton et al. 2014). The estimate of abundance from model 1 (955) was higher than the half-normal structure/visibility model (model 5; 912).

Goodness of fit tests for the most supported model (model 1, Table SM1.1) suggested adequate fit ($\chi^2$=6.15, df=4,p=0.18). Kolmogorov-Smirnov tests (0.034, p=0.99) and Cramer-Von-Mises tests (0.02, p=0.99) also suggested fit was adequate. The model averaged estimate of abundance from all model in Table SM1 was 949 bears (SE=168.9, CI=618-1280, CV=17.7%), If the *RSveg* models were removed from the analysis then the estimate was 914 (SE=162.6, CI=596-1232 ,CV=17.7%) which was close to the model averaged estimate from the previous analysis (Stapleton et al. 2014) of the coastal and inland zones (929, SE=186).

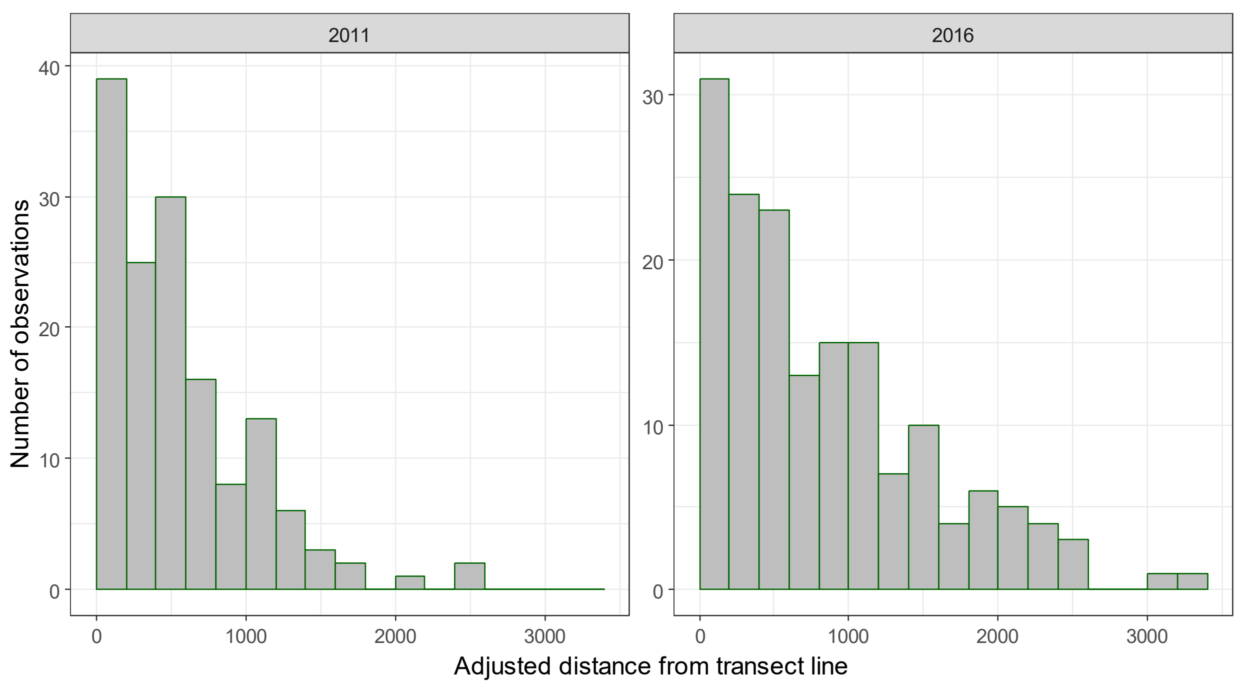



Figure SM1.1: A comparison of the distribution of detections for 2011 and 2016 surveys.

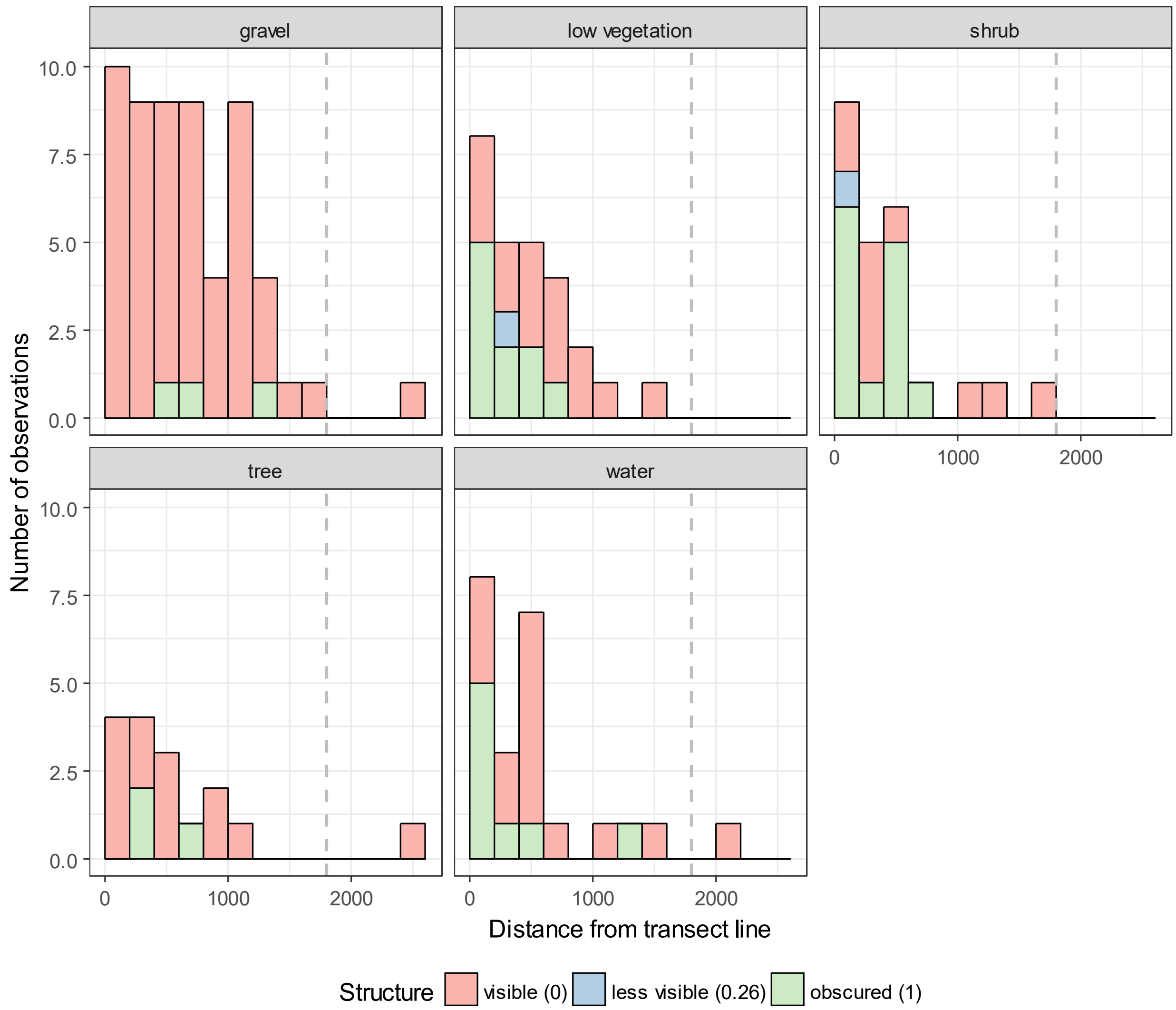



Figure SM1.2: The distribution of the remote sensing based habitat classes (*RSveg*) for the 2011 survey. The structure covariate used to describe whether observations were obscured is shown as sub bars for comparison purposes. The left truncation distance of 1800 used in the 2011 survey is shown as a vertical line.

Table SM1.1: Model selection results for 2011 Hudson Bay distance sampling analysis. Akaike information criterion (AIC), the differences between AIC of the given model and most supported model ΔAIC, Akaike weight ($w_i$), and Log-likelihood of each model is also shown.

| No | DF | Covariates | AIC | ΔAIC | $w_i$ | K | LogL | N | Conf. Limit | | CV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | HR | RSveg2+vis+structure | 2060.49 | 0.00 | 0.47 | 7 | -1023.2 | 955 | 675 | 1350 | 17.7% |
| 2 | HR | RSveg+vis+structure | 2062.40 | 1.91 | 0.18 | 8 | -1023.2 | 948 | 671 | 1338 | 17.6% |
| 3 | HR | RSveg2+vis | 2062.59 | 2.10 | 0.16 | 6 | -1025.3 | 953 | 670 | 1355 | 18.0% |
| 4 | HR | RSveg+vis | 2064.59 | 4.10 | 0.06 | 7 | -1025.3 | 953 | 670 | 1354 | 18.0% |
| 5 | HN | structure+vis | 2064.91 | 4.41 | 0.05 | 3 | -1029.5 | 912 | 655 | 1270 | 16.9% |
| 6 | HN | RSveg+vis | 2066.10 | 5.61 | 0.03 | 6 | -1027.0 | 951 | 680 | 1330 | 17.1% |
| 7 | HN | structure+vis+size | 2066.79 | 6.30 | 0.02 | 4 | -1029.4 | 894 | 643 | 1244 | 16.8% |
| 8 | HR | structure+vis | 2067.85 | 7.36 | 0.01 | 4 | -1029.9 | 932 | 650 | 1338 | 18.5% |
| 9 | HR | structure+vis+size | 2068.99 | 8.50 | 0.01 | 5 | -1029.5 | 990 | 645 | 1520 | 22.0% |
| 10 | HN | structure | 2069.73 | 9.24 | 0.00 | 2 | -1032.9 | 875 | 635 | 1206 | 16.4% |
| 11 | HR | RSveg nowater+vis | 2070.28 | 9.79 | 0.00 | 6 | -1029.1 | 936 | 648 | 1353 | 18.8% |
| 12 | HN | structure+size | 2071.48 | 10.99 | 0.00 | 3 | -1032.7 | 903 | 636 | 1281 | 17.9% |
| 13 | HR | structure+size | 2074.20 | 13.71 | 0.00 | 4 | -1033.1 | 949 | 636 | 1416 | 20.5% |
| 14 | HR | Rsveg-hab | 2075.31 | 14.82 | 0.00 | 5 | -1032.7 | 915 | 641 | 1308 | 18.3% |
| 15 | HR | RSveg2 | 2075.55 | 15.06 | 0.00 | 5 | -1032.8 | 864 | 614 | 1216 | 17.5% |
| 16 | HR | RSveg | 2076.74 | 16.25 | 0.00 | 6 | -1032.4 | 883 | 624 | 1249 | 17.7% |
| 17 | HN | constant | 2077.36 | 16.87 | 0.00 | 1 | -1037.7 | 852 | 608 | 1195 | 17.2% |
| 18 | HN | RSveg | 2078.07 | 17.58 | 0.00 | 5 | -1034.0 | 869 | 628 | 1203 | 16.6% |
| 19 | HN | size | 2079.35 | 18.86 | 0.00 | 2 | -1037.7 | 856 | 601 | 1221 | 18.1% |
| 20 | HR | constant | 2079.75 | 19.26 | 0.00 | 2 | -1037.9 | 869 | 602 | 1255 | 18.8% |
| 21 | HR | size | 2081.71 | 21.22 | 0.00 | 3 | -1037.9 | 905 | 604 | 1356 | 20.7% |

# SUPPLEMENTARY MATERIAL 2 TO THE WESTERN HUDSON BAY POLAR BEAR AERIAL SURVEY REPORT : ANALYSIS OF TREND

## Methods

Trend was estimated using results of the distance sampling surveys in 2011 and 2016 as well as counts of bears during coastal surveys that occurred in August from 2011 to 2016.

### Coastal surveys

Coastal surveys were conducted along the coast line of the high and moderate south survey strata to the Ontario-Manitoba border from 2011 to 2016 by the government of Manitoba as well as years preceding 2011. We analyzed this survey data to allow another trend estimate for comparison with trend based on the ratio of the 2011 and 2016 survey estimates. Of additional interest was whether trend in adult males which display higher movements and home range areas was similar to adult females with dependent offspring and subadults that potentially display lower movement patterns. Therefore, we analysis was stratified by these classes to assess similarity of trends. Log-linear models (McCullough and Nelder 1989, Thomas 1996) were used for trend analysis. More exactly, a generalized linear model with a quasi-Poisson distribution of counts was used with an exponential link term. The exponent of the slope term from this model provided an estimate of annual rate of change ($\lambda$). Analyses were conducted for adult males, adult females with dependent offspring (and lone females), subadult/unknown bears, and pooled classes. Emphasis was placed on the adult male and adult female with offspring classes since these groups could be classified with highest certainty.

### Distance sampling surveys

Model averaged estimates from 2011 and 2016 for pooled sex classes were compared using t-tests. Population rate of change was also estimated as the 5$^{th}$ root of the ratio of the 2011 and 2016 estimate. Of added interest was whether there were trends in age and sex class as indicated by an adult male class and adult female (lone and with dependant offspring) class. Estimates for these 2 classes were obtained by first classifying each group encountered as an adult male class, adult female/offspring, and subadult/unknown class or a mixed class if both adult males and females/offspring and subadult/unknown bears occurred in the group. The data was then post-stratified by these classes and estimates were derived from the most supported distance sampling (2011) or distance sampling-mark-recapture model (2016). Group-specific estimates were then extracted from the mixed groups by multiplying the estimate by the proportion of each class in the mixed group. Estimates for each group from the mixed groups were then added to the respective adult male or adult female/offspring/subadult category. Variances were estimated using the delta method (Buckland et al. 1993).

## Results

### Summary of counts

Counts of polar bear age and sex groups from coastal and distance sampling (coastal and inland) surveys are summarized in Figure SM2.1 which suggest a large degree of variability in the adult male class compared to other classes. For example, the adult male class seems to increase with year for both coastal and distance samples whereas the other classes appear to be stable. A different classification scheme was used for coastal counts in 2011 which resulted in less age and sex classes. This year was used in the overall trend analysis but was not used in the age-class specific trend analysis due to the different classification scheme. The higher count of bears in the 2016 distance survey was due to better survey conditions as discussed previously in Supplemental Material 1. However, the increase in counts appears to be due mainly to an increase in counts of adult males compared to other age-sex classes. There were roughly equal numbers of unknown bears in coastal surveys from 2012-6 and roughly equal numbers of subadults/unknown bears in the 2011 and 2016 distance sampling surveys.

### Trend analysis of coastal surveys

Log-linear model results suggest significant negative trends for the female/subadult class and positive but non-significant positive trends for the male and pooled classes (Table SM2.1).

Plots of log-linear model predictions suggest reasonable fit with most counts contained within confidence limits (Figure SM2.2).

**Distance sampling surveys**

Comparison of model averaged estimates of abundance for 2011 (949 bears , SE=168.9, CI=618-1280, CV=17.7%) and 2016 (842 bears SE=142.6, CV=16.9%,CI-562-1121) using t-tests suggested the difference between the 2 estimates was not significant (t=0.48, df=452,p=0.63). The ratio of the 2 estimates resulted in a gross change of 0.89 which translates to an annual change ($\lambda$) of 0.98 (CI=0.89-1.08).

We note that another estimate of abundance of 1030 that combined coastal surveys and inland samples was produced for the 2011 data set (Stapleton et al. 2014). Coastal surveys were not conducted in unison with distance sampling in 2016 and therefore this type of estimate could not be derived for 2016. Therefore, the most comparable estimates in terms of assessing trends are the distance sampling only estimates from the two years which used similar methodologies. We note that the 2011 estimate of 1030 (CI=754–1406) and the 2016 are not significantly different (t=0.87, df=454, p=0.39).

Post-stratified estimates of adult male and adult female/offspring/subadult classes were derived from the most supported models for 2011 and 2016. In all years the majority of bears were contained within segregated “pure” groups with few bears in mixed groups (Table SM2.2). For example, in 2011 there were 5 groups with adult males and adult females/offspring or subadults/unknown. These groups contained 13 bears of which 4 were adult males, 6 were adult females and 3 were subadults/unknown. Subadult/unknown class bears comprised 19% and 13% of the abundance estimate in 2011 and 2016 respectively.

A comparison of pooled and post-stratified age class estimates reveals a decrease, as with the coastal surveys, of the adult female and offspring class, an increase in the adult male class and a decrease in the pooled estimate (Figure SM2.3). None of the differences were statistically significant at $\alpha$=0.05).

Estimates of annual trend (λ) from coastal and distance sampling surveys reveal roughly similar trends for age-sex groups with declining adult female & offspring classes and an increasing adult male class. The pooled estimate of trend for coastal surveys suggest increasing abundance whereas the distance sampling estimate suggests decreasing abundance, however, both estimates of trend are not significant with estimates overlapping 1 (Figure SM2.4).

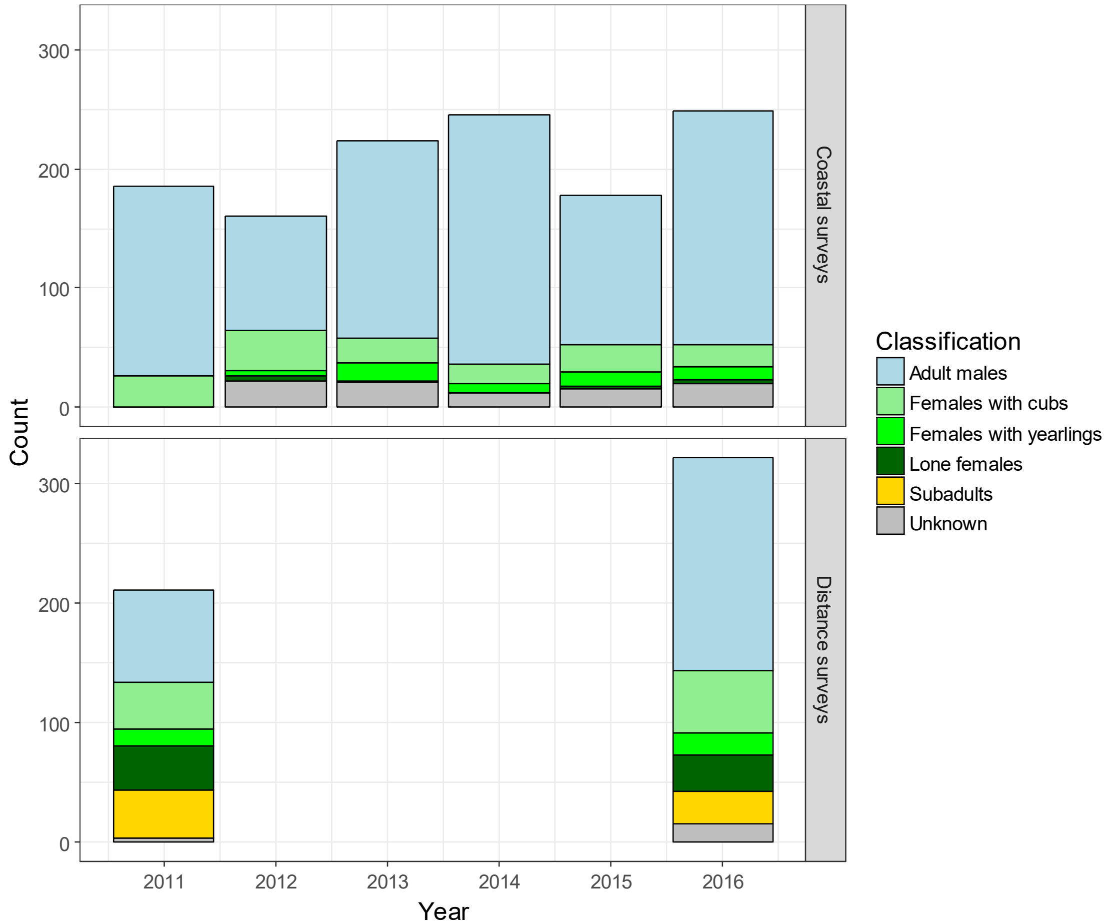



Figure SM2.1: Counts of sex and age-classes by coastal and distance sampling surveys. The counts from the distance sampling surveys only include on transect observations to ensure comparability with estimates of abundance from surveys.

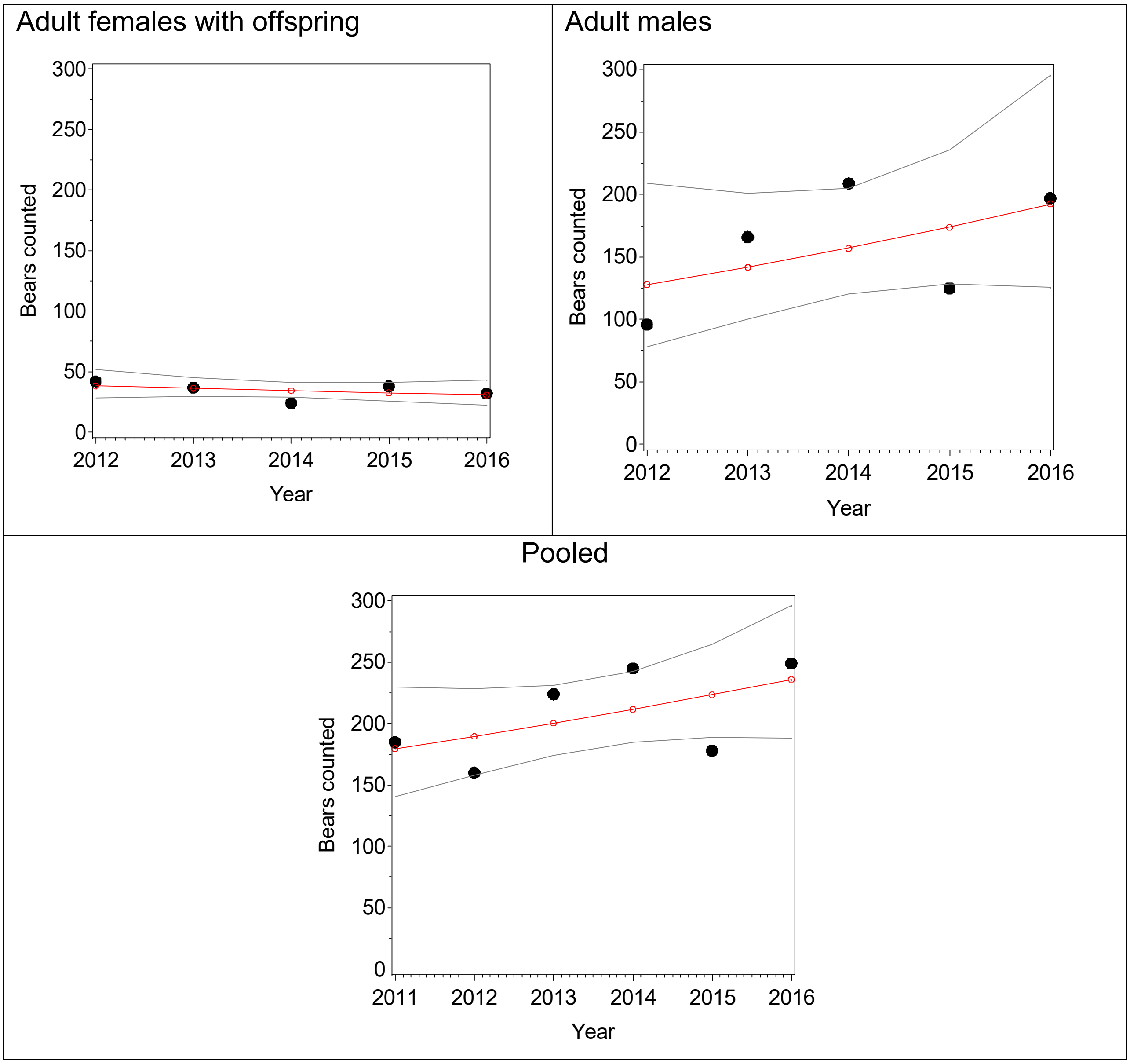



Figure SM2.2: Predicted trend from log-linear models of coastal survey. Counts are given as black dots with model predictions as red lines with associated confidence limits.

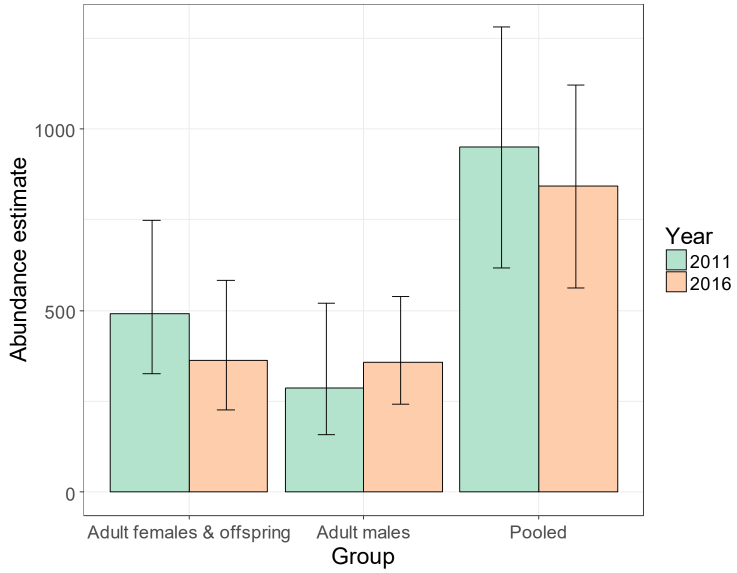



Figure SM2.3: A comparison of model average pooled estimates and sex/age group post stratified estimates for 2011 and 2016.

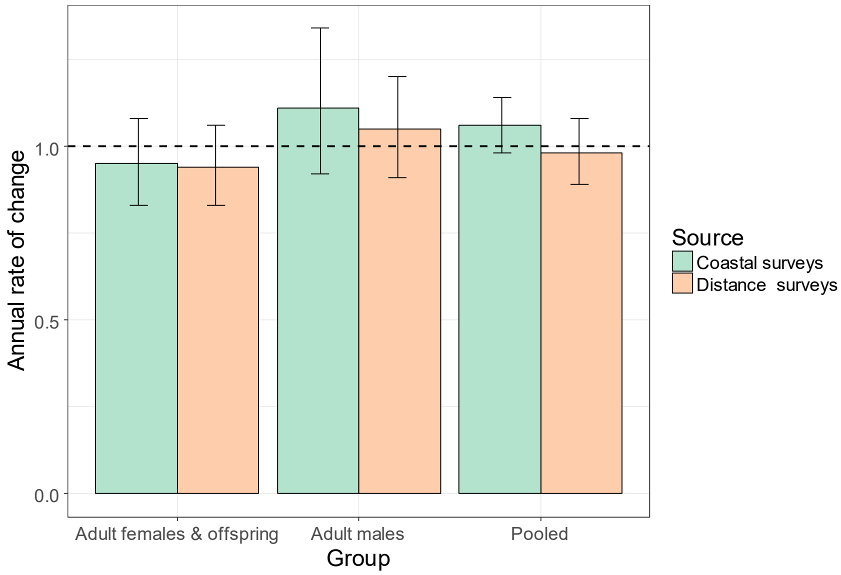



Figure SM2.4: Comparison of annual trend from counts of bears on coastal surveys (2011-6) and distance sampling survey estimates (2011 and 2016). An annual rate of change estimate of 1 that indicates population stability is shown as a dashed line.

Table SM2.1: Estimates of trend from log-linear models for the adult female/offspring/subadult, adult males, and pooled groups for the Hudson Bay coastal surveys. The slope term (β) which is an estimate of *r* (the intrinsic rate of increase) is given with confidence limits and significance tests. Estimates of λ are derived as the exponent of β slope term.

| Group | Log-linear model results | | | | | | Trend (λ) estimate | | |
|---|---|---|---|---|---|---|---|---|---|
| | β | SE(β) | Conf. Limit | | $\chi^2$ | p | λ | Conf. Limit | |
| Adult females & offspring (2012-6) | -0.06 | 0.07 | -0.18 | 0.07 | 0.70 | 0.401 | 0.95 | 0.83 | 1.08 |
| Adult males (2012-6) | 0.10 | 0.10 | -0.09 | 0.29 | 1.13 | 0.288 | 1.11 | 0.92 | 1.34 |
| Pooled (2011-6) | 0.05 | 0.04 | -0.02 | 0.13 | 1.88 | 0.170 | 1.06 | 0.98 | 1.14 |

Table SM2.2: Post-stratified estimates of age and sex groups for the 2011 and 2016 distance sampling surveys

| year | group | groups | Bears counted | N | SE | Conf. Limit | | N CV |
|---|---|---|---|---|---|---|---|---|
| **Adult females/offspring** | | | | | | | | |
| **2011** | Pure | 54 | 88 | 484 | 101.4 | 321 | 728 | 21.0% |
| | Mixed | 4 | 6 | 8 | 4.1 | 3 | 21 | 49.5% |
| | total | 58 | 94 | 492 | 101.5 | 325 | 749 | 20.6% |
| **2016** | Pure | 69 | 118 | 355 | 84.5 | 223 | 564 | 23.8% |
| | Mixed | 8 | 5 | 9 | 3.7 | 4 | 20 | 41.1% |
| | total | 77 | 123 | 364 | 84.5 | 227 | 583 | 23.3% |
| **Adult males** | | | | | | | | |
| **2011** | Pure | 53 | 76 | 280 | 84.9 | 155 | 505 | 30.4% |
| | Mixed | 5 | 4 | 6 | 2.7 | 2 | 14 | 49.5% |
| | total | 58 | 80 | 285 | 85.0 | 157 | 519 | 29.8% |
| **2016** | Pure | 71 | 163 | 324 | 60.0 | 226 | 466 | 18.5% |
| | Mixed | 8 | 18 | 32 | 13.2 | 15 | 71 | 41.1% |
| | | 79 | 181 | 357 | 61.4 | 241 | 537 | 17.2% |
| **Subadults/unknown** | | | | | | | | |
| **2011** | Pure | 35 | 40 | 173 | 40.2 | 110 | 273 | 23.2% |
| | Mixed | 5 | 3 | 4 | 2.0 | 2 | 10 | 49.5% |
| | total | 40 | 43 | 178 | 40.2 | 112 | 283 | 22.6% |
| **2016** | Pure | 24 | 27 | 96 | 29.3 | 53 | 174 | 30.4% |
| | Mixed | 8 | 8 | 14 | 5.9 | 7 | 32 | 41.1% |
| | total | 32 | 35 | 111 | 29.9 | 60 | 205 | 27.0% |

# CONSULTATION SUMMARY NOTES FOR THE 2016 WESTERN HUDSON BAY POLAR BEAR AERIAL SURVEY COMPILED DURING MEETINGS CONDUCTED BETWEEN 4-7 JULY 2017

4 July, 2017: Rankin Inlet HTO, Rankin Inlet

5 July, 2017: Issatik HTO, Whale Cove

6 July, 2017: Arviat HTO, Arviat

7 July, 2017: Aqigiq HTO, Chesterfield Inlet

Department of Environment, Government of Nunavut

Igloolik, NU

Prepared: 11 July, 2017

## Executive Summary

Government of Nunavut, Department of Environment representatives together with delegates from Nunavut Tunngavik Inc. and the Kivalliq Wildlife Board conducted consultations with the Hunters and Trappers Organizations of Rankin Inlet, Whale Cove, Arviat, and Chesterfield Inlet on July 4, 5, 6, and 7, 2017, respectively. Invited Baker Lake HTO representatives did not attend the meeting in Chesterfield Inlet on 7 July 2017.

The primary purpose of these consultations was to provide co-management partners with:
1) an overview of the most recent scientific study results on the western Hudson Bay (WH) polar bear sub-population (Appendix 1); and
2) the GN's management recommendation of no change to the current TAH despite a decline in abundance in the 2016 population estimate (842, 562-1121 95% CI) relative to the 2011 aerial survey estimate (1030, 754-1406 95% CI).

In addition, the GN representatives collected feedback on the results and any additional information or management concerns expressed by co-management partners. This included public safety concerns expressed by the Arviat HTO, to which the GN suggested it would recommend re-setting the current TAH of 28 bears to the NWMB, thus eliminating existing polar bear tag credit issues so as to allow each community full, restored access to its quota allocation.

Only communities that hunt from the WH polar bear sub-population were consulted.

The feedback and information collected during these consultations will be considered when forming Total Allowable Harvest (TAH) recommendations for the WH sub-population to be submitted for decision to the Nunavut Wildlife Management Board (NWMB) at its September, 2017 meeting.

This report attempts to summarize the comments made by HTO members/participants during these consultation meetings.

# CONSULTATION SUMMARY NOTES FOR THE 2016 WESTERN HUDSON BAY POLAR BEAR AERIAL SURVEY COMPILED DURING MEETINGS CONDUCTED BETWEEN 4-7 JULY 2017

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## Preface

This report represents the Department of Environment's best efforts to accurately capture all of the information that was shared during consultation meetings with the Hunters and Trappers Organizations of Rankin Inlet, Whale Cove, Arviat, and Chesterfield Inlet.

The views expressed herein do not necessarily reflect those of the Department of Environment, or the Government of Nunavut.

## Table of Contents

## 1.0 Report Purpose and Structure

This report is intended to: 1) provide the details of the GN DOE presentation and resulting management recommendations for the WH polar bear subpopulation assessment, 2016 (Appendix 1), and 2) collate and summarize comments, questions, concerns and suggestions provided by the HTOs in response to the results from the recent western Hudson Bay (WH) scientific study. In addition, these consultations were conducted with community HTOs to collect feedback and TK prior to submitting formal recommendations for the WH sub-population to the NWMB that include no change to the current TAH. The following community HTOs were consulted from July 4-7, 2017:

- 4 July, 2017: Rankin Inlet HTO, Rankin Inlet
- 5 July, 2017: Issatik HTO, Whale Cove
- 6 July, 2017: Arviat HTO, Arviat
- 7 July, 2017: Aqigiq HTO, Chesterfield Inlet

After these consultations, the DOE will provide a submission to the NWMB for decision that includes no change in the existing TAH and management approach, but as per Arviat HTO's suggestion GN DOE will recommend to re-set and zero credits so that communities are able to harvest bears but are also in a position to deal with defense of life and property kills, should the situation arise.

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In addition to the HTO Board members, co-management representatives from Nunavut Tunngavik Inc. (NTI), and the Kivalliq Wildlife Board (KWB) also attended each of the consultations. The NWMB had no delegates present during these meetings.

## 2.0 Purpose of Consultations

The purpose of these consultations was to discuss the newest scientific information that was collected during the 2016 aerial survey regarding the WH polar bear sub-population, and as reported in the final GN report which was produced by several co-authors. After the consultations the GN DOE will submit TAH recommendations for the WH sub-population to the NWMB for decision which will include no change in the existing TAH and management approach, but as per Arviat HTO suggestion to re-set the credits to zero. This would allow communities to harvest bears while also being in a position to deal with defense of life and property kills, should the situation arise.

## *2.1 Format of Meetings*

The meetings were held in the evenings, usually between 19:00 and 22:00, and ran approximately 2.5 hours depending on HTO engagement. Meetings were facilitated and led by the GN Polar Bear Biologist, M. Dyck, who was also the presenter. Each consultation session began with an overview of the study design, study execution, and results from the aerial survey study conducted on the WH polar bear sub-population (Appendix 1). It was also mentioned that the population has remained relatively stable and that no difference between the 2011 and 2016 aerial survey results existed. The GN's position, therefore, was to recommend no change in the current TAH for the WH sub-population. The participants were invited to ask any questions, raise concerns, or provide recommendations throughout the meetings. After the presentation, questions/discussions continued until no further questions were raised.

# 3.0 Summary by Community

The objectives of the consultations were made clear to the HTO members prior to and at the start of each meeting. There were many similar questions, concerns and suggestions raised by HTO Board members in all the communities consulted. A full report of the questions and comments from each community follows in Appendix 2.

## *3.1 Rankin Inlet Consultation Summary*

**Date**: 4 July, 2017

**Representatives:**

- GN-DOE, Polar Bear Biologist: Markus Dyck
- GN-DOE, Regional Manager: Rob Harmer
- GN-DOE, Conservation Officer: Joanne Coutu-Autut
- NTI: Raymond Mercer
- NTI: Robert Karetak
- Rankin Inlet HTO, Secretary: Nigel Kubluitok
- Rankin Inlet HTO, Temporary Secretary: Clayton Tartak
- KWB Representative: Qovik Netser

**Comments and questions:**

There were no HTO board members present in Rankin Inlet, however, several questions regarding the presentation and results of the study were raised by representatives. The question whether there is current concern for this population was raised, and it was discussed that although there does not seem to be a significant decline in abundance, declines in body condition, survival rates, and reproduction have been documented for years. In particular, there are some effects on cubs-of-the-year that only allow a small proportion to survive to the yearling stage.

There was also some support for a new IQ study, and a fall coastal survey to determine when and how many bears migrate through and are in the vicinity of the community.

### *3.2 Whale Cove Consultation Summary*

**Date**: 5 July, 2017

**Representatives:**

- GN-DOE, Polar Bear Biologist: Markus Dyck
- GN-DOE, Regional Manager: Rob Harmer
- NTI: Raymond Mercer
- NTI: Cheryl Wray
- KWB Representative: Nick Arnalukjuaq
- Issatik HTO: Shirley Kabloona
- Issatik HTO: Eva Voisey
- Issatik HTO: Martha Arualak
- Issatik HTO: Chris Jones
- Issatik HTO: Robert Enuapik

**Comments and questions:**

In response to questions asked by M. Dyck regarding when many bears would show up near the community, HTO members responded usually in the fall between October and December, and that there may be a disproportionate migration of bears north from Manitoba. HTO members agreed that there were fewer polar bears during the 1960s and 1970s, and that during the 1980s more bears were seen on the land. It was also suggested whether biopsy sampling could be used in order to track problem bears near the community, or if a fall coastline survey could be used to determine some trends over time. There also seemed to be support for a renewed study in order to continue the monitoring of the WH polar bears.

### *3.3 Arviat Consultation Summary*

**Date**: 6 July, 2017

**Representatives:**

- GN-DOE, Polar Bear Biologist: Markus Dyck
- GN-DOE, Regional Manager: Rob Harmer
- GN-DOE, Conservation Officer: Joe Savikataaq Jr.
- NTI: Raymond Mercer

- NTI: Cheryl Wray
- NTI: Bert Dean
- NTI: Robert Karetak
- KWB Representative: Nick Arnalukjuaq
- KWB Chairperson: Stanley Adjuk
- Arviat HTO: Thomas Alikaswa
- Arviat HTO: Ludovic Issumatarjuak
- Arviat HTO: Gordy Kidlupik
- Arviat HTO: Angelina Suluk
- Arviat HTO: Sam Garry Muckpa
- Arviat HTO: Jamie Kablutsiak
- Arviat HTO: Mary Issumatarjuak

**Comments and questions:**

In response to questions asked by M. Dyck regarding when many bears would show up near the community, HTO members responded usually in the fall between October and December. HTO members agreed that there were fewer polar bears during the 1960s and 1970s, and that during the 1980s more bears were seen on the land. It was also discussed if a fall coastline survey could be used to determine some trends over time. Concern over the TAH was expressed and that it is likely low to deal with problem bears. M. Dyck suggested to bring forward to DOE whether it is possible to re-set credits and TAH for the new harvest season. Some HTO members suggested that bears in the Arviat area move inland up to 120 miles – and that this was important local information that should be documented for the next aerial survey. Problem bears do also not seem to be scared anymore of people like they used to.

### *3.4 Chesterfield Inlet Consultation Summary*

**Date**: 7 July, 2017

**Representatives:**

- GN-DOE, Polar Bear Biologist: Markus Dyck
- GN-DOE, Regional Manager: Rob Harmer
- GN-DOE, Conservation Officer: Peter Kattegatsiak Sr.
- NTI: Raymond Mercer
- NTI: Cheryl Wray
- NTI: Bert Dean
- NTI: Robert Karetak
- KWB Representative: Nick Arnalukjuaq
- Aqigiq HTO: Harry Aggark
- Aqigiq HTO: Leonie Mimialik
- Aqigiq HTO: Patrick Putulik

- Aqigiq HTO: Jerome Misheralak
- No Baker Lake HTO members attended the meeting after invitations and travel was arranged to Chesterfield Inlet

**Comments and questions:**

In response to questions asked by M. Dyck regarding when many bears would show up near the community, HTO members responded usually in the fall between October and December, but also in the spring time. HTO members agreed that there were fewer polar bears during the 1960s and 1970s, and that during the 1980s more bears were seen on the land, and that there are bears from 2 sub-populations near the community (e.g., Foxe Basin and WH). It was also discussed if a fall coastline survey could be used to determine some trends over time.

## 4.0 Summary

Some common themes that were apparent during several HTO discussions were that communities would likely support a fall coastal survey allowing to monitor bears near communities, and possibly means of genetic biopsy sampling so that bears near communities could be identified and their background examined if they had contact with communities and humans before. It also seemed that HTOs would be in support of a new traditional knowledge study that would examine whether freeze-up patterns near their communities have changed during the past 20-30 years, and how the fall distribution of bears near communities has changed from the 1970s to the present. The Arviat HTO commented that the current TAH likely is not sufficient to cover problem bears and it was suggested that a credit re-set could be considered so that the full TAH is available for all communities, given the public safety concern. M. Dyck and R. Harmer offered all communities to forward questions to the GN should they arise so that anything that was not discussed or unclear at the meetings could be explained.

# CONSULTATION SUMMARY NOTES FOR THE 2016 WESTERN HUDSON BAY POLAR BEAR AERIAL SURVEY COMPILED DURING MEETINGS CONDUCTED BETWEEN 4-7 JULY 2017

1. **Rankin Inlet**
   Date: 4 July 2017
   Time: 19:00 – 21:00

   Present: R. Harmer, GN, Regional Manager Kivalliq
   J. Coutou, GN, Conservation Officer, Rankin Inlet
   M. Dyck, GN, Polar Bear Biologist II
   Nigel Kubluitok, Secretary, Rankin Inlet HTO
   Clayton Tartak, Secretary (temporary), Rankin Inlet HTO
   Raymond Mercer, NTI
   Robert Karetak, NTI
   Qovik Netser, KWB Representative
   - **No HTO Board members present –**

a) M. Dyck welcomed everyone to the meeting, and also explained that the timing is likely not the best because many board members will be out on the land and a meeting during October would have been much better. However, the Minister thought this was a high priority to report back the results from the 2016 survey, and so we are here to do just that. M. Dyck presented the current status of the western Hudson Bay (WH) polar bear population, i.e., what is currently known from a scientific perspective. The presentation (attached in English and Inuktitut) included a background of the scientific findings up to 2015, why a new study is needed, what the basis was for the new aerial survey, how it was designed, what information was used to design it, how it was conducted, and what the results were of this study. The presentation also included the position of the GN on the current status of WH polar bears, i.e., that the population appears to be stable and the GN currently does not support an increase in the TAH.

b) Questions that arose from the presentation:
   i) Q: R. Mercer: Do you think there is a concern with this population currently?
   A: M. Dyck: The population appears to be stable based on the new aerial survey results where we could not detect a significant difference between the last survey from 2011 and the current one from 2016. However, as in the previous aerial survey and

other previous ECCC studies, the reproductive performance of the population is poor compared to other Hudson Bay complex polar bear populations (see Table in ppt presentation). There are few coys surviving into the yearling stage. ECCC also documented that body condition, survival and reproduction has been decreasing for many years in this population. Abundance-wise the population appears to be stable, but something concerning is going on regarding the reproduction. Ongoing monitoring of this population is needed as well as sea-ice monitoring for the future.

ii) Q: Nigel: I heard there is some tagging going on?
A: R. Harmer/M.Dyck: There is a PITT tagging program going on for polar bear hides to monitor export and identity of the population where bears were harvested – that is a collaborative program between ECCC and the GN. In addition, ECCC and the University of Alberta is putting out satellite ear tags in Manitoba to monitor and examine male polar bear movements and how they are distributed during freeze up.

iii) Q: Nigel: When will the next survey be?
A: M. Dyck: Ideally we want to survey every 3-5 years. If intervals are too large between aerial surveys then all the investment in previous surveys was for nothing so we need to maintain a rigorous monitoring schedule. I will make sure that we can have the next survey in 2020 for WH.

iv) Q: R. Mercer: If we wanted to conduct a coastal survey in Nunavut like Manitoba does, how much would it cost?

A: M. Dyck: I think that with about 10-15K we could cover most of the coastal area, and it would be a great effort to collect this information over the next few years, in addition to traditional knowledge, to examine fall distribution of bears in Nunavut. We could get money from the GN, and likely NWMB, and maybe the RWO to apply together to secure funding.

Meeting adjourned around 21:30
Notes by M. Dyck

2. **Whale Cove**
Date: 5 July 2017

Time: 19:00 – 21:00

Present:
Rob Harmer, GN, Regional Manager Kivalliq
Markus Dyck, GN, Polar Bear Biologist II
Eva Voisey, Whale Cove HTO
Shirley Kabloona, Whale Cove HTO
Martha Arualak, Whale Cove HTO
Chris Jones, Whale Cove HTO
Robert Enuapik, Whale Cove, HTO
Raymond Mercer, NTI
Cheryl Wray, NTI
Nick Arnalukjuaq- KWB Representative

a) M. Dyck welcomed everyone to the meeting, and also explained that the timing is likely not the best because many board members will be out on the land and a meeting during October would have been much better. However, the Minister thought this was a high priority to report back the results from the 2016 survey, and so we are here to do just that. M. Dyck presented the current status of the western Hudson Bay (WH) polar bear population, i.e., what is currently known from a scientific perspective. The presentation (attached in English and Inuktitut) included a background of the scientific findings up to 2015, why a new study is needed, what the basis was for the new aerial survey, how it was designed, what information was used to design it, how it was conducted, and what the results were of this study. The presentation also included the position of the GN on the current status of WH polar bears, i.e., that the population appears to be stable.

b) Questions that arose from the presentation:

   i) Q: Eva Voisey: How can you tell if it is a male or female from the air?
   A: M. Dyck: We tested this in the Baffin Bay but it is difficult. The males are easy to spot as they have distinctive features like larger necks and scars on their faces. We are flying 300-400 feet up and we take the GPS location, then we go to about 100 feet, take a picture and can tell the differences. But there are times, when we don’t know the sex of the bear and we do state that.

   ii) Q: Rob Harmer: how far inland is that photo taken (slide 18)?
   A: M.Dyck: I can’t remember specifically but around 30-40 kilometers inland.

iii) Q: Nick Arnaklujuaq– I don't see any partners that include HTO's? Why don't we include that on our slides?
A: M. Dyck: This slide only includes organizations that provided financial assistance and fuel. We did include the HTO's during consultations and I can add a slide that shows the HTO's that were involved. I have to apply for funding from a lot of different organizations and that is what I am trying to convey here.
A: R. Harmer: I just want to add that we are in no way trying to be disrespectful and not listing the different individuals or HTO's. We do not in any way under value the contributions of individuals or HTO's and we realize the importance and that is conveyed to upper management.

iv) Q: Chris Jones: Did you mention that there was a concentration of family groups in Manitoba? In Coral Harbour the females with cubs would always stay away from the big males.

v) Q: Are the transects 7 km apart? Maybe the transects are too far apart to get an accurate count?
A: M. Dyck: We designed the study so that the transects were closer in areas where we knew the densities were higher. It wouldn't make any difference if we spaced the transects closer, as there just are not more bears. Having transects closer in some areas would not mean that we find more bears – the effort was already maximised considering density of bears and costs involved. We need to work closer together with communities and HTO's to determine when the best time of the year to survey.
Chris Jones: Our problems are in October to December when we see a lot more bears, and what we think is happening that a greater proportion of bears from Manitoba are moving into Nunavut.
Markus: See that is very interesting as this is the first time I have heard that there are proportionally more bears moving up and not just an increase in the population overall.

vi) Markus: Q: Have you seen a change in the sea ice freeze-up patterns here? Maybe ice freezers here sooner than in Churchill and that is why bears move into Nunavut faster in higher

numbers. We need to collect that information. When did you see a change in bear numbers occurring in your community?
Eva/Chris: In the 60s and 70s there were very few bears around and people were on the land in spring or summer and did not see bears. In the 80s that started to change and more bears were seen. Usually the number of bears in Whale Cove seems to be higher in October before freeze-up.
Markus explains also that between the 1800s and early 1900s about 55K polar bears were harvested by explorers and whalers, and not many bears were suspected to be left across the arctic, that is why the international agreement was put in place – to contribute towards conservation. But also the tourism industry in Churchill began and by the mid 1990s it was in up-swing – there are bears habituated to tourism, the Ladoon dog yard, and other activities, and maybe all these combinations lead to have more bears showing up in Nunavut during early fall. We need to collect the IQ that is out there, and try to get genetic samples of all bears that are frequenting the communities, and then compare that to the ECCC data base which will allow us to find out the history of each bear in communities where it is know. Then we can hopefully explain better why there are more bears in Nunavut, and how we can manage that situation. I have brought this issue up with Manitoba several times, and I think they are seeing this more now as a concern and are willing to collaborate on that topic.

vii) Chris Jones: Maybe we can use the biopsy darts as part of our deterrent and help collect the information.
Markus: we should discuss this and if the HTO is willing to do this, then I think that would be great.

viii) Eva Voisey: I think the climate change has a lot to do with impacting the bear populations. Also when we have the bear problems; they are used to people from being habituated in Churchill.
Markus: I did research this in Churchill and I think that the tourism has allowed habituation and conditioning and now Nunavut is paying for it.
Chris Jones: Deterring bears has changed dramatically in that they are not scared anymore.

Chris Jones: there is a trail that the bears use to move around Whale Cove.
Rob Harmer: Have the conditions of the bears changed?
Chris: we had an older male last year. We have a lot of bears in town. Female with 2 cubs under the houses.

ix) Eva Voisey: I don't understand this quota thing? Why does it come from America?
Markus/Rob: I think you are talking about CITES and the trade of the hides.
Eva: it's not only humans that kill the bears. It's also contamination from plastics etc.

x) Chris Jones: When is the next time you'll be in the communities?
Markus: My plan is to conduct the next survey in 2020. But that is also dependent on where the community concerns are. We are traveling to all the WHB communities to provide updates. We need to keep up a regular interval with the surveys as it makes the data set stronger. We can detect a change if we maintain a rigorous survey interval.

xi) Chris Jones: do you guys regularly count the bears in Arviat?
Rob: we have a couple of employment positions that are bear monitors and keep track of wildlife sightings.
Markus: We can work with the communities as we have darts that will take a sample but also colour it so you can keep track of what bears are moving through.

Meeting adjourned at 21:30

Notes by Cheryl Wray

3. **Arviat HTO**
Date: 6 July 2017
Time: 19:00 – 21:00

Present:
Rob Harmer, GN, Regional Manager Kivalliq
Markus Dyck, GN, Polar Bear Biologist II
Joe Savikataaq Jr., GN Conservation Officer
Thomas Alikaswa, Arviat Vice-Chairman HTO
Ludovic Issumatarjuak, Arviat HTO
Gordy Kidlupik, Arviat HTO
Angelina Suluk, Arviat HTO
Sam Garry Muckpa, Arviat HTO
Jamie Kablutsiak, Arviat HTO
Bert Dean, NTI
Robert Karetak, NTI
Raymond Mercer, NTI
Cheryl Wray, NTI
Nick Arnalukjuaq- KWB Secretary/Treasurer
Stanley Adjuk – KWB Chairperson
Mary Issumatarjuak, HTO Office
Bobby Suluk, Interpeter

a) M. Dyck welcomed everyone to the meeting and presented the current status of the western Hudson Bay (WH) polar bear population, i.e., what is currently known from a scientific perspective. The presentation (attached in English and Inuktitut) included a background of the scientific findings up to 2015, why a new study is needed, what the basis was for the new aerial survey, how it was designed, what information was used to design it, how it was conducted, and what the results were of this study. The presentation also included the position of the GN on the current status of WH polar bears, i.e., that the population appears to be stable and the GN would not recommend an increase in TAH.

b) Questions that arose from the presentation:
   i) Q: Markus: One of the questions I asked the other HTOs was when do you see these bears coming into the communities? Also is there a difference in when the bears would show up historically vs present day? I believe that if we work together and partner western science and IQ that we can get a better idea of when the bears pose problems to the communities to keep people safe.

   ii) Q: Gordy – Can we share this information with the public with people in our communities?

A: Markus: Yes this information is public to Nunavut right now, but when I get back to Igloolik next week I will share the information with Manitoba, Parks Canada. It has also been shared with NWMB.

iii) Q: Sam: For aerial surveys would it be possible during the migration to conduct surveys during that time of the year? We hear that sometimes 20-30 bears are moving by the community.
A: Markus: What I think we could is during the fall time is to conduct a coastal survey. Manitoba conducts a survey during the fall down to the Ontario border. What I think we should do in Nunavut is that we survey north of the border and see how many bears up during this time frame. I think we should think about this. In order to time this right, we can discuss with all the HTOs as to when a good time would be. The other option is that we can genetically biosample bears, I think we could do this throughout the community. Joe is already helping with this. But we can compare the genetics of the bears moving by the community to what ECCC has and learn the history of these bears then we will be able to determine if bears had past encounters with humans, the dump in Churchill and whether this contributes to bears near communities. If there are bears that have been captured before we can compare the genetics to what ECCC has and learn the history of this bear such as if it was captured in Manitoba. Myself and some other HTOs think is that some of these bears that have been conditioned in Churchill could possibly be bears that are coming into our communities here in Nunvaut. We don't know this, but the genetics could tell us a story. I also have darts that can mark a bear with colour as well as take a biopsy. This could actually help us monitor if it is a bear that is returning or different bears moving through. We have some options and we should discuss this further.

iv) Q: Gordy: We need to keep in mind that the bears we see here will be in another community in a couple of weeks. Maybe October is a good month to conduct the surveys. They will be here and then in Whale Cove in a couple of weeks.

v) Q: Markus – have you seen a change in the sea ice in the last 15-20 years in freeze up? By knowing all these different pieces of the puzzle, we can figure out how the bears are moving and whether they are coming from the Churchill area. Churchill now has a weir and perhaps that can play a factor in how the ice freezes now in that area and that could be a contributing factor.

vi) Q: Thomas: There is a difference between thin bears and large bears that spend more time on the ice and that thin bears have been walking for miles. It's not because they can't hunt, it's because they have been walking for a long time. The second point is that I don't believe that there is a decrease in the numbers but rather there are bears further out in the ocean.
A: Markus – thanks for your comments and observations.

vii) Q: Ludoric: The elders used to say that the populations were quite low in the past and have witnessed that there weren't many bears in the past as I am a hunter. I also support what my colleague Thomas is saying in that the bear population is not declining but rather is a lack of food and they are walking farther. It's not possible to stay in tents in the summers anymore as there are so many bears.

viii) Q: Markus – we heard in Whale Cove that in the 60's there were fewer bears and then in the 80's the numbers started to increase. Is this what you have seen as well?
A: Ludoric: Yes I agree with what Whale Cove has said that we are now seeing more.
Q: Robert – is that around the time that Churchill closed their dump?
A: Markus: the military was killing a lot of animals when they were in Churchill and the bears have had time to rebound and maybe that's why we are seeing more as there is now a quota system. Bert: the mid to late 80s hunters from Rankin would come down to Arviat and Churchill to harvest bears as there weren't many in the Rankin area. Even in the early 90s, Rankin wouldn't even fill their quota.
Ludoric – I remember this time well.
Rob Harmer/Markus – between 1890's and 1930's there were about 55K bears killed in Canada by whalers and explorers

were killing many bears. This is the time when Governments became concerned that the number of bears were declining. Ludoric – I can remember this lady from Rankin was speaking about the number of bears harvested and they were declining.

ix) Q: Jamie – When should we as people from communities expect to get our TAH's back? Can you take this back to the GN that we want to see our quota increase to where it was previously?
A: Markus: The population estimate that we have now is stable. The Government's position now is that there is no increase in TAH as the population is stable. I can take that request back to my Director and see if there is a way to even out the credits and overharvests to get back to the original TAH.
Bert – The NWMB is going to be doing a public hearing in the fall on the Polar Bear Mgmt Plan and your HTO will send someone to this meeting. This meeting will allow a discussion as to how the populations can be managed. I think it is worthwhile to start thinking about a workshop to discuss the Mgmt Plan as we are hearing from a lot of communities that public safety is a huge issue.

x) Q: Gordy: During the 50/60s to the 90s, Tommy had noticed that the bear numbers were increasing and people were starting to get scared and wanted him to harvest it.

xi) Q: Thomas: When you conduct your surveys, how far inland do you go and how do you decide that? We have seen bears about 120 miles inland at a caribou outfitting camp.
A: Markus: That would have been good information to have so we could survey in those areas. When we discussed this initially during the consultation for the design this did not come up.

xii) Q: Thomas – we travel inland on quad and have seen bears and those bears aren't counted?
A: Markus – we have surveyed from between 80-120 km's inland. If there are any locations that you have during the summer months where you have seen bears that far inland. Can you please report those areas to the CO so we can search

that area for the next survey. That's important information to know as it would help us.

xiii) Q: Ludoric: I have heard guide/people talking about seeing bears in a sports camp at a caribou camp 120 miles inland.
A: Markus – We hope to have a lot of this information for our next survey so that we can search better if we need to go inland.

xiv) Q: Sam Garry – in 2007 my grandfather mentioned that almost every night there was a polar bear encounter at a sports camp near Dianne River.
Ludoric – I have also witnessed that as I have helped the sports hunters for bears. I have also heard from my ancestors that some bears could be spending their entire life cycles in the ocean. They have even stated that the bear's eyes are red because they are so large.

xv) Q: Raymond: In Whale Cove they said they are seeing a lot of seals. I am wondering if this is the same in Arviat?
A: Sam Garry – boating near Century Island we noticed a lot of seals. A lot more seals than we have seen.
Ludoric – there does seem to be a lot more seals.

xvi) Q: Rob – Can there be some sort of agreement that maybe bears are more comfortable around humans now. Do you guys feel that they might be too comfortable with us now due to them becoming conditioned and used too our deterrence efforts? Could that be a possibility as to why we are having more occurrences because they're becoming more bold and have lost their fear of humans?
A: Ludoric: Nodding head. Gordy: I believe that it is more about finding food. I think the bears know that they can access food near the communities. Andy Derocher showed me a graph as to when the bears started declining and it was around when we say more around the community and it occurred to me that they were looking for food near our communities.
Rob: What we think is that bears are coming up from Manitoba and they aren't scared of people anymore due to Manitoba's deterrence program; so when they get to Arviat or Whale Cove

they aren't affected by rubber bullets, or bangers, etc. and aren't deterred anymore. Manitoba had a serious problem bear last year and notified us that this bear would be a problem for us, but fortunately that bear moved onto the ice before it got here.

xvii) Q: Ludoric: I have heard that because the garbage is now managed at Churchill that they are going after our dumps because the food is available there.
Robert Karetak: There was a workshop conducted on wildlife deterrents in Churchill and we want to have another workshop like that. If there was funding they thought they might hold a workshop in Arviat or Rankin. There was a final report issued on the workshop and I can forward that to you.

Nick: closing remarks. Nick thanked the GN for the presentation about the results, but he does not agree with the survey results and we need to conduct new surveys in the future. When it comes to animals, it's like every single result was never positive and constantly lowered and that impacts Inuit. To the Inuit this is not justified. If we did not have defense kills, our quotas would be fine. In the long run, I would like to see effective communication and build on our relationship between RWO/HTO and the GN. With powers and authorities we need to be able to manage our wildlife populations with the government. We need to continue and maintain the surveys as we want accurate numbers as we know that populations will stabilize. So we want the IQ and western science to work together.

Meeting adjourned at 22:00

Notes by Cheryl Wray

4. **Chesterfield Inlet**
Date: 7 July 2017
Time: 17:00 – 19:00

Present: Rob Harmer, GN, Regional Manager Kivalliq
Markus Dyck, GN, Polar Bear Biologist II
Harry Aggark, Chesterfield Inlet HTO
Leonie Mimialik, Chesterfield Inlet HTO
Patrick Putulik, Chesterfield Inlet HTO
Jerome Misheralak, Chesterfield Inlet HTO
Simon Aggark, Summer Student, Chesterfield Inlet GN
Bert Dean, NTI
Raymond Mercer, NTI
Cheryl Wray, NTI
Robert Karetak, NTI
Nick Arnalukjuaq- KWB Representative
Jennifer Sammurtok – Interpreter
Peter Kattegatsiak Sr. – COII, GN-DOE
**NO BAKER LAKE HTO BOARD MEMBERS PRESENT (travel arrangements were made for 2 members which did not show up for the meeting)**

a) M. Dyck welcomed everyone to the meeting, and also explained that the timing is likely not the best because many board members will be out on the land and a meeting during October would have been much better. However, the Minister thought this was a high priority to report back the results from the 2016 survey, and so we are here to do just that. M. Dyck presented the current status of the western Hudson Bay (WH) polar bear population, i.e., what is currently known from a scientific perspective. The presentation (attached in English and Inuktitut) included a background of the scientific findings up to 2015, why a new study is needed, what the basis was for the new aerial survey, how it was designed, what information was used to design it, how it was conducted, and what the results were of this study. The presentation also included the position of the GN on the current status of WH polar bears, i.e., that the population appears to be stable.

b) Questions that arose from the presentation:
   i) Q: Markus – I am posing the same question to you as I have with other communities. In Whale Cove, they told us that in the fall time they would have a lot of bears in their community. What time of the year do the bears show up in your community?
   A: No comments.

   ii) Q: Markus - The COY's are not surviving into the first year and maybe hunters can help us understand why that is. Maybe the

males are killing the cubs or the mothers are not in good condition and killing off the weaker COY, or there are other reasons that local knowledge could help us understand.
A: No comments.

iii) Q: Jennifer Sammurtok: July 1st long weekend we saw a mother with 2 cubs on the Inlet. Also the elders have stated that bears are being fed in Churchill so they are not afraid anymore.
A: Rob/Markus: We have heard this is in every community where all of a sudden all the bears show up at once and where that didn't happen 15-20 years. We would like to gather more information from the communities as to why all of a sudden these bears show up at once.
Leona: in the spring time when the ice breaks we see them near the community.
Rob: During the spring time are they problematic or are they just moving through? Leonie: it is scary for us as the kids are out of school and we have to tell them to go home. Also the bears are walking down the roads.
Leona: Because the community is on a point, the bears are coming from all directions.
Markus: Is there a time frame when the bears weren't problematic?
Leonie: Previously we were able to go camp.
Harry: In the mid 60's we would be able to camp on the islands without seeing bears.
Rob: do you find that there is a difference in the bears now – are they less fearful then they used to be?
Leonie: they are not scared anymore and approach the communities. Previously if a dog was barking, the bear would get scared and run, but that doesn't happen anymore. We have a camp not far from here and we can't even go there to eat anymore because of the bears. The bear was hiding and watching them so we had to leave and go back to town.

iv) Q: Harry Aggark: I know the reason why we have low populations in August is because they are south in Manitoba. We see them in the fall time when the ice starts to freeze. Also we have both the WHB and FB populations here so that is why we see more bears.

v) Q: Harry: so you stated that Ontario has done their studies but you don't know what those numbers are yet?
A: Markus: Yes I haven't seen that data yet.

vi) Q: Harry: It might be best to do WHB and FB surveys at the same time, as they move around at the same time.
A: Markus: Yes it makes sense. The issue is I have been the only biologist for the GN right now, and there at times competing resources and priorities.

vii) Q: Jerome Misheralak: It might be more effective if you have a team working from the south and another working from the north conducting the surveys.
A: Markus: explained how the work was done in WH and why.

viii) Q: Harry Aggark: Are you collaring bears still?
A: Markus: We haven't collared in 6 years.
Rob: people have expressed that they don't want bears collared anymore.
Markus: There is ECCC and Universities that are still collaring and tagging bears.
Harry: We know that there was a bear collared near Manitoba and then saw a bear at Ungava Bay that had a collar.
Harry: I don't support collaring as it causes a lot of damage to the bears neck.
Rob: We have pulled back on collaring on bears because of that reason.
Harry: We are not really concerned about where they move but rather if there numbers are increasing or decreasing.

ix) Q: Rob: Do you guys tell Peter whenever you see a bear even if it isn't problematic.
A: Jennifer: yes, he is always notified.

x) Q: Leonie: Why did you not survey between Rankin and Chester?
A: Markus: It's considered a different population (Foxe Basin).

xi) Q: Jennifer: Why are you not surveying bears north of the boundary line?

A: Rob – we know that bears move beyond each management zone. Different population/management zones are created through tracking and previous surveys that the bears occupy.
A: Leonie: I understand what you are saying but I know that bears are moving between zones.
Markus: I totally believe that bears are moving between areas.
Leonie/Jennifer: We don't understand why Foxe Basin/WHB aren't surveyed together?
Rob: With these surveys it's about time and money. Markus is the only biologist currently and we don't have time and money to do every management zone or population on a consistent schedule . Markus has to request funds from other interested partners which takes time. We also want to survey areas every so many years which makes sense. We don't want to survey an area every 15 years or every year; by doing that it wouldn't be productive to gather consistent data.

xii) Q: Jerome Misheralak: Do you survey the area into Baker Lake for bears, I know a bear was there last year? We know when we go to that area to hunt caribou that we see bears.
A: Rob: We know that Baker Lake isn't a natural habitat for bears so we don't include that area for bear surveys. Baker Lake has had two occurrences where polar bears were sighted and killed as a result of defence kills. One of these was last summer just east of Baker Lake in Cross Bay.
Markus: That might be important information for us to know if there are more bears going inland so that we can include this area on our next Foxe Basin survey.
Rob: Do you regularly report your sightings to the CO so that's he can let Markus know.

A: Peter Kattegatsiak: To elaborate for Leonie, the Foxe Basin inclues different communities like Coral Harbour, Repulse Bay, Kimmirut, etc. They are different subpopulations. And Markus cannot survey everywhere at once.

xiii) Q: Harry – would it possible to conduct surveys once in August and then again in September or October?
A: Markus: We have talked to other communities about this as well. I think what we could do is look at a coastal survey and get information from the communities as to when a good time to do survey. We could potentially do a survey in

September/October. Manitoba does coastal surveys in the spring and fall and I think that this would be a good idea for Nunavut. Coastal surveys would be good to tell us what bears are near the communities but we may miss females in dens or already on the ice.

xiv) Q: Jerome Misheralak: I think it's a good idea to do surveys in WHB and then FB at the same time.
A: Markus: We need a lot of money and manpower to do that. We don't want to confuse the populations. But if we just wanted to look at how many bears are near the communities, then that might be possible.

Bert Dean: NWMB is going to have a public hearing on the Management Plan in the fall, I think it's very important that these issues be brought up at those hearings. Even working in Parks Canada as they manage Wager Bay and could help with surveys.

xv) Q: Harry Aggark: My question is about the survival of the COYs.
A: It's something that we have observed on our surveys. We are noticing that cubs aren't surviving and maybe males are eating cubs.

Bert Dean: They are still handling bears in Wapusk and has anyone asked whether they are still drugging cubs?

A: Markus: I would have to look further into that, but the ECCC capture programme has been relatively small in recent years in Manitoba.

xvi) Q: Leonie – when is that Polar Bear Mgmt Plan meeting?
A: Bert – they haven't decided yet but as soon as NWMB does know, they will let the HTOs know.

xvii) Q: Leonie: When the public hearing happens is there the possibility to have an elder, youth and middle age?
A: Bert: The reason why the public hearings were delayed is that NWMB would only fund 6 representatives in each region. Baffin has 13 seats and they were upset that all communities weren't invited so Baffin boycotted and Kivalliq supported them.

End of meeting: 19:20

Notes taken by C. Wray

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information:** **Decision: X**

**Issue:** Management Plan for Peary Caribou in Nunavut

**Background:**

Peary caribou are currently listed as an endangered species under the Species at Risk Act. Regulations under the Wildlife Act are currently outstanding and there is no management regime in place for Peary caribou in Nunavut.

The draft Management Plan for Peary Caribou in Nunavut (the plan, separate attachment) will serve as the basis for recommendations on new management units, Total Allowable Harvest (TAH), and future research and monitoring efforts.

Previous attempts to determine appropriate management units and TAH for Peary caribou were unsuccessful. This effort is less prescriptive in terms of the size and number of proposed management units and the ability of Hunters and Trappers Organizations (HTOs) to have more involvement and say in the monitoring and management of Peary caribou. In addition to recommending management units and TAH levels the plan identifies a collaborative approach to long term monitoring. The Plan uses the information presented in the Department of Environment (DoE) report "*Recent trends and abundance of Peary Caribou and Muskoxen in the Canadian Arctic Archipelago, Nunavut*," (Jenkins et al., 2011) as a baseline to monitor future trends. Through community-based ground surveys that are conducted annually, but on a spatially cyclic basis, changes in herd status can be monitored. An annual meeting to discuss results and potential management recommendations will be used to target future survey efforts and in the event of observed declines or concerns of herd status, trigger further action which may include increased ground survey frequency or aerial surveys. Recommendations that would change harvest rates or Non-Quota Limitations such as harvest seasons would be sent to the NWMB for decision.

The presentation of this submission should take approximately 45 minutes with a similar time period for questions. It is anticipated that the Board may conduct a Public Hearing at a later date to address this request for decision.

**Current Status:**

- The Peary Caribou Management Plan was submitted to the NWMB for decision in 2014 but the process was delayed until the September, 2017 regular board meeting.

- Several distribution and abundance surveys were conducted since the original submission of the plan but the resulting data did not differ from the data used to develop the plan and associated recommendations; therefore, no updates to the original submitted plan were necessary.

**Consultations:**

All communities that harvest Peary caribou were consulted on an initial draft prepared by DoE. This includes Grise Fiord, Resolute and Arctic Bay who routinely harvest, as well as occasional harvesters in the Kitikmeot, including Cambridge Bay, Gjoa Haven, Taloyoak and Kugaaruk. Consultations consisted of in-person meetings with each Hunter and Trappers Organization Board (HTO). This was followed by revisions to the draft based on input received from the HTOs.

A full list of meetings and participants is provided in Appendix 1, the consultation summary. The PowerPoint presentation used in consultations is provided in text format in Appendix 2.

In general the discussion with HTOs focused on four key areas; 1) do the proposed boundaries make sense, 2) is there support for harvest reporting and sample submission, 3) is there support to participate in community ground-based surveys, and 4) are they a species of opportunity or a targeted species and do they occur the same now as in the past?

The information obtained through these discussions was then used to revise the draft. In particular the boundaries in the Kitikmeot region were based entirely on community input.

In addition to the consultation for the plan previous workshops were held in Grise Fiord and Resolute in the fall of 2010 to share research results from the aerial surveys done to estimate Peary Caribou and  Muskoxen population and distribution from 2001-2008. These workshops were very well received and generated significant discussion about management implications and Inuit knowledge about Peary caribou.

The final draft has been sent to the community HTOs for final review however only a few communities have provided comment on the final draft. Resolute did not want to proceed with a plan until results of the 2013 Bathurst Island survey were included; preliminary results have been incorporated into the plan.

The study designs and results of the post-2014 Peary Caribou population assessments were shared with the HTOs of Grise Fiord and Resolute Bay in 2015 and 2016 and were well received.

Overall the communities have expressed support for the Management Plan and its recommendations, in particular because of the ongoing collaborative process it outlines for the management of Peary caribou. There is no consensus on proposed TAH, with Grise Fiord indicating they will oppose any TAH recommendation.

**Recommendations:**

DOE is requesting approval from NWMB on the following:

- Approve the Draft Management Plan for Peary Caribou in Nunavut 2014-2020.
- Determine TAH for Peary caribou based on the management units and recommendations proposed in the plan.

**Appendix 1**
**Peary Caribou Management Plan**
**Qikiqtaalik Region Consultation Summary**
**March 13-20, 2012**

This round of consultations took place in March 2012 in the Qikiqtaaluk communities of Arctic Bay, Resolute, and Grise Fiord. The purpose of the consultations was to determine support for the draft management plan in general terms (as well as for a draft management plan for Peary caribou) and to obtain specific local knowledge to facilitate redrafting to include HTO input and concerns. These specifics include potential management unit boundaries, traditional and current use, and information on historic and current trends.

The sessions varied in length based on how prevalent Peary Caribou were locally and by the number of Board members that could attend. The meetings were all positive with all HTOs expressing interest in participating in development of the management plan as well as an interest in ensuring long term sustainability of Peary Caribou.

**Arctic Bay HTO**
March 13, 2012
GN - Chris Hotson, Peter Hale
HTO Board: Qaumayuq Oyukuluk, Adrian Arnauyumayuq, Josia Akpaliapik, Koonark Enoogoo, Paul Ejangiaq, Jack Willie Sec/Manager
Chris introduced the topic and gave a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.

Specific discussion took place around the following issues:

1) Do the proposed boundaries make sense?
   - Island groups make sense
   - general support from the board for boundaries
   - Discussion looked at needs for monitoring capability, so survey scale and harvest/use

2) Are Peary caribou a preferred species to harvest or a species that is taken by opportunity?
   - They are taken opportunistically and Arctic Bay hunters occasionally harvest
   - Peary Caribou are not a big issue but HTO wants to support Grise and Resolute communities

3) Are harvest levels same now as in the past?
   - It has always been only sporadic harvest, definitely not every year

4) Is there support for harvest reporting and sample submission?
    - Yes, may require some fee for sample

5) Is there interest in participating in community ground-based surveys?
    - Yes (this would allow for combined surveys with muskox) and potentially generate knowledge for other species
    -

Other issues suggested by HTO;
- Why called Peary caribou, should reflect Inuit language

**Resolute HTO**
March 17, 2012,
GN-Chris Hotson, Peter Hale
NTI-Glenn Williams
HTO Board: Philip Manik Sr., Paddy Aqiatusuk, Allie Salluviniq, Norman Idlout, David Kalluk, Simon Idlout, Nancy Amarualik Sec/Manager
Chris introduced the topic and gave a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.

Specific discussion took place around the following issues:

1) Do the proposed boundaries make sense?
    - Island groups make sense
    - general support from the board for boundaries but maybe more so for muskox than caribou
    - they do travel between islands, more so than muskox, something to consider.

2) Are caribou a preferred species to harvest or a species that is taken by opportunity?
    - Opportunistically now
    - Would like to be able to harvest more, particularly Cornwallis Island

3) Are harvest levels same now as in the past?
    - In 1970s only 3 muskox now there are too many on Prince of Wales and Somerset Island
    - Report data from 2001-2003 is misleading, want a new count
    - Proposed TAH at 3% harvest rate is too low
    -

4) Is there support for harvest reporting and sample submission?
    - Yes
    - Glenn raised a point that harvest reporting is not an imposition but a responsibility under the land claim

5) Is there interest in participating in community ground-based surveys?
    - Yes general support (in conjunction with concurrent muskox surveys)

Other issues suggested by HTO;

- Don't all die off when they drop in number, where do they go, they do move
- Totally opposed to collaring
- Need to identify calving areas
- Dust and noise from oil and seismic work negatively effects caribou

**Grise Fiord HTO**
March 21, 2012
GN-Chris Hotson, Peter Hale
NTI-Glenn Williams
HTO Board: Jaypetee Akeeagok, Aksajuk Ningiuk, Charlie Noah, Larry Audlaluk, Jopee kiguktak, Mark Akeeagok Sec/Manager
Chris introduced the topic and gave a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content.

This was followed by discussion and feedback.

1) Do the proposed boundaries make sense?
    - Island groups make sense

2) Are Peary Caribou a preferred species to harvest or a species that is taken by opportunity?
    - They are a targeted species but hard to reach sometimes.

3) Is there support for harvest reporting and sample submission?
    - No intention of creating HTO bylaws to gather harvest numbers
    - Glenn raised a point that sample submission and harvest reporting is not an imposition but a responsibility under the land claim

4) Is there interest in participating in community ground-based surveys?
    - Yes but the use of personal skidoos is a concern as it is difficult to purchase and repair them

Other issues suggested by HTO:

- Muskox and caribou don't mix
- Not alarmed about current decline, they cycle
- Pressure to have a document (plan) but don't want a flawed document
- Communities do not trust the science saying Peary Caribou are declining; have never existed in great numbers
- Would not support a TAH.

**Peary Caribou Management Plan**
**Kitikmeot Region Consultation Summary**
**March 18-23, 2013**

This round of consultations follows meetings that took place in February-March 2012 in the Qikiqtaaluk communities of Arctic Bay, Resolute, and Grise Fiord. The purpose of the consultations was to determine support for the draft management plan in general terms (as it is currently written for the Qikiqtaaluk region) and to obtain specific local knowledge to facilitate redrafting to include specifics for the Kitikmeot Region. These specifics include potential management unit boundaries, traditional and current use, and information on historic and current trends.

The sessions varied in length based on how prevalent Peary caribou (PC) were locally and by the number of Board members that could attend. The meetings were all positive with all HTO's expressing interest in participating in development of the management plan as well as an interest in ensuring long term sustainability of PC.

**Cambridge Bay HTO**
March 18, 2013, 16:00
Bobby Greenley, George Angohiatok, Johnny Lyall, Brenda Sitatak (Sec/Manager)
Chris Hotson, Mathieu Dumond

Mathieu introduced the topic and explained the difference between the recent Environment Canada consultations for Recovery Strategy development under SARA and the draft Nunavut Management Plan.

Chris went through a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.

Specific discussion took place around the following issues;

6) Is PC normally in the Cambridge Bay traditional harvesting area?
    - Yes but only at the northern edge around Hadley Bay
    - Have seen PC mix with Dolphin Union (DU) caribou in small groups and sometimes they move south for a bit with DU

7) Are PC a preferred species to harvest or a species that is taken by opportunity?
    - In 60's and 70's there were no DU caribou around so harvesters travelled north to harvest PC but not now as DU are preferred
    - Would choose to harvest DU caribou over PC when they are mixed together

8) Are harvest levels same now as in the past?

- Lower now; In the 60’s and 70’s there were no DU caribou so harvesters travelled north to harvest PC
- Now they are only taken opportunistically, usually by polar bear hunters that are travelling north to Hadley Bay area
- Harvest levels are now low, a couple of PC every year at best, sometimes none in a year

9) What are potential boundaries for management units?
   - Discussion looked at needs for monitoring capability, so survey scale and harvest/use
   - Based on discussion HTO sees utility in maintaining the Nunavut portion of Victoria Island as one management unit, also potentially Melville Island as another although no harvest occurs there

10) Is there support for harvest reporting and sample submission?
   - Yes, may require some fee for sample but it would help know harvest and perhaps provide help with genetics, other samples were discussed but it was advised that this would be an issue for stakeholder working group to determine

11) Is there interest in participating in community ground-based surveys?
   - Yes as this would allow for combined surveys for Muskox and potentially generate knowledge for other species, such as predators which are a concern

**Taloyoak HTO**
March 19, 2013, 19:00
Joe, David Irqiut, Lucassie Nakoolak, Sam Tulurialik, Abel Aqqaq, Anaoyok, Simon Qingnaqtuq (sec/manager)
Chris Hotson, Mathieu Dumond

Mathieu introduced the topic and explained the difference between the recent Environment Canada consultations for Recovery Strategy development under SARA and the draft Nunavut Management Plan.

Chris went through a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.

Specific discussion took place around the following issues;
1) Are PC normally in the Taloyoak traditional harvesting area?
   - Yes but only north of Taloyoak although local knowledge says they sometimes come further down the Boothia peninsula
   - Also Taloyoak harvesters do travel north to Prince of Wales/Somerset Islands for whale harvest and may take PC there

2) Are PC a preferred species to harvest or a species that is taken by opportunity?
    - In 60's and 70's PC were more common and more were taken
    - PC taste better and have more fat year round so would be preferred if they were more available

3) Are harvest levels same now as in past?
    - In 60's and 70's PC were more common and more were taken
    - There was a period in 80's- 90's when they were not seen but are starting to see again
    - A hunter would be lucky to harvest one every 5-10 years now

4) What potential boundaries for management units?
    - See the entire Boothia Peninsula a potential management unit
    - PC move north and south over the year and over time

5) Is there support for harvest reporting and sample submission?
    - Yes was the general consensus

6) Interest in participating in community ground-based surveys?
    - Yes was the general consensus

Other issues discussed;
- HTO would like to see protection or wildlife conservation areas for the whole of Boothia Peninsula as this is an important area for many species
- HTO is trying to participate in the NLUP process but struggling and needs assistance
- Board members encourage that IQ be used in helping to devise scientific surveys and studies
- PC and Muskox do not mix, increase in Muskox may explain why PC are down
- Need to study wolves/predators in conjunction with PC as they are linked
- May be good to survey wolves as well as PC/Muskox on ground surveys

**Gjoa Haven HTO**
March 20, 2013, 19:00
James Qitsualik, Simon Komangat, David Qiqut, Jacob, Joannie ,and Mark, Ben Kogvik (interpretor)
Chris Hotson, Mathieu Dumond

Mathieu introduced the topic and explained the difference between the recent Environment Canada consultations for Recovery Strategy development under SARA and the draft Nunavut Management Plan.

Chris went through a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.
Specific discussion took place around the following issues;

1) Are PC normally in the Gjoa Haven traditional harvesting area?
   - Yes, the Northwest part of King William Island is the main location for PC.
   - Have not seen many this year but did see some 2-3 years ago
   - Normally hunters go north for whales and may see PC
   - Targeted caribou harvest is to the south, so mainly barren ground are taken

2) Are PC a preferred species to harvest or a species that is taken by opportunity?
   - Would choose to harvest PC as they are fat year round but will harvest any caribou if given the chance

3) Are harvest levels same now as in past?
   - There was a low in the 60's and 70's but coming back now, they decline but also move over time
   - Harvest rates are very low 0-2 a year

4) What potential boundaries for management units?
   - King William Island and Boothia Peninsula to be one management unit, include islands to the northwest between King William and Victoria Islands
   - The rational for KWI and Boothia as a unit is that there is a movement corridor from the southwest of Boothia to the Northeast of KWI (Note: This could be of importance for maritime traffic impact assessment in particular).

5) Is there support for harvest reporting and sample submission?
   - Yes was the general consensus but need a CO in community
   - Payment for samples may be required

6) Interest in participating in community ground-based surveys?
   - Yes was the general consensus, perhaps include other species in surveys in addition to PC/MX

Other issues discussed: DU and PC may mix both spatially and in terms of breeding

- Use least invasive methods to survey
- They do not want to be excluded from future management process/actions
- Wolves, there are too many, can ground-based survey include that?
- PC and Muskox do not mix, must be taken into consideration

**Kugaaruk HTO**
March 21, 2013, 19:00
Barnaby Immingark, Zachary Oogark, Ema Qaggutaq (sec/manager)
Chris Hotson, Mathieu Dumond, Lee McPhail (CO)

Mathieu introduced the topic and explained the difference between the recent Environment Canada consultations for Recovery Strategy development under SARA and the draft Nunavut Management Plan.

Chris went through a short PowerPoint presentation (attached) that introduces the management plan, the history of the initiative, the purpose of the plan, and an overview of content. This was followed by discussion and feedback.

Specific discussion took place around the following issues;

1) Are PC normally in the Kugaaruk traditional harvesting area?
   - Yes but only on northern Boothia Peninsula, at the periphery of current harvest area

2) Are PC a preferred species to harvest or a species that is taken by opportunity?
   - Opportunity based harvest, very infrequent
   - PC is preferred due to taste and fat year round

3) Are harvest levels same now as in past?
   - Harvest very rare; no participating board members had ever seen a PC

4) What potential boundaries for management units?
   - Boothia Peninsula, including Simpson peninsula and Lady Peary Island which has had PC historically

5) Interest in supporting harvest monitoring?
   - Yes was the general consensus

6) Interest in participating in community ground-based surveys?
   - Yes was the general consensus

Other issues discussed: Predation and weather are important to PC and should also be considered.

## Appendix 2
## Community PowerPoint Presentation

The follow section is a text version of the PowerPoint used in the Kitikmeot consultations. The Qikiqtaalik version was the same only using references to the proposed management units specific to that region.

**Draft Peary Caribou Management Plan**

GN Department of Environment
Mathieu Dumond
Chris Hotson

**Outline**

- History of initiative
- Purpose of the plan
- Process
- Overview of content
- Discussion and feedback

**History of the Management Plan**

- Peary caribou are an outstanding issue for regulations
- Would like to have a Nunavut management plan in place prior to the Species at Risk Act recovery process
- The early draft was 10 years old and did not reflect current status
- Process was waiting for the survey report, report is now complete

**Purpose of the Plan**

- Establish goals for taking care of PC
- Identify the importance of working together;
- Provide current population estimates and trends;
- Define roles and responsibilities of the stakeholders;
- Define the information required to effectively manage;

**Purpose continued**

- Describe how to make decisions;
- Provide a framework for determining when management actions should be taken; and
- Ensure full involvement of Inuit in the future monitoring and management of Peary Caribou
- To provide NWMB with a management plan that is ready for implementation.

**Process**

- Consult on the initial draft with communities
- Edit draft to reflect community input and concerns
- Share revised draft with stakeholders for further clarification
- Seek support on final draft
- Submit final draft to NWMB for approval and to form basis for new regulations under the wildlife act

**Overview**

- Summary
- Purpose of the plan
- How it will be developed
- Goals of the plan
- Peary Caribou biology and management

**Review continued**

- The users
- Status
- Monitoring
- Decision making
- How to communicate
- How to update plan
- Appendices

Discussion and Feedback

- Run through each section

**Organization of survey area into Island Groups;**

- 1) Bathurst Island Group
- 2) Devon Island Group
- 3) Prince of Wales/Somerset Island Group
- 4) Ellesmere Island Group
- 5) Axel Heiberg Island Group
- 6) Ringnes Island Group

**Kitikmeot management units?**

**General Recommendations**

- Recommend establishing management units based on six (?) Island groups
- Establish an ongoing community-based ground survey program with appropriate support
- Establish a harvest reporting and sample collection program
- Each harvest should be reported through the submission of hunter kill reports
- Use observed changes from community monitoring program (observations of die offs, population increase or decrease) to trigger:
    1) Potential aerial surveys for severe declines,
    2) Increased frequency and coverage of community ground survey if declines are less significant,
    3) Community based changes in harvest level that would occur within a predetermined upper and lower limit.

# Management Plan for Peary Caribou in Nunavut

## 2014 – 2020

Prepared in collaboration with

The Hunter and Trappers Organizations of Grise Fiord, Resolute Bay, Arctic Bay, Cambridge Bay, Gjoa Haven, Taloyoak, Kugaaruk, GN Department of Environment, Nunavut Tunngavik Inc., and the Nunavut Wildlife Management Board

Third Draft, January 2014

Note:

This draft is based upon the format and language used in the document "*Taking Care of Caribou -The Cape Bathurst, Bluenose West, and Bluenose East Barren Ground Caribou Herds Management Plan"* developed by the stakeholders and Terriplan Consultants and submitted to the Advisory Committee for the Cooperation on Wildlife Management. The majority of technical information is derived from the GN DoE report "*Recent trends and abundance of Peary Caribou (Rangifer tarandus pearyi) and Muskoxen (Ovibos moschatus) in the Canadian Arctic Archipelago, Nunavut"*. The information contained herein is an amalgamation of both documents and the work in both those documents represents the talent, skill and considerable efforts of those involved respectively.

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## 1.0 Summary

Peary caribou (*Rangifer tarandus pearyi*) are a distinct caribou subspecies that occurs almost entirely on islands within the Canadian Arctic Archipelago. These ungulates live the farthest north of all caribou in North America, and are the smallest in stature and in population size. In February 2011 Peary caribou were listed as Endangered under the *Species at Risk Act* (SARA) due to declines in abundance and expected unpredictable declines due to changes in long-term weather patterns.

Caribou are of major cultural, traditional and economic importance to Inuit, and are also a vital part of the Arctic ecosystem. Nunavummiut are concerned about the status of Peary caribou and their habitat as determined through public workshops in Grise Fiord and Resolute Bay. Peary caribou harvest in Nunavut has not been restricted through legislation; rather the Resolute Bay Hunters and Trappers Association (HTA) and the Iviq HTA of Grise Fiord have imposed temporary harvest restrictions on their members during periods of marked declines. Inuit knowledge however suggests that increasing land-use activity, such as resource exploration, poses a greater potential threat to Peary caribou and their habitat than hunting pressure.

The Department of Environment of the Government of Nunavut (GN DoE) has the ultimate responsibility for the management and conservation of Peary caribou within its jurisdiction. To address the DoE mandate for management this plan recommends management units and harvest levels to establish the basis of new regulations under the *Wildlife Act* as well as recommendations for ongoing monitoring of population trends and harvest through an inclusive approach with all co-management partners. This will include provisions for future monitoring and research, Inuit involvement in research, monitoring and decision making, and consensus based decision making in response to observed changes in population.

## 2.0 PURPOSE OF THE PLAN

The need for a management plan for Peary caribou is born out of several issues including Inuit harvest rights, territorial responsibility for species management, changes in land use needs, population declines, and changing climate. The long term Department of Environment study on Peary caribou "*Recent trends and abundance of Peary Caribou (Rangifer tarandus pearyi) and Muskoxen (Ovibos moschatus) in the Canadian Arctic Archipelago, Nunavut"* has produced the first modern, comprehensive assessment of the current status of Peary Caribou in Nunavut. With the completion of the DOE report, and the success of community workshops held in Grise Fiord and Resolute, the development of management plans is essential. The need for a plan is also connected to the survey results, which for some areas are becoming outdated, although the results remain valid as a baseline.

The Peary Caribou Management Plan provides a snapshot of current population estimates and trends for the species across its range and establishes overall principles and goals for the conservation of Peary caribou in Nunavut. It highlights the critical need for co management partners to work together, defines roles of stakeholders, and provides a framework to guide management of the species throughout its range to accomplish the goals identified in Section 4.0.

The GN DoE report "*Recent trends and abundance of Peary Caribou and Muskoxen in the Canadian Arctic Archipelago, Nunavut*" provides greater technical detail on the specific island groups and their status, both historical and current. The more recent GN report "Distribution and abundance of Peary caribou (*Rangifer tarandus pearyii*) and muskox (*Ovibos moschatus*) on the Bathurst Island Group, May 2013" provides additional information.

## 2.1 CO-MANAGEMENT

This plan was developed through cooperation and dialogue between co management partners in Nunavut including participation by:

Iviq Hunters and Trappers Association (Grise Fjord)
Resolute Bay Hunters and Trappers Association
Ikajutit Hunters and Trappers Organization (Arctic Bay)
Spence Bay Hunters and Trappers Organization (Taloyoak)
Ekaluktutiak Hunters and Trappers Organization (Cambridge Bay)
Kurairojuark Hunters and Trappers Organization (Kugaaruk)
Gjoa Haven Hunters and Trappers Organization
Nunavut Tunngavik Inc., Wildlife Department
Nunavut Department of Environment, Wildlife Management Division

## 3.0 HOW THE PLAN WAS DEVELOPED

The Plan was developed in collaboration with the communities that harvest Peary caribou as well as the other co management partners under the *Nunavut Land Claims Agreement* (NLCA). Two rounds of community workshops were conducted in 2010 and 2011 in Grise Fiord and Resolute Bay in addition to the ongoing exchange of information during the aerial and ground surveys.
The workshops were designed to:

- Share results of GN DoE research
- Gather local expert knowledge
- Seek consensus on management and monitoring actions

The initial draft was developed for further community and stakeholder involvement by GN DoE and consultations were conducted in March 2012 in the Qikiqtaalik Region and

March 2013 in the Kitikmeot Region. The final draft will be submitted to the NWMB for approval and will form the basis for development of Regulations under the *Wildlife Act*.

## 4.0 GOALS OF THE PLAN

The goals of the Management Plan are to provide guidance and direction to the co-management partners and are as follows:

- To manage Peary caribou in a co-operative manner that involves the full participation of communities and engagement of co management partners.
- To include Inuit Qaujimajatuqangit and scientific knowledge equally in the management process.
- To promote local and regional involvement in decision making.
- To protect, conserve and manage Peary caribou in a sustainable manner.
- To ensure the full and effective participation of Inuit and co management partners in ongoing monitoring and management of Peary caribou, and decision making.

## 4.1 INUIT QAUJIMAJATUQANGIT

Inuit Qaujimajatuqangit (IQ) is the knowledge and insight gained by Inuit through generations of living in close contact with nature. For Inuit, IQ is an inseparable part of their culture and includes rules and views that affect modern resource use.

The practical application of IQ with scientific information demonstrates the value of local consultations, and documenting and preserving IQ before it is lost. The communities, through the HTOs, will be consulted on an on-going basis to ensure that IQ is utilized in conjunction with scientific information in the management of Peary caribou.

This plan supports those values and reflects the following principles:

- Management decisions will reflect the wise and sustainable use of Peary caribou.
- Adequate habitat (quantity and quality) is fundamental to the welfare of Peary caribou.
- Management decisions will be based on the best available information - both science and IQ; and management actions will not be postponed in the absence of complete information, whether from science or IQ.
- Effective management requires participation, openness and cooperation among all users and agencies responsible for caribou and their habitat.
- We must anticipate and minimize negative impacts to caribou and their habitat.

## 5.0 PEARY CARIBOU BIOLOGY AND MANAGEMENT

**Common name (English):** Peary caribou
**Common name (French)**: Caribou de Peary
**Inuktitut name:** Tuktu

**Innuinaqtun name:** Qinianaq or Tuktuinal (‘small caribou”)
**Scientific Name:** *Rangifer tarandus pearyi*

**Status:** SARA – Endangered
Wild Species 2010 – At Risk

### 5.1 PEARY CARIBOU RANGE

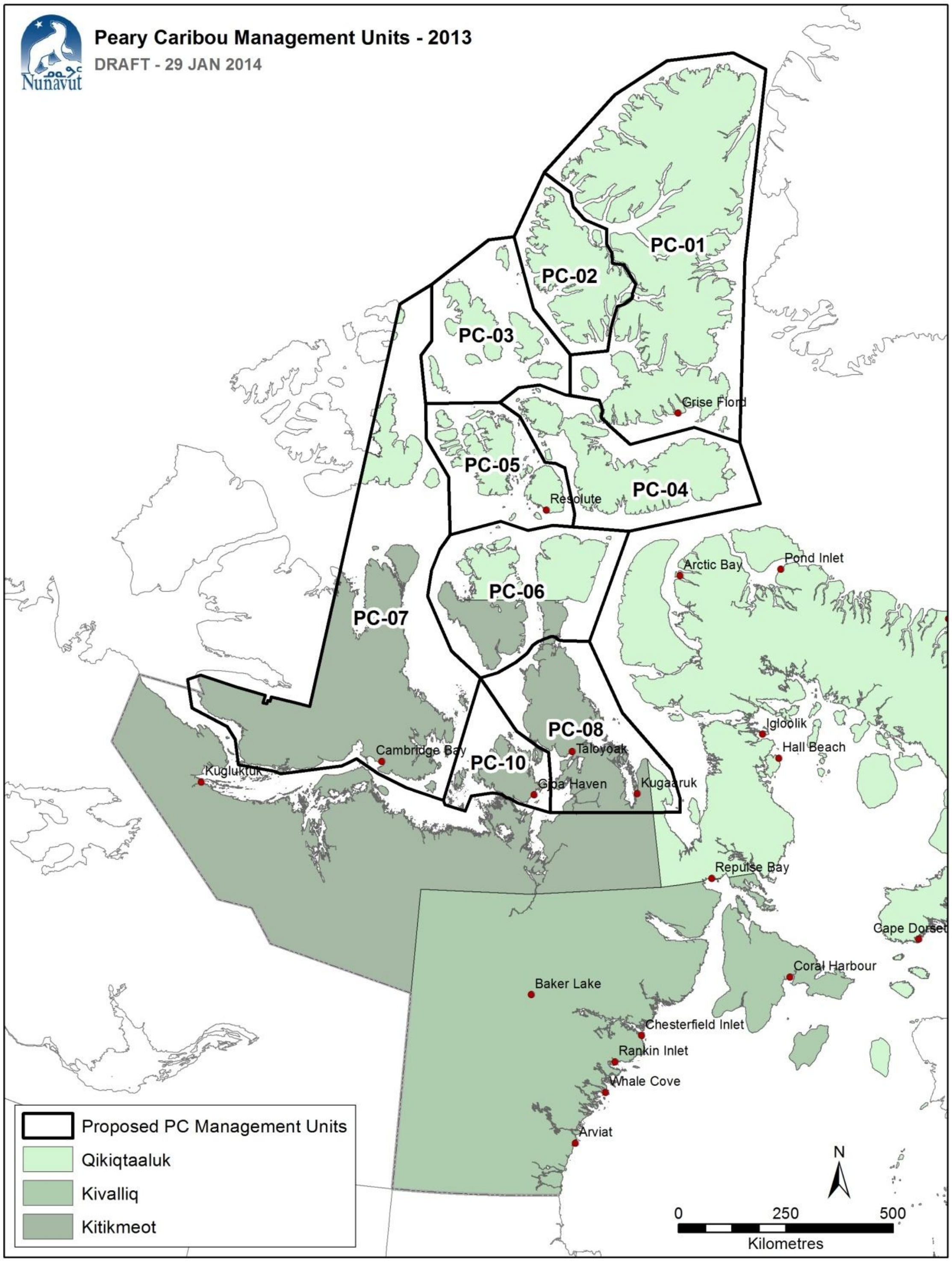
Endemic to Canada, the terrestrial range of Peary caribou is roughly 540,000 $km^2$ and extends across the Queen Elizabeth Islands in the north, the mid-Arctic islands and from the west of Banks Island to Somerset and the Boothia Peninsula in the southeast (Figure 1). Ice surrounds the islands for most of the year and caribou on some islands use the sea ice during seasonal migrations. The range is vast and the area is characterized by extreme weather, long periods of either continual darkness or continual light, and large expanses of ice, bare ground, and rock. The landscape is characterized by a polar desert and polar semi-desert where environmental conditions approach the physiological tolerance limits of plants.

### 5.2 MANAGEMENT OF PEARY CARIBOU BY ISLAND GROUPS

The GN DoE report “*Recent trends and abundance of Peary Caribou and Muskoxen in the Canadian Arctic Archipelago, Nunavut,”* is the most reliable study of Peary caribou in Nunavut to date on which to base this management plan. This report provides the baseline for scientific knowledge of Peary caribou, as well as providing the estimates of numbers of Peary Caribou and specific habitat for management purposes.

As outlined in the report, Peary caribou make seasonal movements among islands within their range, and are also known to make longer distance movements in response to severe weather. The following proposed island grouping (Figure 1) applies the best available scientific information and Inuit knowledge about Peary caribou movement and proposes geographic units that are useful for management of the species. This plan refers to each management group by the ‘Island Group’ name. For the purpose of the management plan, it is important to note that the island group management units are not to be considered as discrete populations or sub-populations as adequate genetic information is not available to define populations at this time.
The Queen Elizabeth Islands (QEI) form the majority of the island groups, with the Bathurst Island group, the Axel Heiburg Island group, the Ringnes Island Group, the Ellesmere Island Group and the Devon Island Group being wholly within the QEI.

**Figure 1. Proposed Peary Caribou Management Units**




Melville Island for the purposes of this management plan is placed within the Victoria Island group.

**5.2.1 Ellesmere Island Group (PC-01)**. Ellesmere Island is the largest of the Queen Elizabeth Islands (197,577 km$^2$). The island is largely covered by mountain ranges and glaciers that are separated by a series of east-west passes. These features fragment the island, particularly where the north end of Vendom Fiord approaches the Prince of Wales Ice Cap, and divides the southern portion of the island from the north. Vegetation is sparse with mosses, lichens, and cold-hardy vascular plants such as sedges and cottongrass dominant at higher elevations while mosses and low-growing herbs and shrubs, such as purple saxifrage, *Dryas spp.,* arctic willow, kobresia, sedge, and arctic poppy more common at lower elevations.

**5.2.2 Axel Heiberg Group (PC-02).** Axel Heiberg Island (42,319 km$^2$) is separated from Ellesmere Island by Nansen and Eureka Sound. This island is mountainous and includes the Princess Margaret Range, which runs north to south through its center. Large ice caps cover much of the landmass and spawn many glaciers that flow primarily to the west. East of the Princess Margaret Range, vegetation progresses from an herb-shrub transition zone at higher elevations to an enriched low shrub zone along the low-lying coast. There, plant species are diverse and dense, dominated by shrubs and sedge meadows.

**5.2.3 Ringnes Island Group (PC-03)**. This island group consists of Ellef Ringnes, Amund Ringnes, Lougheed, King Christian, Cornwall, and Meighen Islands, all situated to the west of Axel Heiberg Island and north of the Bathurst Island Complex. Lougheed Island (1,321 km$^{2)}$ has vegetation described as entirely herbaceous with rich vegetation patches. Ellef Ringnes Island (11,428 km$^2$) is sparsely vegetated with low plant diversity.

Amund Ringnes Island (5,299 km$^2$) is relatively low lying but features greater relief in the north. Vegetation is entirely herbaceous with the southern half of the island supporting more diverse vegetation, primarily herbaceous plants with some shrubs and sedges. To the south of Amund Ringnes is Cornwall Island, a small hilly landmass also dominated by herbaceous vegetation. Meighen Island (approximately 933 km$^2$), to the northeast of Amund Ringnes, is low-lying with sparse herbaceous vegetation and a large centrally located glacier. King Christian Island is located southwest of Ellef Ringnes, has an area of 647 km$^2$.

**5.2.4 Devon Island Group (PC-04).** Devon Island (55,534 km$^2$; including small proximal islands) is characterized by several mountain ranges (e.g. Cunningham Mountains, Treuter Mountains, and the Douro Range), coastal lowlands, and extensive glaciers. The Devon Ice Cap covers a large portion of eastern Devon Island. Extensive uplands stretch west of the Ice Cap across central Devon Island. Low-lying areas occur in coastal areas, primarily along the north and western coast (the Truelove lowlands), but also other smaller areas. The landscape is predominantly polar desert with sparse cover of vascular plants; however low lying areas support a greater diversity of vegetation dominated by low shrubs and sedges.

**5.2.5 The Bathurst Island Group (PC-05).** This group of islands includes the Bathurst Island Complex (BIC), and Cornwallis and Little Cornwallis Islands. The BIC (19,644 $km^2$) includes Bathurst Island and five major satellite islands (> 200 $km^2$; Cameron, Vanier, Alexander, Massey, and Helena), and three minor satellite islands. These islands are low-lying with few areas exceeding 300 m elevation. The terrain is sparsely vegetated however low-lying wetlands such as at Goodsir-Bracebridge Inlet have a higher cover of sedges and low-growing willows. Cornwallis and Little Cornwallis Islands (7,474 $km^2$ including small proximal islands) are low-lying with uplands and hills below 300 m and mostly polar desert with sparse vegetation. Portions of the western coastline and Eleanor Lake watershed (Cornwallis Island) support more diverse vegetation, including prostrate shrubs in moderately moist habitats, and sedges in the wet areas.

**5.2.6 Prince of Wales/Somerset Island Group (PC-06)**. Prince of Wales (33,274 $km^2$) is a tundra-covered island that features many small inland lakes. Although the island is generally below 300 m in elevation, some uplands occur along the eastern coast and across the north. Russell Island and Prescott Island are small proximal islands north and east of Prince of Wales, respectively. Somerset Island (24,548 $km^2$), separated from Prince of Wales Island by Peel Sound, is hilly with extensive uplands.

**5.2.7 Victoria Island Group (PC-07)**. This group includes Victoria Island (217,291 $km^2$) and Melville Island (42,149 $km^2$). Both of these islands have a shared border with the Northwest Territories. The eastern two thirds of Victoria Island lie in Nunavut along with roughly the eastern half of Melville Island. The majority of Victoria Island lies within the Victoria Lowlands is characterized by a discontinuous upland vegetative cover dominated by purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp.*, and moss. Remaining upland areas are largely devoid of vegetation. Besides the presence of Mount Pelly and Little Pelly, elevations lie predominantly below 100 m asl. except in central Victoria Island where elevations rise up to over 200 m asl.

A small portion of Victoria Island, along the northwest boundary with NWT, is composed of the Shaler Mountains. The Shaler Mountains are characterized by a 40-60% vegetative cover mixed with exposed bedrock. Tundra vegetation includes purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp*., and moss. The centre part of the mountains reaches about 760 m asl.

Melville Island is predominately within the Parry Plateau. It has a sparse and discontinuous vegetative cover of moss, along with mixed low-growing herbs and shrubs such as purple saxifrage, *Dryas spp.,* arctic willow, kobresia, sedge, and arctic poppy. The terrain of this plateau is strongly ridged. Their elevations average less than 250 m asl. Separate, flat-floored, longitudinal valleys are transected by rugged, ravine-like cross valleys. On Melville Island, a few hills reach 760 m asl, and cliff-walled fjord-like bays and straits cut deeply into the uplifted plateau.

**5.2.8 Boothia Peninsula (PC-08)**. Boothia Peninsula (32,331km$^2$) is predominately covered by the Boothia Plateau uplands. Vegetation is discontinuous, and dominated by tundra species such as purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp*., and moss. It averages around 760 m asl. Bedrock outcroppings are common.

The eastern side of the Boothia Peninsula along the lowland coastal fringes of Boothia and Simpson peninsulas is composed of plains. It is characterized by discontinuous upland tundra vegetation, dominated by purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp.*, and moss. The region slopes gently southward, ranging from sea level to about 300 m asl.

The south-western coastal portion of the Boothia Peninsula lies within the Victoria Lowlands which is characterized by a discontinuous upland vegetative cover dominated by purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp*., and moss. Elevations lie predominantly below 100 m asl.

**5.2.9 King William Island Group (PC-10)**. King William Island (13,111 km$^2$) is separated from the Boothia Peninsula by the James Ross Strait to the northeast, Rae Strait to the east, Victoria Strait to the west, and Simpson Strait to the south. Satellite islands include the Irving Islands, the Todd Islets, Matty Island, the Tennent Islands, and the Clarence Islands.

This group is in the Victoria Lowlands region which is characterized by a discontinuous upland vegetative cover dominated by purple saxifrage, other saxifrage *spp., Dryas spp.,* arctic willow, alpine foxtail, and wood rush. Wet areas have a continuous cover of sedge, cottongrass, saxifrage *spp.*, and moss. Remaining upland areas are largely devoid of vegetation. Elevations lie predominantly below 100 m asl.

## 6.0 THE USERS

Inuit are the traditional and current users of Peary caribou. The communities of Resolute Bay and Grise Ford were established in the early 1950's by the Canadian government as part of an arctic sovereignty program. Inuit that were relocated to these communities relied on the availability of Peary caribou as a food source. This reliance continues today. Arctic Bay is also an occasional user in the Qikiqtaaluk region. In the Kitikmeot region, the communities of Cambridge Bay, Taloyaok, Gjoa Haven, and Kugaaruk are also occasional users of Peary caribou; when Peary caribou are available they are taken opportunistically by harvesters from these communities.

## 7.0 STATUS OF THE ISLAND GROUPS

### 7.1 SURVEY HISTORY

In 1961 the first comprehensive survey of Peary caribou done in a single season across the Queen Elizabeth Islands was completed. During this survey approximately 25,845 Peary caribou were estimated. The majority of caribou (approximately 94%) were located in the western Queen Elizabeth Islands (QEI) (Bathurst Island Complex, Cornwallis, Melville, Prince Patrick, Eglinton, Emerald, Borden, Mackenzie King, and Brock). Survey coverage of some island groups, particularly Ellesmere, was minimal.

The first population estimates for the western Arctic islands included a 1972 estimate of 11,000 Peary caribou on Banks Island, a 1974 estimate of 5,515 Peary caribou on the eastern islands of Prince of Wales and Somerset Islands and 561 Peary caribou on the Boothia Peninsula in 1974, and a 1980 estimate of 4512 Peary caribou on northwestern Victoria Island. Combined with the 1961 QEI estimate, these estimates of abundance reveal a historic number of 48,000 Peary caribou throughout their entire range.

The decline of Peary caribou is characterized by four major die-offs which were observed primarily in the western Queen Elizabeth Islands between 1970 and 1998. Die-off events have been associated with deep snow and icing, which can limit access to forage, increase energy requirements, and lead to extreme under-nutrition and death. Observations by local Inuit are in agreement, reporting up to 2 inches of ice in some years.

Although limited, the data suggests that periods of decline and recovery vary among island groups, and a variety of factors such as human activities, landscape changes, predation, hunting, and competition with other herbivores may also contribute to the fluctuation of caribou. Inuit in Resolute Bay and Grise Fiord have identified exploration activities (i.e. oil and gas, coal and base minerals) as an additional stressor for caribou during some winters. They suggest that during years of high snow accumulation, industrial activities can prevent caribou from moving into areas that may be vital for their survival.

## 7.2 STATUS OF ISLAND GROUPS

### 7.2.1 Ellesmere Island Group

Results from the first aerial survey in 1961 suggested that there were approximately 200 caribou on Ellesmere Island, but only a small portion of the island was studied. The most recent survey (2005 and 2006) for Ellesmere Island revealed extremely low densities of 8-9 caribou/1000 $km^2$ for Peary caribou, which implies approximately 1,000 animals. Unfortunately surveys of Ellesmere Island are infrequent and limited in their spatial coverage making the determination of a trend in number impossible in this group. By 2003, Inuit reported that numbers of caribou on southern Ellesmere were increasing.

### 7.2.2 Axel Heiberg Island Group

The 1961 estimate of about 300 caribou on the island was based on limited survey coverage. No other surveys of the island have occurred since that time until 2007. The last survey results show a higher number of caribou than the only previous description of caribou abundance for Axel Heiberg Island. Lack of data and this 50-year gap in monitoring make it impossible to discuss population status or trends for Peary caribou on Axel Heiberg Island.

The Axel Heiberg Group currently supports the largest population of Peary caribou in Nunavut, with an estimated 2,291 animals based on 2007 survey results. This population accounts for a significant portion of the total estimated Peary caribou population within the Nunavut range. This may be a consequence of the local climate, plant biomass and diversity of vegetation, the varied topography, and isolation from human disturbance.

### 7.2.3 Ringnes Island Group

The 2007 survey of the Ringnes Island Group estimated a total of 654 caribou. Survey results suggest that caribou abundance is lower than the historical value of 1,324 in summer 1961. Overall it is difficult to interpret trends or fluctuation within this Island Group as survey information is limited, typical seasonal movement patterns are unknown, and the only two surveys completed have occurred at different times of year. Nonetheless, the overall proportion of calves (14%) observed in 2007 is encouraging given the extreme northern latitude and the small calf crops recorded for other survey areas.

### 7.2.4 Devon Island Group

The few surveys conducted suggest that Devon Island supports only a low number of Peary caribou. During a full island survey completed in 1961, 150 Peary caribou were estimated. Minimum counts for western Devon Island in 2002 suggested that caribou numbers were low. In 2008, the count remained low with 17 Peary caribou. Thus, it appears that Peary caribou have existed at low numbers in the Devon Island group, although numbers are decreasing from previous estimates or counts which indicate a declining trend.

Movement patterns for caribou on Devon Island are not well understood and it is possible that there were caribou in other areas of the island at the time surveys were conducted. Inuit knowledge indicates that there have been caribou on the northeastern coast of Devon Island, on the Grinnell Peninsula, and that they can reliably be found along the western coast of the island.

#### 7.2.5 Bathurst Island Group

The 2013 survey showed a significant increase in Peary caribou numbers, more than 1200 caribou, over the previous 2001 estimate of 187, however it is still low in relation to historical values of over 3,000 individuals (including calves) in both 1961 and 1994. Although evaluation of trends in abundance is complicated by differences in survey design and the inclusion or exclusion of calves, the overall trend of decline and current recovery is apparent.

This group has seen sharp fluctuations in 1973-74, and again in 1995-1997. The first two surveys of the Bathurst Island Complex (BIC, which consists of Bathurst, Vanier, Cameron Alexander, Massey, and Marc islands) were separated by 12 years (1961-1973) and revealed an 83% reduction in this caribou population from 3,565 to 608 (both estimates including calves). Late winter and summer surveys in 1973 and 1974 respectively identified a further reduction in caribou numbers to 228 (no calves were observed). This additional 62% decline was attributed to deep snow cover and icing, which caused widespread mortality and resulted in little or no reproductive success. Subsequent surveys from 1985 to 1994 indicated an increase and by 1994 Peary caribou were estimated at 3,100 on the BIC. Aerial surveys in 1995, 1996, and 1997 revealed a second die-off with an all-time low estimate of 78 caribou in 1997. Based on carcass counts, it was estimated that 85% of the overall decline was directly related to caribou mortality (and not movement). During the survey in 2001, the number of caribou in this group was estimated at 187.

Since that time Inuit have reported a slow increase in Peary caribou numbers. In 2010, Parks Canada conducted a reconnaissance survey on Bathurst Island and counted 300 Peary caribou in a non-systematic survey with no estimate derived. An aerial survey was conducted of the entire Bathurst Island group in May 2013 which generated a preliminary updated estimate of 1300 caribou which corresponds to Inuit observation of recovery since 2001.

For the Cornwallis Islands the only observation of live caribou in the 2001 survey was on northwest Cornwallis Island. Two caribou were seen on southern Cornwallis Island, and another single caribou on Little Cornwallis Island during the 2013 survey, but occasional tracks and local knowledge also suggest densities remain very low. Previous estimates that include both Cornwallis Island and Little Cornwallis Island are limited to the summer 1961 and 1988, when 43 and 51caribou (with calves) were estimated respectively. Earlier surveys of Little Cornwallis in 1973 and 1974, produced estimates of 8 and 12 caribou, respectively, with no calves observed. By the mid- to late 1960s, Inuit reported that it was difficult to find caribou on this island and that none were observed from 1990 to 2003. These observations are consistent with ground and aerial survey results from 2002.

### 7.2.6 Prince of Wales Island Group

Peary caribou in this Group declined from an estimated 5,682 caribou (one year or older) in 1974 to a minimum count of two in 1996. Current scientific knowledge indicates that there has been little recovery since 1996. During the 2004 aerial survey, no Peary caribou were observed on the Prince of Wales Island Group. These results are consistent with ground surveys of Prince of Wales Island in 2004 and Somerset Island in 2005, in which crews reported only four caribou after traveling a distance of 4,831 km. Local knowledge however, indicates that there has been some return or increase in recent years as they see more caribou on the coast of Prince of Wales Island however there is presently no monitoring in place to help determine if the herd is recovering.

### 7.2.7 Boothia Peninsula Group.

Boothia Peninsula has had aerial surveys from 1961 to 1995. During this time some surveys have counted both Peary and Barren ground caribou together and others have counted them separately so extrapolation of trend is difficult. Regardless, local knowledge indicates that Peary caribou numbers have always been relatively low with some fluctuation over periods of decades. Peary caribou have been seen primarily north of Taloyoak and less frequently north of Kugaaruk and at the north end of the Simpson Peninsula. Peary caribou are known to have used Lady Parry Island.

Hunters in Taloyoak harvest Peary caribou opportunistically with a couple taken every year. Historically more Peary caribou where taken in the 1960’s and 1970’s when they were more abundant. In Kugaaruk, harvest is also opportunistic with only a caribou harvested every few years. There is currently no system in place to report the Peary caribou harvested at these locations and thus monitor harvest rate.

### 7.2.8 Victoria Island Group.

Both Victoria Island and Melville Island have a long history of aerial surveys. Peary caribou have been more consistently observed, and at higher numbers on Melville

Island with a high of over 10,000 adults in 1961 and a low of 700 in 1972. A recent survey of Melville Island conducted by the Government of Northwest Territories (GNWT) has produced a new estimate of 2,990 adults in 2012 which suggests a recovery from the 1972 low. No harvest currently occurs in the Nunavut portion of Melville Island.

Local and scientific knowledge indicates that Victoria Island has consistently supported Peary caribou at low numbers. IQ also indicates that the distribution for Peary caribou in the Nunavut portion is largely in the north-east near Hadley Bay. The known high was 4,500 (including calves) in 1980 with a known low of 20 adults in 1993. The most recent estimate conducted by GNWT was 150 adults in 2010. Peary caribou are harvested by Inuit from Cambridge Bay opportunistically, usually in conjunction with polar bear hunters travelling to Hadley Bay. Harvest is low with only a few Peary caribou every few years although their harvest is not monitored. Caribou harvest is targeted to Dolphin and Union caribou which are typically closer to the community. Local preference even when Peary caribou are mixed with Dolphin-Union caribou is to harvest the latter.

#### 7.2.9 King William Island Group

This group has little scientific data and most recent data indicates that this area lies outside the normal range of Peary caribou. Local knowledge indicates that Peary caribou occasionally move from Boothia Peninsula to the north coast of King William Island. Local knowledge suggests that here may also be mixing with Dolphin and Union caribou that migrate from Victoria Island.

## 8.0 MONITORING

The number of Peary caribou per Island Group shows fluctuation over time, with periods of abundance and periods of scarcity. Caribou are also known to move over time in response to environmental conditions. Monitoring programs collect information about changes in number, distribution, and changes in ecological factors that affect caribou numbers and health. It is important to involve both scientists and community harvesters in monitoring efforts. This plan seeks to ensure that both science and IQ are effectively collected and used for research and decision making.

The effects of individual factors, such as weather or human disturbance, can affect caribou both individually and at the Island Group level. These factors however can work in combination such that the total or cumulative effects may be greater than that which occurs from each factor on its own. These impacts may be either positive or negative.

### 8.1 MAIN CRITERIA FOR ASSESSING ISLAND GROUP STATUS

The main pieces of information on which management actions will be based include:

- Population size

- Recruitment
- Bull-to-cow ratio
- Body condition and health
- Harvest levels
- Number trend by management units

### 8.1.1 ISLAND GROUP STATUS

The main factor to assess island group status, and the key consideration when recommending the sustainable harvest level for any given island group, is the estimated number of animals in the Island Group. The current baseline survey completed by GN DoE was conducted with aerial distance sampling. Although effective and accurate for determining the number of Peary caribou in an Island Group, this method is costly. Aerial surveys will continue as required. However the implementation of a community-based monitoring program involving ground surveys can be conducted in predetermined areas, such as traditional hunting areas or areas where caribou are normally seen but absent, and provide data to help inform decision making in the interim between aerial surveys.

### 8.1.2 RECRUITMENT

Recruitment refers to the number of calves that survive to one-year of age. Calf/cow ratios are used as a measure of recruitment. Herd composition observed during community-based ground surveys and/or aerial surveys will be useful for determining the cow/calf ratio.

These ratios, while informative, are often difficult to interpret as they are influenced by various factors such as changes in cow mortality. Typically, recruitment rates are low before the number of animals begins to decline, whereas high recruitment rates, particularly several years in a row, may indicate an increase in herd size.

### 8.1.3 BULL-TO-COW RATIO

Caribou bulls can mate with many females within the same season. It is important to monitor the bull-to-cow ratio to help determine if there are enough bulls to impregnate cows. Monitoring herd structure can be done during the rut both by aerial surveys and ground based surveys, by scientists or harvesters, who can provide information on the number of bulls observed in relation to the number of cows.

### 8.1.4 BODY CONDITION AND HEALTH

The health and condition of individual caribou can affect productivity and survival of calves and adults. Sample kits are provided to harvesters to measure or collect: pregnancy (presence of fetus), back fat thickness, left kidney with the fat to assess contaminant levels and condition, blood samples to assess disease, body condition score, collection of lower front teeth for age determination, and location, date and sex of the animal harvested. When a sample kit is not provided, harvesters typically have a general overview of the condition of caribou. Body condition information collected by community members, harvesters and scientists provides supporting evidence of health.

### 8.1.5 HARVEST

Long term monitoring of harvest levels is very important for management decisions, and to help determine sustainable harvest rates. However, there is currently no obligation to report harvest of Peary caribou in the communities. Establishing a harvest monitoring program is a priority and fundamental to the overall monitoring of caribou. Harvest reporting is also a means of participation in management by the users at the individual level.

### 8.1.6 ISLAND GROUP TREND AND RATE OF CHANGE

The trend or the rate of increase or decrease is also a key indicator of island group status. Trend can be determined by comparing island group estimates over many years. When a population estimate is not possible, we can look at other data to help determine the trend, such as recruitment, body condition and health, harvest levels, and bull-cow ratio. Beyond the scope of scientific studies, information on the changes in abundance, movement, and distribution of caribou on an Island Group can be provided by Inuit Qaujimajatuqangit.

## 8.2 ADDITIONAL CRITERIA FOR ASSESSING ISLAND GROUP STATUS

In addition to information on caribou such as population size and cow/calf ratios, there is important information about habitat and land use that should be considered. This can include habitat quality and quantity, predation, and human disturbance that may limit caribou access to parts of their range. Co-management partners can support long-term research and monitoring of these factors that will allow provide greater information for decision making and more effective review into land use permitting processes.

### 8.2.1 PREDATORS

Predators affect caribou behaviour and mortality. Predator numbers tend to decline as caribou decline but usually there is a delay of one or two years.If other prey species are available, predator numbers may not decline at all. When caribou numbers begin to decrease, the impact of predation may become proportionately greater. Caribou users have requested increased monitoring of predator populations, measurement of predation and the impact of predation on the populations.

### 8.2.2 ENVIRONMENT AND HABITAT

Better understanding of cumulative effects at the ecosystem level can be obtained through long term research on habitat quality and quantity and impacts of human activities. Co management partners can continue to call for and support such long-term research and monitoring. With improved understanding there is a better opportunity to use regulatory management tools to limit disturbance on caribou.

Community workshops held in Grise Fiord and Resolute indicate that a combination of heavy snow and increased oil exploration and activity (particularly Bent Horn) in the early 1970s created a combined effect that may have impacted caribou more than either would have on their own. Caribou can move in response to changes in local environmental conditions such as increased snow or severe ice events. However at this time the increased activities on the land, including seismic activity, may have disrupted this ability to move. It was this combination of weather and human activity that caused die-offs during this period. This information highlights the importance of improving our understanding of cumulative effects and collection and use of local knowledge.

Some steps to assess habitat conditions for each island group are:

- Develop and monitor key habitat indicators of quality and quantity using remote sensing and ground surveys;
- Monitor trends in climate and weather; and
- Define seasonal and occasional movement patterns.

#### 8.2.3 HUMAN DISTURBANCE

Disturbance of caribou from human activities such as aircraft over-flights and resource development can influence caribou behaviour and energy use, which in turn can affect condition and health. Indirect effects can also include a reduction in quality and quantity of habitat or access to quality habitat. Particularly when caribou numbers are low, human activities have the potential to alter the rate and extent of the decline or length of time it takes the population to recover.

The range of Peary caribou extends over lands that are protected from development and lands where exploration is occurring. Concern about the impacts of non-renewable resource development has increased as changing ice and weather patterns encourage a renewed surge in exploration and potential resource development.

## 9.0 TOOLS FOR DECISION MAKING

### 9.1 HOW CARIBOU POPULATIONS CYCLE OVER TIME

Inuit Qaujimajatuqangit and scientific knowledge agree that caribou populations rise and fall over time. The length of the phases varies, particularly the length of time that a population stays at a low level. Scientific evidence, the journals of missionaries and trading post managers, and IQ all suggest that caribou populations go through cycles 30-60 years long. The causes for these population cycles in caribou are not well understood, but likely result from several factors such as habitat quality and quantity, climate, and disease. In addition to population cycling, caribou can also move over time.

Although Peary caribou have existed at higher levels than today, they have never existed at numbers such as the large barren ground herds found to the south. The climate and topography of their range favours smaller groups dispersed over the landscape. These groups move with weather and food availability and are more susceptible to extreme weather events which can cause large die offs.

### 9.2 WHEN TO TAKE ACTION

Actions to ensure the future of Peary caribou will be determined in part by the number of Peary caribou found in each island group, and whether it is increasing or decreasing. Management decisions will also be influenced by other information from harvesters and research and monitoring programs, such as recruitment, bull-to-cow ratio, body condition and health.

In this management plan there are four levels of island group status and associated management actions. These are colour-coded green, yellow, orange, and red. The island group status provides a trigger for specific management actions.

| | |
|---|---|
| **Green:** | The population level is high |
| **Yellow:** | The population level is increasing |
| **Orange:** | The population level is decreasing |
| **Red:** | The population level is low |

### 9.3 USING MONITORING INFORMATION TO MAKE DECISIONS

Accurate and timely information is necessary for making good management decisions. Because the island groups are shared between communities and regions, it is also important that information is collected and shared by all harvesters and managers.

Island group status (e.g. green, yellow, orange or red) will be determined based on information including:

- Estimate of the overall population size of the island group
- Previous estimates to provide a trend (increasing, decreasing, or stable)
- Additional monitoring indicators such as ground based surveys to supplement the interpretation.

It is important to have up-to-date information so ensuring sufficient frequency of research and monitoring effort is very important. Certain monitoring will take place regardless of whether the island group status is green, yellow, orange or red. However, the frequency and intensity of monitoring will vary in response to island group status.

Long-term monitoring of environmental factors, including range quality and quantity, development activity and trends, and disturbances that influence caribou populations are important in understanding changes in caribou health and abundance.
Some of these indicators of population status can be difficult or expensive to measure. In these cases there may be some information available through long-term research programs or methodical collection of IQ. All of this information will be considered by the co management partners.

Working with all stakeholders an ongoing community based ground survey program will be established with the appropriate financial and technical support. This would occur, due to the spatial scale, on a rotating basis so that areas will be monitored at least every two or three years, unless observations of decline trigger more intensive efforts. The ground based surveys will be primarily in areas where regular community harvest occurs. Surveys should be followed with an annual meeting of stakeholders to review the results and recommend management changes if required.

Further changes observed from community monitoring programs (observations of die offs, starvation, population increase or decrease) can trigger:
1) Aerial surveys if declines are considered significant,
2) Increased frequency and coverage of community ground survey if declines are considered less significant but still of concern,
3) Community-based changes in harvest level that would occur within a predetermined upper and lower limit.

### 9.4 WHAT MANAGEMENT ACTIONS CAN WE TAKE

The NWMB has the responsibility for decision making as the primary instrument of wildlife management under the NLCA. Regional Wildlife Organizations (RWOs) have the authority to allocate harvest among their member HTOs, and in turn the HTOs can regulate their harvesters and allocate their share of a Total Allowable Harvest (TAH). Through regular annual meetings of the stakeholders, consensus on recommended actions can be reached and submitted to the NWMB for decision. Further, HTOs can make decisions to regulate local harvest through seasons, sex selectivity, area restriction, or reduction. These consensus-based recommendations can also be made to government and land use agencies following the general management actions described below.

### 9.4.1 HARVEST

As an Endangered species under SARA, Peary caribou are automatically protected from harvest, with the exception of Inuit harvest which would require a decision by the NWMB. Any decision of the NWMB should be informed by the consensus based recommendations of the co management partners developed through annual stakeholder meetings or as recommended in this plan. Recommendations can also take the form of harvest composition (e.g. sex selective) or seasonal restrictions or other Non-Quota Limitations (NQLs).

### 9.4.2 LAND USE ACTIVITIES

Increasing land use activity demands that meaningful input and review be provided into the various permitting process in Nunavut, whether it be the Nunavut Impact Review Board (NIRB), Nunavut Water Board (NWB), or the Nunavut Planning Commission (NPC) land use plan. Effort should be made to ensure capacity is available within all co management agencies to ensure effective participation. The community-based ground surveys will gather valuable information for both HTOs and DOE to effectively participate in these permitting processes. Co management partners can continue to recommend actions to help reduce the negative impacts of exploration and development on caribou. Advice can be given to avoid important caribou seasonal ranges like calving grounds, and how to mitigate disturbance from noise and access.

### 9.4.3 COMMUNICATION AND EDUCATION

Co management partners can work together to provide active and accessible communication programs, and recommend education programs. This can include different programs and approaches for elders, harvesters and youth to encourage traditional harvesting practices, use of alternate species and increased trade and barter of traditional foods. It can also include work with members of industry including resource developers.

### 9.4.4 HABITAT

Co management partners can continue to encourage and support increased research and monitoring related to seasonal range use, key habitat indicators, trends in climate and weather, and delineation of calving grounds.

## 9.5 MANAGEMENT ACTIONS BASED ON STATUS

The type of management action and the degree of management intervention will vary depending on the status of each island group. There are four levels of island group status which are colour-coded green, yellow, orange, and red. The island group status will trigger specific management actions or a change in the frequency of action, as described below:

**Green:** the population level is high
Management actions include:

- Support harvest
- Provide standard advice on mitigation of the impacts of exploration and development activities to proponents and regulators
- Provide active and accessible communication, and recommend education programs for all

**Yellow:** the population level is increasing
Management actions include:

- Recommend easing limits on harvest
- Provide standard advice on mitigation of industrial impacts to proponents and regulators
- Provide active and accessible communication and recommend education programs for all

**Orange**: the population level is decreasing
Management actions include:

- Recommend a TAH
- Recommend a majority-bulls harvest
- Recommend harvest of alternate species and encourage increased trade and barter of traditional foods
- Recommend increased community monitoring
- Provide active and accessible communication and recommend education programs for all

**Red**: the population level is low
Management Actions include:

- Recommend no harvest
- Work directly with proponents and regulators of exploration and development activities to advise on mitigation measures
- Recommend harvest of alternate species and meat replacement programs, and encourage increased trade and barter of traditional foods.
- Recommend increased enforcement including increased use of community monitors.
- Provide active and accessible communication and recommend education programs for all.

### 9.6 PROCESS TO MAKE DECISIONS

The co management partners shall meet annually to discuss results of all recent research and monitoring efforts which may include harvest reporting, caribou health monitoring, and ground or aerial surveys. The purpose of this annual meeting is to review information and reach consensus-based recommendations, if required, for submission to the NWMB. Action may also be taken at the local level by HTOs based on the information reviewed.

### 9.6.1 GUIDING DOCUMENTS: ACTION PLAN

This Management Plan is supported by an Action Plan which outlines the management actions to be taken and how they will be implemented. Based in large part on the island group status, the Action Plan will outline specific management actions and how they will be implemented, by whom, and within what timeframe. Funding for the management action will be discussed by the co management partners. A third document, the GN DoE report "*Recent trends and abundance of Peary Caribou (Rangifer tarandus pearyi) and Muskoxen (Ovibos moschatus) in the Canadian Arctic Archipelago, Nunavut,"* will provide the technical baseline for decision making. Inuit Qaujimajatuqangit will be provided by the participating HTOs in the Stakeholder Working Group (See Appendix B). New information will be reviewed as it becomes available ensuring decisions are based on the most up to date scientific and local knowledge.

Implementation of the Action Plan is cooperative, and ongoing community input and support will help to develop and implement management actions. Each co management partner will be responsible for approving the Action Plan for its implementation. The effectiveness of the Action Plan will be reviewed annually.

### 9.6.2 STAKHOLDER MEETINGS

Stakeholders will meet annually after survey work has been completed and annual data summarized to review all new information and implementation of the Action Plan. It will be presented with the best available IQ and scientific knowledge and community based monitoring information. The Action Plan will be reviewed, and possibly updated, at the same time that the stakeholders review the current status of the Island Groups. Although normally revised only following an aerial survey, an Island Group's status or Action Plan may be revised more frequently if, for example, there has been some extreme change observed through community-based ground surveys.

### 9.6.3 ALLOCATION OF HARVEST

If a Total Allowable Harvest (TAH) is recommended it shall be determined and allocated in accordance with processes described in the NLCA.

## 10.0 COMMUNICATION BETWEEN STAKEHOLDERS AND WITH USERS

Communication is the responsibility of all parties engaged in wildlife management. Knowledge must flow both ways - between local knowledge holders and management agencies. There will be varied communication and education techniques used depending on the message and the intended audience. They may include local radio programs, visits to schools, posters or presentations, public meetings, and on-the-land gatherings.

Stakeholders will meet on an annual basis to discuss survey results and island group status and to take appropriate actions when needed. Further details on the annual meeting will be provided in the Action Plan.

The information communicated to the public will include island group status; any voluntary or management limits on harvesting; what is being monitored and why; the results of the monitoring programs; why harvesting mostly bulls rather than cows may be preferable; and education of youth in traditional hunting practices.

## 11.0 UPDATING THE MANAGEMENT PLAN

The Plan will first be reviewed after seven years (i.e. 2020) and at ten-year intervals thereafter. Any party may request a review, at any time, through a letter to the other signatories.

## 12.0 SIGNATORIES TO THE PLAN

Iviq Hunters and Trappers Association
Resolute Bay Hunters and Trappers Association
Ikajutit Hunters and Trappers Organization
Spence Bay Hunters and Trappers Organization
Ekaluktutiak Hunters and Trappers Organization
Kurairojuark Hunters and Trappers Organization
Gjoa Haven Hunters and Trappers Organization
Nunavut Tunngavik Inc., Wildlife Department
Qikiqtaalik Wildlife Board
Kitikmeot Hunters and Trappers Association
Nunavut Department of Environment, Wildlife Management Division

# APPENDICES

## APPENDIX A
## RECOMMENDATIONS AND TOTAL ALLOWABLE HARVEST BY ISLAND GROUP

### General Recommendations

It is recommended to establish management units based on the proposed nine Island Groups. This includes six as presented in "*Recent trends and abundance of Peary Caribou (Rangifer tarandus pearyi) and Muskoxen (Ovibos moschatus) in the Canadian Arctic Archipelago, Nunavut*", and three additional management units in the Kitikmeot region. This will facilitate future collection of consistent data for comparison and management decisions. However there is a need for provisions within the management plans to allow for finer scale management in response to changes in Peary caribou numbers, such as those observed through community observations or by additional survey work where warranted. In particular, the HTOs should control local harvesting within an agreed upon herd size, thus allowing for management at the community level.

Working with all stakeholders, an ongoing community-based ground survey program should be established with the appropriate financial and technical support. This would occur, due to the spatial scale, on a rotating basis so that areas will be monitored at least every two or three years, unless observations of decline trigger more intensive efforts. The ground based surveys would be primarily in areas other than where regular community harvest occurs as normal harvest areas will be monitored through harvest reporting. Surveys should be followed with an annual meeting of stakeholders to review the results and recommend management changes where required.

Observed changes from the community monitoring program (observations of die-offs, starvation, population increase or decrease) would trigger:
1) Potential aerial surveys if declines are considered significant,
2) Increased frequency and coverage of community ground survey if declines are considered less significant but still noteworthy,
3) Community based changes in harvest level that would occur within a predetermined upper and lower limit.

Predominately all island groups have declined and remain at low density with the exception of Bathurst and Melville, which are both showing signs of recovery. Caution must be exercised to prevent local extirpations. As harvest restrictions may only be to the level to address a valid conservation concern, there is currently a strong argument to maintain harvest restrictions for several island groups.

Harvest restrictions must allow communities to have input and control over how harvest will be allocated by allowing flexibility for HTO's to respond to changes in Peary caribou numbers that they observe and monitor through community-based ground surveys. These surveys may trigger more extensive ground or aerial surveys in the case of observed declines. An annual survey/meeting structure will allow for management action at the community level to occur in a timely and responsive manner.

Harvest reporting and sample collection is critical information for management. Each harvest should be reported through a hunter report. Information collected on the reports should include date, location (Latitude and Longitude), hunters name, tag number, sex, approximate age, and size of group harvested from. A Peary caribou health monitoring program should be established and sample kits provided to the hunters. The information provided will further our understanding of survival rates, diet, health, and space use. There is also a need to indentify population boundaries to better manage Peary caribou.

With the current low numbers of Peary caribou in some of the island groups it is suggested to consider male sex selective harvests to help conserve females in the effort to reduce impacts and promote potential recovery.

### Specific Island group TAH recommendations

#### Ellesmere Island Group (PC-01)

It is recommended to maintain existing harvest levels with a TAH of 45- 50 (allowing community to adjust as required within that amount). This harvest rate may impact caribou on south Ellesmere negatively; to alleviate this effect there should be encouragement and support to increase harvest on north Ellesmere. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement.

#### Axel Heiburg Group (PC-02)

No harvest occurs here and the population is abundant, therefore no TAH is required. Should harvest start to occur here, as determined through harvest reporting, the stakeholder working group should discuss potential harvest limits. Recommend no harvest by non- Inuit.

#### Ringnes Islands Group (PC-03)

No harvesting occurs here, therefore no TAH is required. Should harvest start to occur here, as determined through harvest reporting, the stakeholder working group should discuss potential harvest limits. Recommend no harvest by non- Inuit.

**Devon Island Group (PC-04)**
With only 17 animals observed in 2008 and no abundance estimate, this group should be under a moratorium until such time as an increase is observed through community-based ground surveys. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement.

**Bathurst Island Group (PC-05)**
Managing for recovery, a conservative TAH based on the preliminary results of the 2013 estimate of 1200 caribou would be 36 caribou (a 3% harvest rate). Although scientific knowledge and local knowledge agree that there is recovery in this group caution is warranted in order to not jeopardize that recovery. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement.

**Prince of Wales Group (PC-06)**
With too few caribou to support harvesting at current numbers, this group should be under a moratorium until such time as an increase is observed through community based monitoring. Survey frequency should be increase to monitor sign of recovery. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement.

**Victoria Island Group (PC-07)**
As there is no targeted harvest in the area and only an occasional caribou is taken opportunistically, no TAH is required. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement. Should harvest reporting indicate an increase over the current rate of sporadic opportunistic harvest the stakeholder working group should discuss potential harvest limits. Recommend no harvest by non- Inuit.

**Boothia Peninsula Group (PC-08)**
As there is no targeted harvest in the area, and only an occasional caribou is taken opportunistically, no TAH is required. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement. Should harvest reporting indicate an increase over the current occasional harvest, the stakeholder working group should discuss potential harvest limits. Recommend no harvest by non- Inuit.

**King William Island Group (PC-10)**
As there is no targeted harvest in the area and only an occasional caribou is taken opportunistically, no TAH is required. Harvest reporting and sample submission for genetics will assist greatly in understanding the dynamics of Peary caribou genetics and movement. Should harvest reporting indicate an increase over the current rate of

sporadic opportunistic harvest, the stakeholder working group should discuss potential harvest limits. Recommend no harvest by non- Inuit.

**APPENDIX B**
**Recommended stakeholder working group for annual meetings**

The stakeholder working group consists of the Chairpersons (and/or their alternates) of:
Iviq Hunters and Trappers Association
Resolute Bay Hunters and Trappers Association
Ikajutit Hunters and Trappers Organization
Spence Bay Hunters and Trappers Organization
Ekaluktutiak Hunters and Trappers Organization
Kurairojuark Hunters and Trappers Organization
Gjoa Haven Hunters and Trappers Organization
Qikiktaalik Wildlife Board
Kitikmeot Hunters and Trappers Association
And staff from the:

- Nunavut Wildlife Management Board
- Nunavut Tunngavik Inc.
- GN DoE, Regional Biologists and Regional Managers

Additional experts, either scientists or qaujimanilik, will be invited as required for support.

## APPENDIX C
## ACTION PLAN

The following action plan supports the implementation of the management plan. It lists essential tasks that the co management partners recommend for the ongoing monitoring and management of Peary caribou. The actions support and emphasize programs and projects that will be invaluable in decision making and recommends what needs to be done to achieve the goals of the management plan.

The Action Plan assigns responsibilities for conducting programs and projects and covers the following categories:

1. Aerial survey program
2. Community-based ground survey program
3. Establishing harvest reporting and caribou health monitoring programs
4. NWMB Decision on Regulatory Changes
5. Annual Stakeholders meeting

### 1. Establishing an Aerial Survey Program

Background:
Aerial surveys are expensive and require significant logistic preparation. An aerial survey will be used in two fashions, as part of a cyclic program over the long-term to monitor population size and trend as well as other indices such cow/calf ratio and bull/cow ratio.

Problem Statement:
GN DoE has limited funds available for research of all species under its mandate for all of Nunavut. Regular surveys are expensive both in terms of financial and human resources. Co management partners need to agree on a monitoring cycle that is financially viable and still allow for surveys to occur in emergent situations when ground-based surveys observe significant die-offs or declines.

Objectives:
1. Seek support from NWMB for Nunavut Wildlife Research Trust (NWRT) funding for a long term survey as well as seek out other funding sources, such as INAC, and Environment Canada under federal funding programs for species at risk.
2. Stakeholders will agree upon an aerial survey schedule and thresholds that will trigger aerial surveys in emergent situations.

Methods:
1. GN DoE proposal to NWMB for NWRT with inventory schedule and maximum three year term request.
2. GN DoE to make formal requests to other third parties, via letter, for additional financial support for monitoring programs

Schedule:
Upon acceptance of Management Plan – GN DoE to seek support from third parties
January 2015 – GN DoE proposal to NWMB
January 2015 – Letter from co management partners to NWMB supporting DoE proposal

Evaluation: Ongoing at annual Stakeholder meeting

Lead Role: GN DoE

Support Role: HTOs, QWB

**2. Establishing a Community-Based Ground Survey Program**

Ground surveys are expensive and require significant logistic preparation. Community-based ground surveys will be used as part of a cyclic program over the long term to monitor population size and trend as well as other indices such as cow/calf ratio and bull/cow ratio.

Problem Statement:
HTOs have limited capacity to conduct monitoring programs. Regular surveys are expensive both in terms of financial and human resources. Co management partners need to agree on a monitoring cycle that is financially viable and has the financial and technical support to succeed.

Objectives:
1. Seek commitment from NWMB for HTO proposals to the Community Studies Fund for support of community based ground surveys on an annual and cyclic basis. HTOs to seek out other sources such as Habitat Stewardship Program and Aboriginal Fund for Species At Risk.
2. Stakeholders will agree upon a ground survey schedule and thresholds that will trigger additional ground surveys such as observed die offs and extreme weather events.

Methods:

1. HTOs submit proposal to NWMB for Studies Fund.
2. Co management partners to provide technical, logistic and financial support.

Schedule:
Upon acceptance of Management Plan – HTOs to seek support from third parties
January 2015 – HTO proposals to NWMB
January 2015 – Letter from co management partners to NWMB supporting HTOs proposals.

Evaluation: Ongoing at annual Stakeholder meeting

Lead Role: Each HTO that wishes to participate in the ground-based survey

Support Role: QWB, NIWS, GN DoE

### 3. Establishing Harvest Reporting and Caribou Health Monitoring Programs

Background:
Harvest monitoring and caribou health monitoring are identified in the Plan as important factors for management decisions. Collection of harvest data and condition and health data are means of Inuit involvement at the individual level

Problem Statement:
Currently harvest monitoring is not official or well-organized. Efforts have been made at establishing a general caribou health monitoring program, but this needs to be expanded to Peary caribou.

Objectives:

1. Get commitment from stakeholders to implement a harvest reporting program.
2. Harvest reporting will include sample submission that will be utilized in the health and condition monitoring program.

Methods:

1. NIWS, NTI and GN DOE to assist QWB, KRWB in preparing Management Plan
2. NTI and GN DOE to provide letters of support

Schedule:
Upon acceptance of plan - Determine harvest and sample collection needs and design reporting form

Evaluation: Annually at stakeholder meeting

Lead Role:
QWB/ KRWB / HTOs/ GN DOE / NTI Wildlife

**4. NWMB Decision on acceptance of the Plan and Regulatory Changes**

Background:
The co management partners are responsible for the protection, conservation, and management of Peary caribou in a sustainable manner. However the NWMB has the mandate to make decisions under the NLCA with regards to changes in TAH and approval of management plans. GN DoE has the responsibility to develop regulations under the *Wildlife Act*. This Plan will serve as the basis for development of Regulations for the management of Peary caribou under the *Wildlife Act*.

Problem Statement:
The NWMB must approve the proposed management plan, action plan and recommended changes to the regulations. The plan is the result of consultation with the co-management partners.

Objectives:
The co management partners have developed the Management Plan and Action Plan in regard to implementing changes in the management of Peary caribou. The objective is to have the plan approved by NWMB so that the plan can be implemented and regulatory changes can be implemented.

Methods:
1. DoE will submit the draft plan to the NWMB for decision.

Schedule:
Upon completion of an acceptable draft plan submit the draft and briefing note to NWMB for first available regular meeting
January 2014 –submit briefing note and supporting documents to NWMB

Lead Role: GN DOE

**5. Annual Stakeholder Meeting**

Background:
The co-management partners need to ensure that all information gathered annually on Peary caribou, such as harvest and survey results, are shared fully and reviewed

collaboratively for the purposes of taking action when needed. The action plan shall undergo annual review at this meeting and be amended as required.

Problem Statement:
Scheduling and financing meetings in the remote communities of Nunavut is a challenge. Support is needed by all co management partners to ensure that the parties can meet and discuss, by whatever means available, the current information available.

Objectives:
To ensure that participants are adequately supported to effectively participate in the annual stakeholder meeting.

Methods:
1. Co management partners will seek to plan and budget the adequate resources for their respective participants to effectively participate in the annual meeting.
2. Where possible the participants may already be in joint attendance at other meetings (i.e. NWMB) and this should be capitalized upon.

Schedule:
The annual general meeting shall occur at a mutually convenient time that allows for the data collected in the previous year to be analyzed and summarized for use by the co management partners.

Evaluation: Annual stakeholder meeting

Lead Role: QWB/KRWB / GN DOE / NTI Wildlife/ HTOs

# GN High Arctic Region Consultation Report

# 2016

This document contains consultations with regards to the Government of Nunavut, Department of Environment, Wildlife Management, Research Section –High Arctic Region Biologist

# Table of Contents

## 1.0 Peary Caribou Federal Recovery Strategy Consultations

**Kitikmeot Region: February 22-25, 2016**
**Qikiqtani Region: February 29 and March 1, 2016**
**Inuvialuit Settlement Region: March 8-10, 2016**

Representatives from Environment and Climate Change Canada (ECCC) travelled to communities in February and March 2016 to present the draft *Recovery Strategy for the Peary Caribou in Canada*. Where possible, representatives from the Government of Nunavut (GN), the Government of the NWT (GNWT) and Parks Canada were present to answer questions regarding their respective jurisdictions or to provide insight on Peary caribou biology, surveys, management, harvest and information on other arctic species such as muskoxen. The Hunter and Trapper Organizations/Committees/Associations in nine communities as well as community members participated in these meetings.

Peary caribou were federally listed under the *Species at Risk Act* as Endangered in 2011. A recovery strategy must be written to set out the national plan of how to ensure the survival of Peary caribou into the future. A federal recovery strategy is due to be posted on the Species at Risk Public Registry for the 60-day public comment period by the end of March 2017. ECCC presented key sections of the draft recovery strategy and gathered feedback from each community. The following is a summary of the major concerns / topics of discussion.

See 1.9 Community's attendee lists for the list of attendees for each community.

### Main Issue or Concern

### 1.1 Description, Important areas & movement routes, Range

*Gjoa Haven, Taloyoak, Resolute Bay*

Some communities spoke about the need for caribou to migrate between islands or to access large areas of landscape (to mate, give birth, feed, and escape bad weather conditions). For example, in fall when food is getting low, the caribou would be found walking along the shore trying to get across to another island. It was noted that they sometimes die trying to cross between islands if the ice is too thin or there is no ice for them to get across (Gjoa Haven).

*Taloyoak*

Question about the area of the range of Peary caribou? → *ECCC: The extent of occurrence of Peary caribou is estimated a*s 1.9 million km2

*Paulatuk*

Wanted the long "important area" area south of their community (previously identified at the Technical meeting as an Important areas) to be removed, it is not an important breeding area.
→ *Area was removed from figure 2 (see appendix 2 of this document)*

*Paulatuk*

Caribou on Baffin Island is also Peary caribou. Baffin should then be included in the range.
→ *GNWT: to confirm what subspecies occurs on Baffin Island*

*Ulukhaktok*

Identified 3 areas where Peary Caribou are seen: Wynniatt Bay, Shaler Mountains (wintering area), and Hadley Bay

### 1.2 Population Sizes and Trends

*Sachs Harbour, Gjoa Haven, Kugaaruk*
Recognized the importance and the difficulties to survey Peary caribou: hard to see in the winter time, they mix with Dolphin and Union caribou and other caribou in the southern part of their range, and surveys are very expensive.
*Sachs Harbour, Ulukhaktok*
Concerns about surveys being too far apart in years and not covering the whole caribou range. [Explained that surveys are very expensive, so GNWT try to survey group of islands at the same time, and prioritize areas where there are communities as they harvest caribou.]
*Sachs Harbour, Kugaaruk*
Showed interest in knowing how many caribou we need so that populations don't go extinct or to have a healthy population. [Explained that we don't have enough information, have part of the cycle but do not know what the safe range is. GNWT try to survey more often.]
*Gjoa Haven*
Community members stated that they were not very concerned about Peary caribou because Peary caribou are hardly ever seen there; they are mainly concerned about the Barren-ground caribou.

#### 1.2.1 Have Peary Caribou been increasing or decreasing in your area over the past: 10 years / 30 years?

*Sachs Harbour*
Notably increasing compared to 5 years ago. Seems to be linked to the decreasing Muskox population.
*Ulukhaktok*
30 years period: decreased.
*Paulatuk*
See small herds in fall, very few herds. They are not migrating anymore. Don't seem to expand.
*Cambridge Bay*
Very few Peary caribou have been sighted close by. Even 30 years ago, used to go many miles north before finding Peary caribou. Had a lot of caribou around in the 80s, it has been way down in the last few years.
*Gjoa Haven*
We should not expect a big expansion of Peary Caribou, population level was always low.
*Taloyoak*
Saw them in the 80s-early 90s and used to eat them in the mid-80s early 90s but not since then, would not know if they are increasing, mainly because nobody goes there anymore. Started to see a decline in the 80s.
*Kugaaruk*
Never had large populations. Catch a few in the late 80s but now hardly see them.
*Resolute Bay*
In the last 4-5 years, seen an increase especially on Bathurst Island (Allison Inlet), but also in Grise Fiord area and on Cornwallis Island. Have seen females with two calves.

#### 1.2.2 Are the changes in population most likely from births/deaths or from Peary caribou moving from one area to another?

No comments.

## 1.3 Threats to Peary Caribou

### 1.3.1 Climate Change

*Cambridge*
Bay Noticing that the summers are warmer; so flies/mosquitoes are now really bad. New types of insects can now be seen.
*Sachs Harbour*
Have observed new types of mushrooms, some are poisonous for the wildlife (caribou/muskox). Abundance of mushrooms has increased last summer. Have observed land erosion occurring after melting.
*Sachs Harbour, Cambridge Bay*
Concerns about ecological shifts: advantages for predators (hares still white when no more snow on the ground, grizzly bear's hibernation is shorter.)
*Sachs Harbour*
Increased temperature might have a positive impact on vegetation, but might not be food that caribou eat/prefer as shrubs are expected to increase.

### 1.3.2 Marine Traffic

*Ulukhaktok, Cambridge Bay, Kugaaruk*
More ships of different types (cargo, cruise ship, sail boat, coast guard, etc.) are going through the ocean, opening the water longer than it normally would be. [Need to have the migration routes identified and then work with other governments/jurisdictions to mitigate shipping impacts.]
*Ulukhaktok*
Increased marine traffic will bring more pollution/contaminant in the north.
*Cambridge Bay*
Working on preventing ships going through NW Passage and nearby areas. Asking for no sailing by the last week of October for the safety of hunters and caribou.
Was raised that the Elders Committee with the DoE (GN) notified the Minister of Environment that when the ice started freezing no ships should go through.

### 1.3.3 Parasites and Disease

*Paulatuk*
Concerns about caribou disease.
*Sachs Harbour, Ulukhaktok*
Parasites and diseases should be higher in the list, linked with interactions with muskox and migratory birds. Many concerns expressed about the big die-off of muskox recently; parasites and diseases confirmed in other caribou (Woodland and Barren-Ground).

### 1.3.4 Resource Extraction

*Sachs Harbour, Taloyoak*
Concerns about resource extraction activities, especially near or at calving grounds.
Sachs Harbour
gave an example where calving areas were identified by the community as conservation areas where the company should not go, but the company did work there anyways.
Ulukhaktok

Concerns about industries and exploration activities pushing wolves and other predators north.
Grise Fiord, Resolute Bay
Concerns that if many mining projects are approved or there is a greater interest in mining, Peary Caribou may go back to being Endangered. Concerns about noise pollution

## 1.4 Competition / Predation

### 1.4.1 Muskox

*Ulukhaktok, Gjoa Haven, Taloyoak*
Concerns about the increasing population of muskoxen. Muskox is moving the caribou off. Often mentioned that caribou avoid muskox, they do not get along (competition for forage, strong smell).
*Taloyoak*
especially concerned about a calving ground at PoW/Boothia peninsula; used to find a good population of caribou and hardly any muskox. Ancestors say the caribou move away because muskoxen eat the same thing.

### 1.4.2 Wolves

*Paulatuk, Ulukhaktok, Sachs Harbour (public only, not the SHHTC), Cambridge Bay, Gjoa Haven, Taloyoak, Resolute Bay*
Communities expressed great concerns about the high and increasing number of predators – mainly wolves – on Peary caribou. Wolves were seen in many communities as becoming a huge problem for caribou
*Cambridge Bay*
Wolves are more of a concern than Grizzly bears.
*Cambridge Bay*
Have seen wolves chasing caribou out on the ocean or hunting caribou on the sea ice with still open or partly frozen water. Communities are seeing changes to wolf pack structure. Cambridge Bay noted that wolf packs were getting bigger, and the wolves were healthy and brave. However in Sachs Harbour (where caribou numbers were noted to be increasing) wolves were observed to be thin and packs getting smaller.

### 1.4.3 Grizzly bears & Wolverines

*Sachs Harbour, Cambridge Bay*
Concerns about the high/increasing numbers of grizzly bears and the impacts on caribou.
*Cambridge Bay*
Seeing grizzly bears emerging earlier from their dens, sometimes as early as the first week of April, and returning to their dens for hibernation later in the season.
*Cambridge Bay*
Wolverine numbers are increasing

### 1.4.4 Human Disturbance

*Ulukhaktok, Sachs Harbour, Cambridge Bay, Taloyoak, Kugaaruk*
Concerns about the increasing activities/numbers of helicopters, planes, snowmobiles, drones and their impacts on caribou.
- Noise was the main concern among the communities (increasing in intensity and frequency)

- Minimum height
- Timing of flight (calving season, hunting season-for subsistence)
- Caribou accumulate less fat because often in a flee situation

*Cambridge Bay*
Flight guidelines are given to the industry/pilot and best management practices have to be followed, but it seems that it is not always followed. Should be reported to GNWT.
*Cambridge Bay*
Concerns about sensory disturbance associated with military exercises during critical life stages for Peary caribou.
*Gjoa Haven*
A lot of people get out on the land when it gets warmer: scientists, explorers, etc. All these activities are a major disturbance for caribou and make them move away. One community member suggested that stopping federal government researches or mining exploration for a year might help and make a difference.
*Paulatuk*
Someone was interested in knowing the proportional contributing impacts of different sectors: tourism, military, research… [Explained it is only the global impact in the recovery strategy but specific contribution or locations could be addressed in an Action Plan.]
*Sachs Harbour*
An Elder expressed concerns about the use of quads and snowmobiles by the community and the impacts on caribou (scare them)
*Resolute Bay*
Concerns about the increasing activities in the next few years in the new Park on Bathurst. Community should identify critical area (calving areas, migrating routes) to minimize disturbance.→ Will be addressed in a Park Management Plan with Parks Canada

### 1.4.5 Harvesting

*Paulatuk*
Not a threat for now, but in the southern range of Peary caribou, where they mix with other caribou (ex. Bluenose), it could become a threat if hunting resumes for herds currently under restrictions. Hunting pressure could increase on Peary and Dolphin and Union caribou.
*Sachs Harbour*
Quotas are not respected. HTC by-laws are not respected neither enforced. Overharvesting is a big concern/threat for the Sachs Harbor HTC (illegal harvesting, not reporting captures).

### 1.4.6 Pollution and Contaminants

*Sachs Harbour, Paulatuk, Cambridge Bay, Kugaaruk, Resolute Bay*
Contaminants left over on sites are seen as a threat as well as the equipment and fuel.
*Paulatuk, Cambridge Bay, Resolute Bay*
Identifying and cleaning up contaminated sites was identified as a high priority.
*Paulatuk, Sachs Harbour, Ulukhaktok, Cambridge Bay*
Many communities noted smoke and dust from forest fires in the NWT or surrounding areas, could have negative effects on wildlife including Peary caribou.
*Kugaaruk*
It had been specified that air pollution was mostly man-made.

### 1.4.7 Are there any threats that exist in your region that we have not identified? Which threats stand out to you as having the most impact on Peary caribou in your area?

No comments.

### 1.4.8 Do you agree with the order of the magnitude of the threats?

*Ulukhaktok, Cambridge Bay, Gjoa Haven, Taloyoak, Resolute Bay*
Although predation (mainly wolves) is ranked as a low threat across the entire range of Peary caribou, these communities rank predation as a high threat in their area due to increasing numbers.
*Cambridge Bay, Gjoa Haven, Taloyoak and Resolute Bay*
identified wolves as the main threat in their region.
*Taloyoak*
Muskoxen and wolves are the biggest threats. Caribou started to decline when muskoxen population increased.
*Taloyoak*
In summer time, starting to witness caribou trying to cross in the ocean in the open water, usually would not witness this. These caribou cannot cross the open water, they froze and die.
*Cambridge Bay*
A lot of Peary caribou may drown while migrating. Ulukhaktok Already seeing caribou drowning because of shipping or thin ice.

*Sachs Harbour, Ulukhaktok*
Parasites and diseases should be higher in the list, linked with interactions with muskox or migratory birds.

### 1.5 Population and Distribution Objectives

*Cambridge Bay*
Stressed the importance of recognizing the natural cycle of caribou, that fluctuation is natural and that die-offs occur periodically. [The natural limits (upper and lower population level or safe range) have not yet been identified because more data is needed.]

### 1.6 Critical Habitat and Knowledge Assessment

*Paulatuk, Cambridge Bay, Grise Fiord*
Community members discussed reasons for needing such large areas of critical habitat. These reasons brought up included that caribou use a wide range of habitats and have unpredictable migration routes, and thus need access to large areas of landscape.
*Sachs Harbour, Paulatuk, Grise Fiord*
Discussed that once critical habitat is identified in the recovery strategy and posted as final, Environmental Assessments have to consider Peary Caribou habitat in their evaluation. This means development is possible in the future but consideration will be given to the caribou in projects that will be going on in critical habitat.
*Sachs Harbour*
One calving ground (Community Conservation Plan) at the southern tip of Banks Island might not be all identified as critical habitat. → *GNWT: to confirm* Concerns on how critical habitat will impact their local activities like the establishment of cabins.
*Sachs Harbour, Taloyoak*

Need to take care/protect the habitat and the calving areas. Sachs Harbour had concerns about effectively protecting sensitive areas identified in the Community Conservation Plan, on a long-term basis.
*Cambridge Bay*
Had a question about having a plan to identify Critical habitat on the lower hashed out area (critical habitat not yet identified). [ECCC will work with territorial governments to determine how habitat will be identified.]

*Cambridge Bay*
Beneficiaries working at Alert should be contacted to get information from them on caribou distribution on the northern tip of Ellesmere Island.
*Grise Fiord*
Corrections to the areas of critical ice habitat in the area of Cardigan Str and Norwegian Bay were pointed out. → *These corrections have been made to the Figure 4 (see **1.10 Revised maps** of this document)*

*Grise Fiord*
Axel Heiberg and Ellesmere are seen as potential locations for future coalmines.

## 1.7 Strategic Direction for Recovery

*Ulukhaktok*
Would like to work with Nunavut so they can work in the same direction for the caribou.
*Grise Fiord*
Had been discussed that once the Recovery Strategy is final it will serve as a high-level guidance document for regional plans as the Nunavut Land Use Plan (LUP). Identified critical habitat in the Recovery Strategy could be one of the ways to set aside Protected Areas as part of the LUP, or to protect critical habitat outside of Protected Areas. As the Recovery Strategy is not yet final, community members should stressed the important of this habitat to QIA/Planning Commission.

### 1.7.1 Monitoring and research

*Ulukhaktok, Kugaaruk*
Need to know more about caribou crossing (when and where) and movements on the ice.
*Resolute Bay*
Need to identify areas of calving routes in summer. Some areas are used year after year.
*Cambridge Bay*
Monitoring of vessel traffic through the range of Peary caribou for the routes and timing of travel, and type of ships.
*Sachs Harbour, Ulukhaktok*
Need was expressed that more research is needed on relationships between caribou, muskox and wolf.
*Sachs Harbour*
HTO receives a lot of demand from university researchers. They now want to prioritize research activities on their territory.
*Ulukhaktok*
Need to have more studies on grizzly bear.

*Sachs Harbour, Ulukhaktok*
Surveys are very important. Need for new survey technology: less intrusive and less expensive (by snowmobile, drones,…). More money should be invested into communities to do ground survey with the biologists (by snowmobile with local hunters) – would also be an opportunity to work collaboratively.
*Ulukhaktok*
Research needed on parasites and diseases, linked with interactions with muskox or migratory birds.
*Ulukhaktok*
Need more studies on vegetation: eg caribou diet, grazing impact, recovery after grazing, plant growth
*Resolute Bay*
Showed interests in monitoring the caribou population. This type of work is called community-based monitoring programs (CBMP).

### 1.7.2 Habitat and species conservation and management

*Paulatuk, Ulukhaktok, Cambridge Bay, Taloyoak, Kugaaruk, Resolute Bay*
Since wolves have a great impact on caribou, something needs to be done about wolves. Communities suggested that the wolf or predator (wolves + grizzly bears) populations should be controlled. This is something they can control and that had been done in the past for wolves. [There is a lot of controversy about culling wolves; we need to better understand potential impacts of wolf management. GNWT might be considering it; they currently have a wolf program where skulls are collected; there is a fur bonus.]
*Paulatuk, Cambridge Bay, Resolute Bay*
Concerns about cleaning-up old exploitation sites. Sites identified as critical habitat and containing waste/contaminants (from past researches, extraction sites, military or Ranger exercises…) should be prioritized and cleaned-up. Cleaning up contaminated sites should be done by professionals with the proper equipment.

### 1.7.3 Education and awareness, stewardships and partnerships

*Cambridge Bay*
Promote education among the mining and marine sectors (sensitive areas and seasons). Promote education amongst harvesters.
*Kugaaruk*
Educate young generation (eg don't waste the meat).
*Ulukhaktok*
Educating young people to identify the different caribou while hunting. Transfer knowledge to the younger people so they can learn where are the important areas to hunt and the migration routes. Young people will be able to hunt for their subsistence when hunting will resume, it is their future.
*Resolute Bay*
Are developing a program aiming at transferring knowledge to young people on where and how to hunt caribou, but lack of money is big issue. For the Recovery Strategy, would like to see something like: ''Promote education amongst youth or young harvesters" or "Better practices for youth". Should also replace the word 'harvesters' with 'hunters'. Harvesting could also mean berry picking or to people who use things from the land for use, not just animals but plants.

### 1.7.4 Law and Policy

*Ulukhaktok, Cambridge Bay*
Some communities recommended higher restrictions for flights (minimum height, specific for calving season) or that the existing rules are enforced. The community of Ulukhaktok doesn't allow flying around calving season.
*Paulatok, Kugaaruk*
Some communities recommended higher restrictions for marine traffic (controlling timing of ship traffic). Migration routes on sea ice should be protected.
*Taloyoak*
Resource extraction or exploration activities should be prohibited at/near sensitive areas.
*Sachs Harbour*
Enforcement on quota should be stronger.
*Ulukhaktok*
Hunters should have their tag before they go out hunting, like it is currently done for polar bear.

### 1.7.5 Does your organization have any comment on the broad strategies and general approaches? Are there other things that should be done?

*Grise Fiord*
In many aspects, Inuit hunters are already practicing the recovery of the caribou. Discussion that imposing laws and quotas may actually increase hunting. Respect for what the community says about how to manage the caribou is important to the success of the recovery effort.

## 1.8 Other Comments

*Gjoa Haven*
Had a suggestion to do one-on-one interviews to gather more information in the future.
Cambridge Bay
Breeding between Peary and Barren-ground caribou has started. Peary may be migrating with Dolphin and Union to mainland.
*Ulukhaktok*
Importance of Elder knowledge on caribou hunting sites since community members cannot travel long distance anymore, too expensive.

*Ulukhaktok, Cambridge Bay*
Concerns from communities passing information over to the people at the federal level:

- Seem to pass it over often;
- Expect (would like) to receive feedback from them (e.g. noticing wolves, caribou decline);
- Governments take too much time to take actions and save a species.

*Taloyoak*
Need expressed that biologist should come regularly to their meetings on caribou management; to address wildlife issues, share information. Hunters should go with biologist when they are going to count caribou in the field (aerial survey). Getting funding for surveys is an issue for communities.
*Paulatuk*
Concerns about NWMB if they want more time to accept the recovery strategy, this will delay the process. Stressed that co-management is essential, cooperation is needed. [Explained that Nunavut, co-management partners and stakeholders were involved in the process from the start in order to address the concerns at the beginning and be refined through the process.]

Communities expressed great hope in this Recovery Strategy to help Peary caribou populations.

## 1.9 Community's attendee lists

### 1.9.1 Kitikmeot Region: February 22-25, 2016

Ekaluktutiak HTA Meeting
Location: Cambridge Bay, Nunavut
Date: February 22, 2016
Attendees: Mark Haongak – HTO Director, Peter Evalik – Secretary – Treasurer, Bobby Greenley – Chairperson, Jimmy Haniliak – Director, John Lyall – Director, Howard Greenley – Director, Dennis Kaomayok – Hunter, Devon Oniak – Hunter, Chad McCallum – Hunter, Sam Anghiatok Sr. – Elder, Jimmy Maniyoena – Elder, Roland Eminyak – Hunter, William Pawialak – Hunter, Dawn Andrews – Environment and Climate Change Canada (ECCC), Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

Community of Cambridge Bay Public Meeting
Location: Cambridge Bay, Nunavut
Date: February 22, 2016
Attendees: Jimmy Haniliak – EHTO Director, Ruby Haniliak, Jack Ekpakohk, Nigeonak – Kitikmeot Corp., James Ekpakohak, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

Gjoa Haven HTA Meeting
Location: Gjoa Haven, Nunavut
Date: February 23, 2016
Attendees: Molly Halluqtaluk – HTO Manager, David Qirqqut – Hunter, Jacob Keanik – HTO, Ralph Porter SR – Elder, Paul Ikaullaq – Translator, Rebeccal Ikualluq – Search and Rescue Org., Marvin Aqittuq – HTO, Jimmy Qirqqut – Elder, Kenneth Puqiqrak – HTO, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

Spence Bay HTA Meeting
Location: Taloyoak, Nunavut
Date: February 24, 2016
Attendees: Jimmy Oleekatalik – HTO Manager, Anaoyoak Alookee – Secretary Treasurer, Sam Tuluriazik – Chairperson, George Aklah– HTO Member, Bruce Takolik – HTO Member, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

Community of Taloyoak Public Meeting
Location: Taloyoak, Nunavut
Date: February 24, 2016
Attendees: Simon Qingnaqtuq – Chair KRWB, Noah Aklait, Isaac Panigayak – Hunter, Eunice Panigayak – Hunter, Danniki Plookee – Hunter, Participant – name written in Inuktitut, David Totalik – Hunter, Bruce Italkell – Hunter, Lorraine Ukuqtunnuaq – Hunter, Simon Taktoo – Hunter, Ruth Ruben – Hunter, Nannu U., Andrew P – Hunter, Joseph Quqqiaq – Interpreter, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

Kugaaruk HTA & Public Meeting
Location: Kugaaruk, Nunavut
Date: February 25, 2016
Attendees: Joshua Kringorn – HTO Manager, Mariano Uqqarqluk – HTO, Edward Inuituinuk, Adam Pujuardjuk, B. Oralri, Len Anaittuq – HTO, Tom Kayaitok – Interpreter, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife

### 1.9.2 Qikiqtani Region: February 29 and March 1, 2016

Grise Fiord Board Meeting
Date: February 29, 2016
Attendees: Jaypetee Akeeagok – HTO Chairman, Charlie Noah – HTO V-Chairman, Marty Kuluguqtuq – SEC/MES, Aksakjuk Niniuk – B.O.D., Jopee Kiguktak, Larry – Interpreter, Morgan Anderson – Department of Environment, GN, Igloolik, Andrew Maher – Parks Canada, Iqaluit, Julia Prokopick – ECCC, Canadian Wildlife Service, Iqaluit, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife

Grise Fiord Public Meeting
Date: February 29, 2016
Jaypetee Akeeagok – HTO Chairman, Annie Audlauk, Miinie K., Laisa Watsleo, Tina Qamaniq, Subie Kiguktak, Jopee Kiguktak, Jonathan Kiguktak, Amarulunnquaq A, Amon Akeeagok, Charlie Noah, Naomi Kuluguqtuq, Aksakjuk Niorjruk, Jamie Christensen, Justin Kaunak, Morgan Anderson – Department of Environment, GN, Igloolik, Andrew Maher – Parks Canada, Iqaluit, Julia Prokopick – ECCC, Canadian Wildlife Service, Iqaluit, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife

Resolute Bay Public Meeting
Date: March 1, 2016
Attendees: Martha Kalluk, Nathaniel Kalluk, Tabitha Mullin, Philip Manik – HTO chairman, Aleeasuk Idiout, Morgan Anderson – Department of Environment, GN, Igloolik, Andrew Maher – Parks Canada, Iqaluit, Julia Prokopick – ECCC, Canadian Wildlife Service, Iqaluit, Dawn Andrews – ECCC, Canadian Wildlife Service, Yellowknife

### 1.9.3 Inuvialuit Settlement Region: March 8-10, 2016

Sachs Harbour HTC Meeting
Location: Sachs Harbour, NWT
Date: March 8, 2016
Attendees: Joseph Carpenter – President, SH HTC, Wayne Gully – HTC, Norm Anikina – HTC, Richard Carpenter – HTC, Perter Sinkins – Parks Canada, Inuvik, Tracy Davison – Environment and Natural Resources, GNWT, Inuvik, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife, Isabelle Duclos – ECCC, Canadian Wildlife Service, Yellowknife

Community of Sachs Harbour Public Meeting
Location: Sachs Harbour, NWT
Date: March 8, 2016
Attendees: Joseph Carpenter – President, SH HTC, Participant – Visitor, Kyle Wolki – SHHTC/SHCC, Bridget Wolki – Caterer / driver, Shanon Green – Parks Canada / Caterer, Norman C. – Sachs Harbour, Edith Hoogak, Warren Esav – Hunter, John Keogak – SHHTC,

Jean Harry – Translator, Perter Sinkins – Parks Canada, Inuvik, Tracy Davison – Environment and Natural Resources, GNWT, Inuvik, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife, Isabelle Duclos – ECCC, Canadian Wildlife Service, Yellowknife

Ulukhaktok HTC & Public Meeting
Location: Ulukhaktok, NWT
Date: March 9, 2016
Attendees: Matthew Inuktalik, Willy Akoakhion, Corrie Soss Alice Omingmak – Elder, Markus Kuptana Margaret Kanayok – Elder, Laura Inuktalik, Allison Ekpahkyoak, Isaac Inuktalik – Hunter + trapper, Mason Alanak, Annie Inuktalik, Allison KlenKenberg, Kolten? Inuktalik, Macayla Alanak, Laverna Klengenberg – OHTC, Kieranne Joss,T. Kuptana, Grant Kuptana, Morris Nigiyok – Elder, Tobin, Mabel Nigiyok – Elder, Angen, MaryJane, Nigiyok Allison, Sadie Joss – OHTC, Corben, Donald Inuktalik – Member of Ulukhatok, Krista, Lily Alanak – Community member, Blaine, Margaret Notaina – Elder, Kaia, Mollie Oliktoak, Chelsey, Devon Notaina, Joe Nilgak, Madison Nigiyok, Maegan Klenkengberg, Pat Ekpakohak –Elder, Trent Kuptana, Jean Ekpakohak –Elder, Peter Koplomiak, Connie Alanak, Tyrell Kuptana, George Alanak, Nickolas Alonak, Andy Akoakhion, Niami Klengkenberg, Gibson Kudlak – OHTC, Allen Joss – Elder, Mary Akoakhion – Elder, Joshua Oliktoak, Jack Akhiatak, Gibson Kudlak, Julia Ekpakhoak, John Alikamik, Darlene Nigiyok, Collin Okheena, Lena Nigiyok – Youth Council, Wyatte Joss, Patrick Joss, Ross (Carmella Klengkenberg), Effie Katoyak – Elder, Perter Sinkins – Parks Canada, Inuvik, Tracy Davison – Environment and Natural Resources, GNWT, Inuvik, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife, Isabelle Duclos – ECCC, Canadian Wildlife Service, Yellowknife

Paulatuk HTC & Public Meeting
Location: Paulatuk, NWT
Date: March 10, 2016
Attendees: Lawrence Ruben – HTC, Ray Ruben – HTC, Joe Illasiak – PHTC, Bill S. Ruben – PTHC, Tony Green – PHTC, Liz Kuptana – Elder, Eric Lede – Student, Sarah Green – Member, Charlene Green, Perter Sinkins – Parks Canada, Inuvik, Tracy Davison – Environment and Natural Resources, GNWT, Inuvik, Amy Ganton – ECCC, Canadian Wildlife Service, Yellowknife, Isabelle Duclos – ECCC, Canadian Wildlife Service, Yellowknife

## 1.10 Revised maps

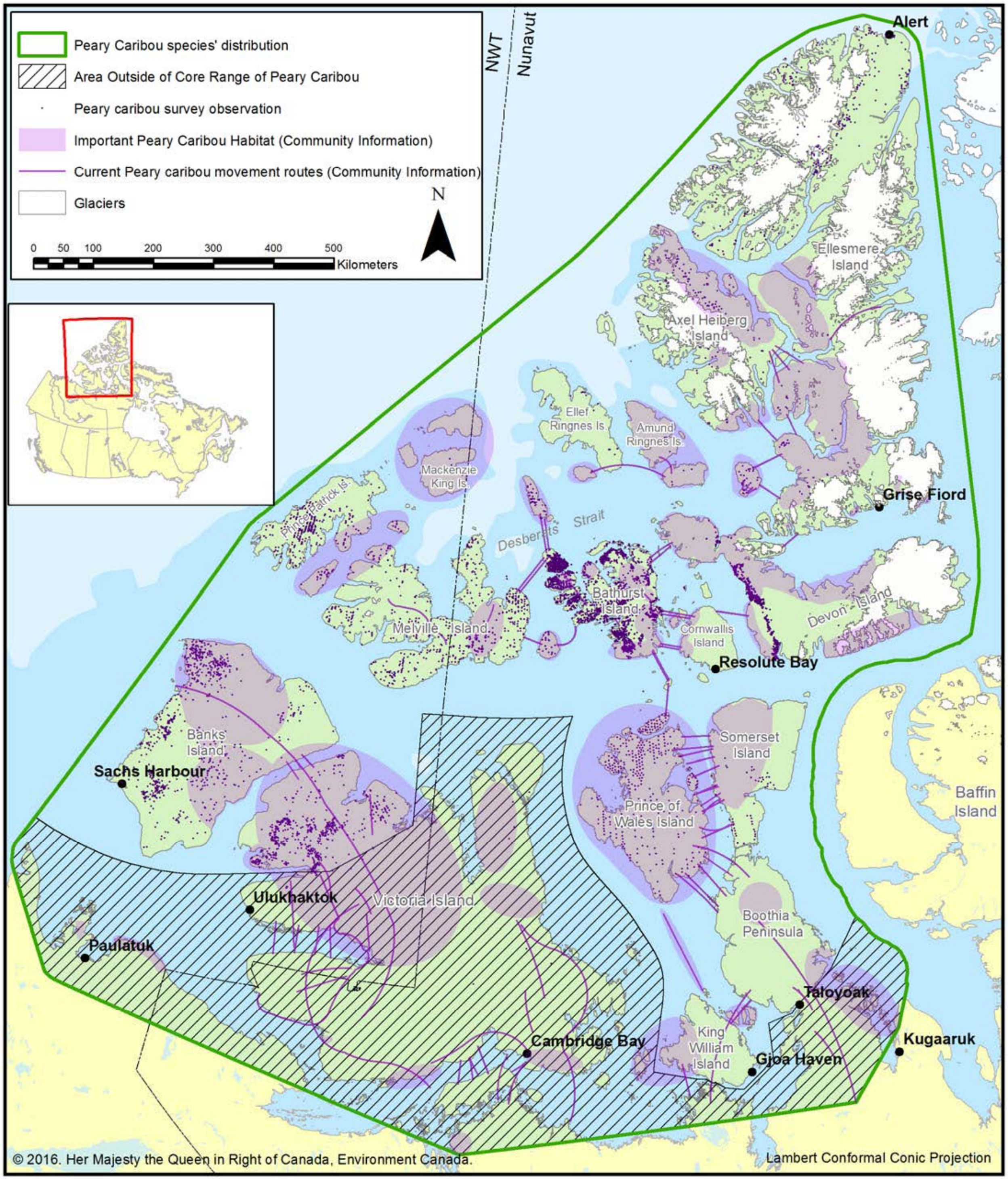



Figure 2. Peary Caribou distribution defined using a standard convex polygon methodology enclosing survey data and community information (1970-2015) modified from Johnson et al. 2016 (Johnson et al. 2016) to differentiate between core range and areas outside of core range.

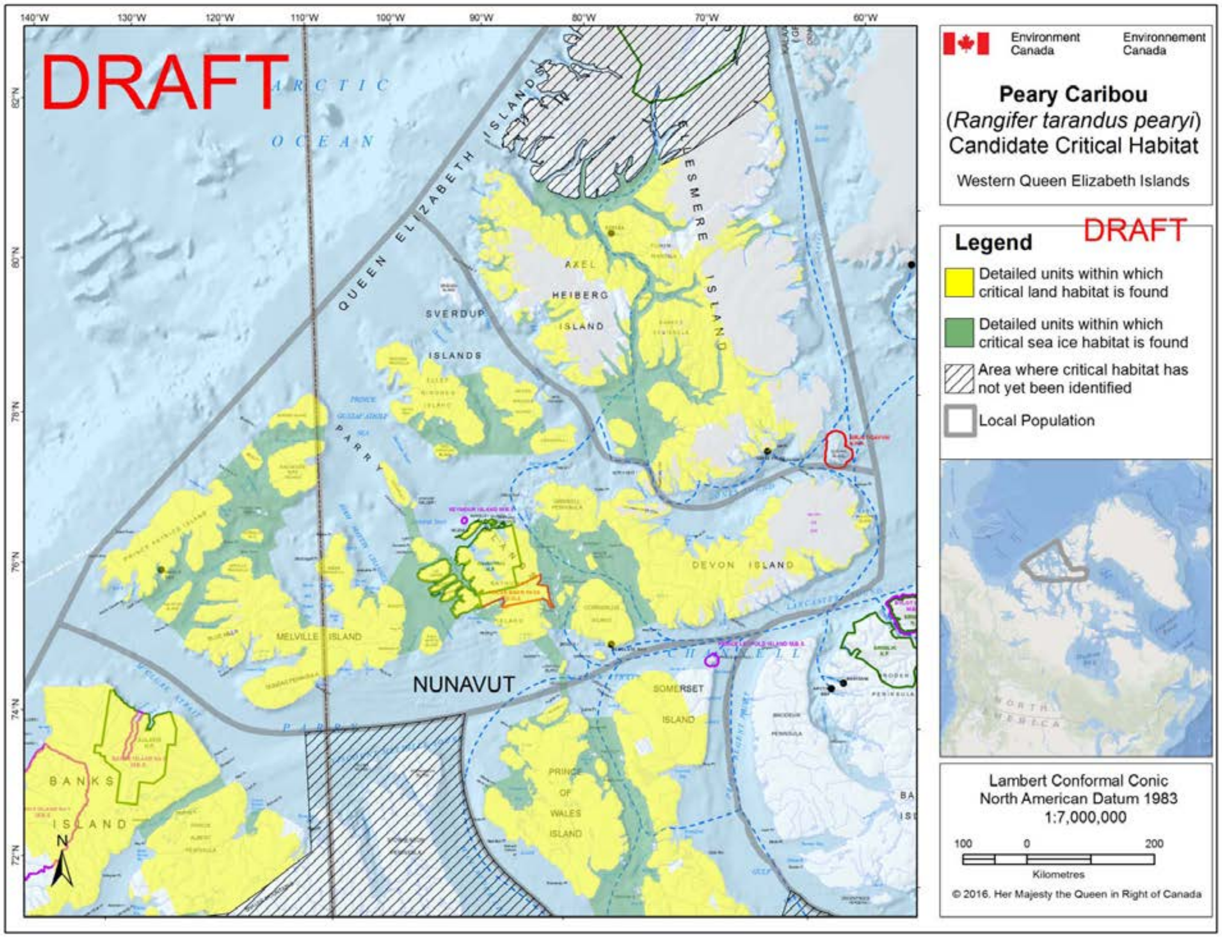



Figure 4. Detailed units that contain critical habitat for Peary Caribou in the Western Queen Elizabeth Islands local population (NT & NU).

## 2.0 Questions to the GN WRT Baffin Caribou Subpopulation Delineation

QWB Caribou Ranges Workshop – Jun 22 2016 ~16:00

Ben – how were the boundaries developed, and what consultation was conducted in determining them? Could have serious consequences to harvesters so requires consultation under NLCA

David – how many years would the system be imposed? Also note that the male-only harvest could have impacts on people since cows are better for clothing and hunters can select cows without calves to reduce the impact. Imposing boundaries on harvest would require consultation under the NLCA

Joannie – frustrated by the boundary, Kimmirut's recommendation would be not to have boundaries since they are allowed to harvest anywhere as beneficiaries, and the reindeer on Baffin from the 1930s have been used up or are gone and that's the only place where it seemed like a boundary would make sense

Mike – overview that populations change over time and the boundaries change over time and need to be updated, for example Pangnirtung wouldn't originally have fallen within the range delineated for south Baffin caribou but as the caribou moved this was updated. Usually this is based on IQ to update boundaries. Lines are developed for a point in time – Elders suggest that when the population is low there is less well-defined structure and more mixing, there may be one population at those times, and they are located less predictably on the landscape

Qikiqtarjuaq – these boundaries were not presented during consultations – concerned that they would not be able to harvest

Jackie – Troy and Jaylene did meet with the communities and QWB was invited but they were short-staffed and unable to attend, so she can't speak to what information was exchanged at those meetings

David – these boundaries might have been presented for research purposes but not for harvest purposes, so maybe the boundaries were consulted on in the context of research rather than for tag distribution and harvest areas

Ben – some people around the table may not know what we're discussing, and it isn't meant as a slight against researchers but there needs to be incorporation of peoples' harvesting areas and need for understanding of where and when people harvest – boundaries should be removed until that can be incorporated. Boundaries may not be valid if they were developed at a different population level and should be evaluated for current situation as well.

Abraham – thought he might be thinking of a different boundary than the one under discussion – this would be like for polar bears? Seems like an underhanded move by the government to force the NMWB into making a decision

David – current system allows communities to renegotiate tags if some are not used so that other communities could use them – can't see how that would be possible with the boundaries in place

Would there be something like for polar bears where a 30-km overlap area is incorporated around the boundary?

Mike – the lines are meant to be for caribou, not people

Lynda – People could theoretically harvest from multiple zones that reflect their hunting practices, it would be a matter of HTOs and QWB working together to assign tags in different areas to different communities, while addressing the concern that arose with the NWMB that there would be too much harvest pressure in areas where there were few caribou – i.e. south Baffin communities transferring a large number of tags to Pond Inlet and potentially exerting unsustainable harvest pressure on the north Baffin caribou

Since the hall had to be vacated and cleaned up by 17:30 and it was now 17:00 the discussion was put on hold until it could be addressed at a later date and the meeting was adjourned.

## 3.0 RE: Devon survey

### 3.1 From: rbhta [rbhta@qiniq.com]

You replied on 2/3/2016 11:27 AM.
Sent: Wednesday, February 03, 2016 10:52 AM
To: Anderson, Morgan; Mullin, Tabitha
Hi
RBHTA Directors wanted Devon Island survey if Grise Fiord HTA agree to that to.
Thanks
Nancy Amarualik
Manager
RBHTA

From: Anderson, Morgan [mailto:MAnderson@GOV.NU.CA]
Sent: February0216
8:59 AM
To: rbhta; Mullin, Tabitha
Subject: RE: Devon survey
Oh, looks like I can do Devon afterall… unless people really want Bathurst done, I can try to switch things around.

From: Anderson, Morgan
Sent: January 28, 2016 3:30 PM
To: 'rbhta'; Mullin, Tabitha
Subject: RE: Devon survey
Hi Nancy and Tabitha,
Do you have any thoughts on a Bathurst Island survey this spring? I just found out that my director wants me to fly Bathurst Island instead of Devon. So I'm touching base with you guys to see if you have any preference. I haven't heard of any big changes in the caribou or muskox on Bathurst and we just flew it 2 years ago, so I'm more interested in seeing what's going on with Devon, like if Bathurst caribou have moved over there (plus it gives an update on the northeast side for Grise). I'm still trying to get something going for Prince of Wales and Somerset this summer…
Morgan

From: rbhta [mailto:rbhta@qiniq.com]
Sent: January 25, 2016 5:03 PM
To: Anderson, Morgan
Subject: RE: Devon survey
Hi Morgan,
Directors had a meeting and read your email letter and if have the funding to do the survey at Devon and if Grise Fiord HTA agree too. Director still want Somerset Island and Prince of Wales Island to be survey too.
Nancy Amarualik
Manager
RBHTA

From: Anderson, Morgan [mailto:MAnderson@GOV.NU.CA]
Sent: January1216
10:59 AM
To: rbhta
Subject: Devon survey
Hi Nancy,
I was planning on doing a survey on central/northern Ellesmere with Grise Fiord in March, but we don't have enough fuel at Eureka to do it, so I was thinking of switching over to Devon Island, since I have funding to fly a survey until March 31. Grise has been getting a few caribou there in the last couple years and it hasn't been surveyed since 2008, so it seems like a good option. Maybe see what the Board thinks about it, or if they have any recommendations? I was thinking of splitting the survey between Grise and Resolute so both communities flew over the areas where they usually travel and harvest.And I'm still trying to make Prince of Wales/Somerset work for the summer. I'll let you know how it goes as the plans evolve… and I should be able to do a few days of pellet collection on Bathurst and Lougheed Island again this year like we've done in the past, so I'm looking forward to working with the Resolute folks on that again too.
Morgan
Morgan Anderson
Wildlife Biologist, High Arctic Region

### 3.1 Comments by Email from Resolute SAO on March 22, 2016

- Good Afternoon, Council didn't have any recommendation or concerns regarding the Perry Caribou and Muskox Survey that will be conducted on Devon Island.
  *Angela Idlout, Senior Administrative Officer*

### 4.0 Support from Resolute HTA for POWSI survey

Resolute Bay Hunters & Trappers Association
P.O Box 61
Resolute Bay NU X0A-0V0
P-867-252-3170
F-867-252-3800
Email- rbhta@qiniq.com
October 9,2015
To: Morgan Anderson
Wildlife Biologist
Department of Environment
Government of Nunavut
P.O Box 209
Igloolik NU X0A-0L0

RBHTA Directors are giving they support for the air survey at Somerset & Prince of Wales Island for musk ox and caribou .
Thanks
Nancy Amarualik, RBHT

## 5.0 Research Project Updates and Proposals, July 18 2016

Grise Fiord Hamlet Building 19:30-21:30
Meeting with Iviq Hunters and Trappers Association
In attendance: Jaypetee Akeeagok (chair), Jopee Kiguktak, Amon Akeeagok, Imooshie Nutaraqjuk, Aksakjuk Ningiuk, Etuangat Akeeagok, Charlie Noah, Monasie (secretary-manager filling in for Terry Noah), Morgan Anderson.

Jaypetee introduced Morgan and the purpose of the meeting; Morgan provided an overview of research results to date and upcoming projects for comment; Monasie provided translation throughout the meeting.

### 5.1 Devon Island survey

Morgan showed maps of the transects and survey strata and rationale, followed by observations of muskox and caribou groups and tracks on the island and total estimates (minimum count of 14 caribou – not an estimate – and 1963±SE343 muskoxen). Concentration areas for both caribou and muskoxen were in areas where they had previously been observed, although we did not see any caribou around Truelove – they may have been missed between transects if they are at such low densities, and the report acknowledges this. Caribou are believed to be stable at low density on the island, but muskoxen have almost quadrupled from historic estimates, so we can look at changing management for muskoxen on Devon Island. Morgan proposed that the TAH could be increased from the 15 tags currently available (a conservative harvest of 5% of the population would be about 100 tags), and maintaining tags might allow multiple communities to better coordinate harvest. Alternatively, the TAH could be removed entirely, but coordination would still be important. Morgan showed the difference she found between the voluntary reporting of the Nunavut Wildlife Harvest Study and the mandatory reporting of muskox tags. More muskoxen were reported when it was a requirement, and this is important for establishing basic needs level (if it ever needed to be determined for muskoxen) and provides a good dataset for making management changes and supporting decision-making. Morgan pointed out that prior to any official changes for the Devon Island TAH through NWMB in September, if people are interested in doing a hunt, we can put through an exemption to increase the number of tags available for it.

*Comments – Jaypetee suggested that the Board further discuss options for Devon Island. His personal opinion was that opening up the harvest completely could be problematic, especially if communities that are not used to hunting muskoxen might not know the best ways to harvest them responsibly. Maintianing tags but increasing the number might be a good approach. Jaypetee and Aksakjuk both reminded everyone that the muskox might be in a 'boom' right now, but that population booms are followed by busts, and we still need to be careful. Aksakjuk pointed out that increasing muskox harvest now, while their numbers are high, could be beneficial for caribou, since Peary caribou tend to be at low numbers when muskoxen are abundant. The Board will be meeting on July 21 and will further discuss.*

### 5.2 Upcoming surveys

Morgan provided a brief overview of plans for Prince of Wales and Somerset island caribou/muskox surveys in August and offered to provide results of the surveys to the Board, since although they do not harvest those areas directly, the population dynamics there might influence populations that they do harvest. In March/April 2017, Morgan is working on setting up an aerial survey, following the same protocols as Devon and south Ellesmere islands in 2015 and 2016, to survey central and northern Ellesmere Island. It be about 180 hours of Twin time, so getting the funding and logistics in place will determine whether/how much of the survey can be accomplished. It would be from Grise Fiord, Eureka, Tanqary Fiord, and potentially Alert.

*Comments – no specific comments.*

### 5.3 Peary caribou genetics

Morgan showed the two most recent maps of population groupings for caribou in the Arctic Archipelago. First, a more broad scale map showed division between mainland caribou, Peary caribou, and Banks Island caribou. Victoria Island and Boothia Peninsula had more mixing. Second, a finer scale map investigating just the island caribou still pulled out Banks Island as a unique group, with another group in the south-central Queen Elizabeth Islands (Bathurst Island) and another group further north (Ellesmere Island). There was more mixing between Bathurst Island/Ellesmere Island groups than with Banks Island, suggesting more movement between these island groups than with Banks Island. Another interesting point was that samples from Bathurst Island before the die-off in the 1990s and afterwards had the same haplotypes, suggesting that caribou on the island now are related to the ones prior to the die-off. This doesn’t mean that they didn’t move over from other nearby islands, since caribou on nearby islands like Devon also share the same genetics, but it does mean that there wasn’t an influx of caribou from the Boothia Peninsula, Ellesmere Island, or Banks Island to aid in the recovery of the population. Fieldwork plans this summer are to gather more samples from Lougheed Island and Bathurst Island, and we will add Dolphin-Union caribou samples to get a better view of how caribou interact on Banks Island and Victoria Island.

*Comments – Jaypetee was pleased to see that the genetics reflected what was known about movements and populations through IQ, although it is unfortunate that we have to wait for science to double-check what is already common knowledge to Inuit. Still, he is glad that this information will be better used and incorporated now with both IQ and science backing it up.*

### 5.4 Eureka wolf work

Morgan showed maps of the home ranges and explained the minimum convex polygon ranges, which connect all the locations to provide a total area used by the wolves, and the Brownian bridge movement model home ranges, which show the intensity of use, where wolves spend 95% of their time and 50% of their time. She also showed the time series locations in Google Earth so everyone could watch the wolf movements over the seasons – especially W444’s move to Axel Heiberg Island, where he is now the breeding male, and W445’s movement to Dundas Harbor on Devon Island. Morgan showed a map of location clusters and pictures of several typical cluster locations – look out points, dens, and kill sites (only muskox kills have been found to date). Even clusters that were created over a couple hours were checked, to make sure caribou were not being missed. The extent to which the muskoxen have been consumed leads us to believe that there might not be any bones left from a caribou, but the rumen and hair pile would likely still be obvious. Morgan also gave a brief overview of some unusual observations from the last 2 field season, including multiple cases of more than one breeding female, and two cases this season where wolves from another pack killed pups.

*Comments – Members were quite interested in W445’s route along southern Ellesmere, and pointed out where she turned back at Hell Gate and likely skirted open water to cross Jones Sound on the ice. Amon suggested she may have been living off seal pups, since wolves will hunt them. She apparently passed just north of town while most people were at the fishing derby on Devon Island. Jaypetee wanted to know whether the collars that were no longer* *functioning had actually dropped off the wolves. Morgan explained that of the 4 collars no longer functioning, 2 had dropped and been recovered, another had apparently dropped in a pond and could not be found, and the one on Devon Island had not been checked yet. She is trying to arrange for aircraft in the area to retrieve it, or if anyone will be boating in the area she will provide coordinates for retrieval. It's important to get the collars back to find out whether they dropped or whether the wolf died, and also to download activity data that helps interpret behaviour. Jaypetee found the cases of pup-killing quite interesting, but pointed out that in sled dogs if you wash the puppies even up to about 6 months old, sometimes the mother will kill them, so it isn't unexpected to happen with wolves, which are closely related. He pointed out that the film crew, if they got footage of the wolves killing the pups, should be careful how they interpret it if they show it, since it is part of nature. Members were also curious how the wolves were captured, so Morgan explained that her preferred method was darting from close range on the ground, since the wolves were less stressed this way, followed by helicopter net-gunning (which allows more control over how much drug is administered and less impact on injection), and finally helicopter darting, which has also been very effective. We've watched darted wolves after recovery to see if they limp or have any obvious issues at the impact site and they've been walking or running normally. As a general comment, Jaypetee was glad to have this kind of in-person communication of research results (not just for the wolf work), since it almost never happens after the Board approves projects, and they're expected to track down and accept whatever results are produced. It's good to be involved throughout the process, and the information is quite useful.*

### 5.5 Lancaster Sound bears

Morgan gave a very brief introduction of plans for genetic capture-mark-recapture work to update population estimates of Lancaster Sound polar bears in 2018, after Gulf of Boothia and Davis Strait populations. Since the method was the same as the Kane Basin work recently completed, it was more of an information item that the Board would consider. She also pointed out some knowledge gaps that the Board might consider assisting the Polar Bear Biologist with, including when the survey should be flown (spring/fall), good places to base operations from, and whether people would consider deploying collars or eartags to update movements and population delineations. It was introduced as questions that the Board might consider and discuss, which could be incorporated into the study design at this early stage of planning.

*Comments – Jaypetee was not familiar with the satellite ear tags, and would like more information on their impact and the quality of data as compared to collars, so that the Board could consider options. Jopee explained a little about their size and configuration, as he had worked on the Kane Basin tagging. Jaypetee suggested that basing out of Grise Fiord any time October to March would allow plenty of bears to be sampled right in town. There were not many specific comments, as it was the first time the Board had been introduced to the project, so they will discuss it further.*

## 6.0 Devon muskox at NWMB (TAH)

### 6.1 From: rbhta [rbhta@qiniq.com]

Sent: Thursday, August 18, 2016 10:54 AM
To: Anderson, Morgan
Subject: RE: Devon muskox at NWMB

Good morning,
Ola the board hasn't made they're decision yet, can bring it up again at the next meeting.I can also tell them we can wait tell next year to do so.

Thank you so much
Delilah manik
Acting manager
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### 6.2 From: Iviq HTA [gfiviq_hta@qiniq.com]

Sent: Thursday, September 01, 2016 2:48 PM
To: Anderson, Morgan
Subject: RE: Devon muskox at NWMB

Hi Morgan,
The board has decided that they would like the TAH for Musk-ox on Devon Island to be raised to 100 and would require a review by all communites involved at an agreed later date. Also, they would like to be informed on how many of those 100 will be designated to North Devon Island (Grise Fiords quota).

Thanks,
Terry Noah
Manager, Iviq HTA
P: (867) 980 9063
F: (867) 980-4311

-----Original Message-----

### 6.3 From: Anderson, Morgan [mailto:MAnderson@GOV.NU.CA]

Sent: Wednesday, August 17, 2016 7:07 PM
To: gfiviq_hta@qiniq.com; rbhta@qiniq.com
Subject: Devon muskox at NWMB

Hi guys - just a reminder if the Boards have any resolutions or written support letters for increasing/removing TAH on Devon muskox that we'll need to get those into NWMB. Without that support and comment, it's quite likely that NWMB will just defer the Request for Decision to the next meeting, and it would be good to get it at least addressed at the September meeting...

It looks like the department would also potentially support a short-term larger or unlimited harvest as long as there was solid reporting in place, although I have no idea the logistics involved in that and I suspect it might be more realistic for next year... but if you have any comments on that, please add it to any letter or Board decision.

Thanks! Morgan

**DISTRIBUTION AND ABUNDANCE OF PEARY CARIBOU (*Rangifer tarandus pearyi*) AND MUSKOXEN (*Ovibos moschatus*) ON DEVON ISLAND, MARCH 2016**

MORGAN ANDERSON[1]

Version: 13 July 2016

[1]Wildlife Biologist High Arctic, Department of Environment
Wildlife Research Section, Government of Nunavut Box 209 Igloolik NU X0A 0L0

STATUS REPORT 2016-01
NUNAVUT DEPARTMENT OF ENVIRONMENT
WILDLIFE RESEARCH SECTION
IGLOOLIK, NU

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ᑎᑎᖅᑲᖅ: 13 ᔪᓚᐃ 2016

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Anderson, M. 2016. Distribution and abundance of Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) on Devon Island, March 2016. Nunavut Department of Environment, Wildlife Research Section, Status Report 2016-01, Igloolik, NU. 37 pp.

**Summary**

We flew a survey of Devon Island including Philpots Island (Muskox Management Zone MX-04), by Twin Otter in 58 hours between March 22 and 30, 2016, to update the population estimate for caribou and muskoxen in the study area. The previous survey, in 2008, reported a minimum count of 17 Peary caribou and population estimate of 513 muskoxen (302-864, 95%CI). The 2016 survey found the highest reported abundance estimate for muskoxen (1,963 ±343 SE), and a minimum count of 14 Peary caribou suggests that they continue to persist at low densities on the island, although the low number of observations precludes calculation of a reliable population estimate.

Muskoxen were abundant in the coastal lowlands where they have been found historically, at Baring bay, Croker Bay, Dundas Harbour, and the Truelove Lowlands. They were also abundant on the north coast of the Grinnell Peninsula, and particularly abundant on Philpots Island, where we observed 310 muskoxen. Although most previous surveys covered only part of Devon Island, they did target these lowlands and their abundance estimates or minimum counts likely represent the majority of the muskox population. This survey indicates a large increase in muskoxen on Devon Island, with more observations in all lowland areas compared to 2008, and a particular increase on Philpots Island. This population trend is mirrored on neighboring Bathurst Island to the west, surveyed in 2013, and southern Ellesmere Island to the north, surveyed in 2015.

We only saw 14 Peary caribou during the survey, concentrated on the north shore of the Grinnell Peninsula, and tracks were seen south of Baring Bay. No caribou were seen in the Truelove Lowlands, although hunters from Grise Fiord have caught caribou there over the past several years. It is likely that the low density and patchy distribution of caribou in this area meant that they were not detected on the survey flights. Previous surveys also found caribou in small numbers in specific locations, including a minimum count of 17 caribou in 2008 and 37 caribou on western Devon Island in 2002. Combined with the local knowledge of residents of Grise Fiord and Resolute Bay, it is likely that this population of Peary caribou remains stable at low densities, patchily distributed on Devon Island.

ᐋᓐ ᑐᕐᓴᓐ, ᒍ. 2016. ᓇᓃᖃᑦᑕᕐᓂᖏᑦ ᐊᒻᒪᓗ ᐅᒥᕐᓂᖏᑦ ᖁᑦᑎᒃᑐᕐᒥᐅᑦ ᑐᒃᑐᖏᑕ ᑕᐃᔭᐅᔪᑦ (*Rangifer tarandus pearyi*)–ᒥᒃ ᐊᒻᒪᓗ ᐅᒥᖕᒪᐃᑦ ᑕᐃᔭᐅᔪᑦ (*Ovibos moschatus*)–ᒥᒃ ᑕᓪᓗᕈᑎᐅᑉ ᕿᑭᖅᑕᖓᓂ, ᒫᔾᔨ 2016. ᓄᓇᕗᒻᒥ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᐆᒪᔪᕐᓂᒃ ᖃᐅᔨᓴᖅᑎᒃᑯᑦ ᖃᓄᐃᓕᖓᓂᖏᓂᒃ ᐅᓂᒃᑳᖅ 2016-0, ᐃᒡᓗᓕᒃ, ᓄᓇᕗᑦ

**ᓇᐃᒻ ᓕᑎᖅᓯᒪᔪᖅ**

ᖃᖓᑕᓚᐅᖅᐳᑦ ᓈᓴᐃᓪᓗᑕ ᑕᓪᓗᕈᑎᐅᑉ ᕿᑭᖅᑕᖓᓂ ᐃᓚᐅᓪᓗᓂ (Philpots Island) (ᐅᒥᖕᒪ ᓕᕆᓂᕐᒥ MX-04), ᖃᖓᑦᔨᕋᓛᒃᑯᑦ 58–ᒥ ᓂᒥᒃ ᐊᑯᓂᐅᑎᓕᓪᓗᑕ ᒫᔾᔨ 22 ᐊᒻᒪᓗ 30, 2016 ᐊᑯᓐᓂᖓᓂ, ᒫᓐᓇᒍᑦ ᓇᓗᓇᐃᕐᓗᒍ ᖃᓄᖅ ᐊᒥᓲᑎᑎᖕᒪᖔᑕ ᒥᒃᓴᐅᓴᒃᓯᒪᓕᖅᑐᑦ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᑕᐅᕙᓂ ᖃᐅᔨᓴᕐᕿᑎᔭᑦᑎᓐᓂ. ᓈᓴᐃᓂᐅ ᓚᐅᖅᓯᒪᔪᖅ, 2008–ᒥ, ᓇᓗᓇᐃᖅᓯᓚᐅᖅᓯᒪᖕᒪᑕ ᐊᒥᓲᖕᓂᖏᑦ ᓈᓴᖅᑕᐅᔪᑦ 17 ᖁᑦᑎᒃᑐᕐᒥᐅᑦ ᑐᒃᑐᖏᑦ ᐊᒻᒪᓗᒥᒃᓴᐅᓴᒃᑕᐅᔪᑦ 513–ᖑᓪᓗᑎᒃ ᐅᒥᖕᒪᐃᑦ (302-864, 95%CI). ᑖᒃᑯᐊ 2016–ᒥ ᓈᓴᖅᑕᐅᔪᑦ ᖁᑉᕙᓯᓛᖑᓚᐅᖅᓯᒪᕗᑦ ᐅᖃᐅᓯᐅᔪᑦ ᖃᔅᓯᐅᓂᖏᓂᒃ ᓈᓴᐃᑎᓪᓗᒋᑦ ᐅᒥᖕᒪᖕᓂᒃ (1,963 ±343 SE)–ᖑᓪᓗᑎᒃ, ᐊᒥᓲᖏᓛᖑᓪᓗᑎᒃ ᓈᓴᖅᑕᐅᔪᑦ 14 ᖁᑦᑎᒃᑐᒥ ᑐᒃᑐᖏᑦ ᓇᓗᓇᕈᓐᓃᖅᑯᓂ ᐊᒥᓲᓕᖅᓯᒪᖏᑐᑦ ᑕᐃᑲᓂ ᕿᑭᖅᑕᒥ, ᑖᒃᑯᐊ ᑕᑯᔭᐅᔪᕕᓃᑦ ᐊᒥᓲᖏᓂᕐᓴᐅᒐᓗᐊᖅᑎᓪᓗᒋᑦ ᑕᒪᒃᑭᖅᓯᒪᙱᒪᖖᑕᓘᓐᓄᑦ ᒥᒃᓴᐅᓴᒃᑕᐅᓯᒪᔪᑦ ᒪᓕᒃᑯᒋᑦ.

ᐅᒥᖕᒪᐃᑦ ᐊᒥᓲᓂᖅᓴᐅᓚᐅᖅᐳᑦ ᓯᒡᔭᖅᐸᓯᖕᒥ ᓇᑎᕐ ᓇᐅᓂᕐᓴᓂ ᑕᐅᕙᓕᓗ ᓇᓂᔭᐅᔪᓐᓇᕐᓂᕐᓴᐅᕗᒃ ᑲᒥᒃ ᐅᖃᐅᓯᑐᖃᒃᑯᑦ, ᐅᑯ ᓇᓃᓚᔪᒃᑯᑎᒃ, (Baring bay), ᑯᓛᑯ ᖃᖏᖕᑯᒃ, ᑕᓪᓗᕈᑎ, ᐊᒻᒪᓗᑦ ᑕᐅᖅ ᖃᓪᓗᓈᑦ ᑲᖏᖕᑯᐊᑕ ᐊᑦᑎᖕᓂᖏᓂ. ᐊᒥᓲᓂᖅᓴᐅᓚᐅᕐᒥᔪᑦ ᐅᐊᖕᓇᖓᓂ ᓯᒡᔭᖅᐸᓯᖕᒥ (Grinnell Peninsula)–ᒥ, ᐊᒻᒪᓗ ᐊᒥᓲᓂᕐᓴᐅᓪᓗᑎᒃ (Philpots Island)–ᒥ, ᓈᓴᐃᓚᐅᖅᑐᒍᑦ 310–ᓂᒃ ᐅᒥᖕᒪᖕᓂᒃ. ᒫᓐᓇᓕᓴᐃᑦ ᕿᓂᕐᓃᑦ ᐃᓚᐃᓐᓇᖕᓂᐅᓚᓗᐊᖅᑯᓂ ᑕᓪᓗᕈᑎᐅᑉ ᕿᑭᖅᑕᖓ, ᕿᓂᕐ ᕼᖃᓗᐊᓚᐅᖅᐳᑦ ᐊᑦᑎᖕᓂᖏᓂ ᓄᓇᐃᑦ ᐊᒥᓲᓂᖅᓴᐅᓂᖏᑦ ᒥᒃᓴᐅᓴᒃᑕᐅᔪᑦ ᓈᓴᖅᑕᐅᓪᓗᑎᒃ ᐊᒥᓲᓂᕐᓴᒻᒪᕆᐅᓯᒪᖕᒪᑕ ᑕᐅᕝᕙ ᐅᒥᖕᒪᐃᑦ ᖃᔅᓯᐅᓂᖏᑦ. ᑖᓐᓇ ᓈᓴᐃᓂᐅᔪᖅ ᓇᓗᓇᐃᖅᓯᕗᖅ ᐊᒥᓯᕈᕆᐊᒃᑲᓐᓂᕐᓯᒪᓂᖏᓂᒃ ᐅᒥᖕᒪᐃᑦ ᑕᓪᓗᕈᒻᒥ, ᓈᓴᖅᑕᐅᔪᕕᓃᑦ ᐊᑦᑎᖕᓂᕐᓴᓂ ᓄᓇᓂ 2008–ᒥᓂᑦ, ᐊᒻᒪᑦ ᑕᐅᖅ ᐊᒥᓯᕈᕆᐊᒃᑲᓐᓂᕆᓪᓗᑎᒃ (Philpots Island)–ᒥ. ᑖᒃᑯᐊ ᐊᒥᓲᓂᖏᑕ ᐋᖅᑭᒃᑕᐅᓯᒪᓂᕆᔭᖏᑦ ᐃᓚᒋᔭᐅᕆᕗᖅ ᖃᓂᒋᔭᓕᒫᖓᓂ ᑐᒃᑐᓯᐅᕐᕕᐅᑉ ᕿᑭᖅᑕᐅᑉ ᐊᑭᓐᓇᖓᓂ, ᓈᓴᖅᑕᐅᓯᒪᔪᑦ 2013–ᒥ, ᐊᒻᒪ ᐊᐅᓯᐃᑦ ᑑᑉ ᐅᐊᖕᓇᖓᓂ ᕿᑭᖅᑖᓗᑉ ᐅᐊᖕᓇᖓᓂ ᑕᑉ ᐸᐅᖓ ᐅᐊᖕᓇᖕᓗᓄᑦ, ᓈᓴᖅᑕᕕᓃᑦ 2015–ᒥ.

ᑕᑯᑐᐃᓐᓇᓚᐅᕆᕗᒍᑦ 14–ᓂᒃ ᖁᑦᑎᒃᑑᑉ ᑐᒃᑐᖏᓂᒃ ᓈᓴᐃᑎᓪᓗᑕ, ᑲᑎᖅᑯᓯᒪᓚᐅᖅᑐᑦ ᐅᐊᖕᓇᖓᓂ ᓯᒡᔭᖅᐸᓯᖕᒥ (Grinnell Peninsula)–ᒥ, ᑐᒥᓂᒡᓗ ᑕᑯᔭᖃᓚᐅᕆᓪᓗᓂ ᓂᕆᐊᓂ (Baring Bay). ᑐᒃᑐᓂᒃ ᑕᑯᔭᖃᓚᐅᖏᑐᓐ ᖃᓪᓗᓈᑦ ᑲᖏᖕᑯᐊᓂ, ᑭᓯᐊᓂᓕ ᐊᐅᓯᐃᑦ ᑐᕐᒥᐅᑦ ᐊᖑᓇᓯᒃᑎᖏᑦ ᑐᒃᑐᖃᑦᑕᖅᓯᒪᕗᑦ ᑕᐃᑲᓂ ᐊᓂᒍᖅᑐᓂ ᐊᕐᕿᒍᓚᓴᖕᓂ. ᑐᑭᓯᓇᖅᑯᔨᓕᖅᑐᖅ ᐊᒥᓲᙳᐊᕐᓂᖏᑦ ᑲᑎᙵᓛᖃᑦᑕᕐᓂᖏᑦ ᑐᒃᑐᐃᑦ ᑕᐅᕙᓂ ᓈᓴᖅᑕᔪᑦ ᐱᔾᔪᑎᖃᕋᔭᕐᒪᖔᑕ ᑕᑯᔭᐅᙲᑦᑕᕆᐊᒃᓴᖏᓂᒃ ᖃᖓᑦᔨᒃᑯᑦ ᓈᓴᐃᔪᓂᑦ. ᖃᖔᖅᑎᐊᕈᓗᒃ ᓈᓴᐃᑎᓪᓗᒋᑦ ᓇᓂᓯᓚᐅᖅᐳᑦ ᐊᒥᓲᖏᑐᓂᒃ ᑐᒃᑐᓂᒃ ᑕᐅᕙᓂ ᕿᓂᕐᕕᐅᔪᒥ, ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᓇᓴᖅᑕᐅᔪᑦ 17–ᖑᓚᐅᖅᑐᑦ ᑐᒃᑐᐃᑦ 2008–ᒥ ᐊᒻᒪᓗ 37–ᖑᓪᓗᑎᒃ ᑐᒃᑐᐃᑦ ᐊᑭᓐᓇᖓᓂ ᑕᓪᓗᕈᑦ ᕿᑭᖅᑕᖓᓂ 2002–ᒥ. ᑲᑑᔾᔨ ᖃᑎᖃᕐᓱᒃᑎᒃ ᓄᓇᓕᖕᓂ ᖃᐅᔨᒪᔨᑕᐅᔪᓂᒃ ᐊᐅᓯᐃᑦ ᑐᒥ ᖃᐅᓯᐃᑦ ᑐᒥᓗ, ᓇᓗᓇᖅᑰᔨᙶᖅ ᖁᑦᑎᒃᑑᑉ ᑐᒃᑐᖏᑦ ᑕᐃᒪ ᐃᔅᓴᐃᓐᓇᖅᐳᑦ ᐊᒥᓲᓗᐊᕋᑎᒃ, ᑲᑎᙲᑕᖅᐸᒃᓱᒃᑎᒃ ᑕᓪᓗᑉ ᕿᑭᖅᑕᖓᓂ.

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## Introduction

Peary caribou (*Rangifer tarandus pearyi*) are a small, light-coloured subspecies of caribou/reindeer inhabiting the Canadian Arctic Archipelago in the Northwest Territories and Nunavut from the Boothia Peninsula in the south to Ellesmere Island in the north. They are sympatric with muskoxen (*Ovibos moschatus*) over much of their range although diet, habitat preferences, and potentially interspecific interactions separate the two species at a finer scale (Resolute Bay Hunters and Trappers Association [HTA] and Iviq HTA, pers. comm.). Arctic wolves (*Canis lupus arctos*) occur at low densities throughout Peary caribou range, but the most significant cause of population-wide mortality appears to be irregular die-offs precipitated by severe winter weather and ground-fast ice that restricts access to forage (Miller et al 1975, Miller and Gunn 2003, Miller and Barry 2009).

Peary caribou have been surveyed infrequently and irregularly on the Canadian Arctic Archipelago since Tener's 1961 survey, which provided a best guess estimate of 150 Peary caribou on Devon Island, although persistent fog prevented the Colin Archer Peninsula from being surveyed (Tener 1963). Since Tener's survey, unsystematic surveys have been conducted irregularly, usually with a focus on muskoxen in the lowland areas where they are concentrated. In 2002, the western Devon Island was surveyed as part of a program to update population estimates for Peary caribou across their range, and a minimum count of 37 was recorded (Jenkins et al. 2011). The entire island was surveyed in 2008, with a minimum count of 17 caribou (Jenkins et al. 2011). Residents of Grise Fiord and Resolute Bay have not noticed a marked increase or decline in caribou on Devon Island (Iviq HTA, pers comm.), but with higher caribou populations to the west on the Bathurst Island Complex, residents of Resolute were interested in whether caribou have moved onto northern or western Devon Island. Grise Fiord hunters regularly travel the Truelove Lowlands and catch caribou there. Community members were interested in the abundance and distribution of caribou in that area as well as in other areas where the caribou potentially move to.

Population estimates for muskoxen on Devon Island have mostly been estimated based on their abundance in discrete lowland habitat patches. In 1961, Tener surveyed the entire island (except the Colin Archer Peninsula, due to fog) at 6% coverage, and estimated that the population was about 200 muskoxen (Tener 1963). Subsequent surveys focused on the lowland areas where muskoxen could be reliably located. The overall population of muskoxen was believed to be around 300-400 through the 1970s to 1990s (Freeman 1971, Hubert 1977, Decker in Urquhart 1982, Pattie 1990, Case 1992), reaching 513 (302-864 95%CI) by 2008 (Jenkins et al 2011). This was also the first systematic survey of the entire island, although much of Devon Island is unsuitable habitat and it is unlikely that the unsystematic surveys of lowlands missed large numbers of muskoxen. Muskoxen were located consistently in the lowlands around Baring Bay, Maxwell Bay, Dundas Harbour, Philpots Island, Truelove Inlet, Sverdrup Inlet, and the northeast shores of Grinnell Peninsula.

The Peary caribou and muskoxen of western and northern Devon Island are important to the communities of Resolute Bay and Grise Fiord. Arctic Bay hunters also access the southern shores of Devon Island, and with the decline in Baffin Island caribou, Devon Island might become more important in the harvest activities of Arctic Bay. Muskoxen have been hunted in the area since the government ban on muskox hunting was lifted in 1969. As species of presumption of need, subsistence tags are currently set aside and allocated for subsistence, commercial use, and sport hunts according to the allocation of Regional Wildlife Organization (RWO) and Hunter and Trapper Organizations/Associations (HTOs/HTAs). Caribou have been regularly hunted in the region since the communities of Resolute Bay and Grise Fiord were established in the 1950s, although parts of Devon Island have been important harvest areas for centuries. This survey was conducted to update the population estimates, demographic characteristics, and distribution of Peary caribou and muskoxen on Devon Island.

**Study Area**

The survey area is predominantly polar desert and semi desert, with rugged topography along the mountains and fiords of the south and east coasts, which rise from sea level to 700 m, transitioning to rolling terrain dissected by deep river valleys in the interior and on the Grinnell Peninsula. The island is dominated by the 14, 590 $km^2$ Devon Ice Cap, rising to 1800 m AMSL in the center, which is also the highest point on the island. Several smaller glaciers are scattered along the south coast, Grinnell Peninsula, and Colin Archer Peninsula. Cushion forb barrens or cryptogam-herb barrens dominate the island, usually at <5% cover and <100 $g/m^2$ biomass, with isolated patches of prostrate dwarf shrub and prostrate dwarf shrub/graminoid tundra in the coastal lowlands, where vegetation cover increases to 5-50% and biomass increases to 100-500 $g/m^2$ (Gould et al. 2003, Walker et al. 2005).

Mean July temperatures are 3-5°C on the west side of the study area and 5-7°C in the east (Gould et al. 2003 and references therein). In March 2016, the average daily low and high temperatures in Resolute were -32.2°C and -26.1°C; in Grise Fiord, average daily low temperatures were -32.4°C and average daily high temperatures were -25.6°C (Environment Canada weather data, available http://climate.weather.gc.ca/index_e.html). Most of the study area was snow-covered, although some valleys, particularly along the northeast coast, were largely windswept. There was 26-29 cm snow recorded on the ground at Resolute in March 2016 and 4.3 mm of precipitation, compared to 0-5 cm of snow on the ground in Grise Fiord and 5.1 mm of precipitation (Environment Canada weather data).

The March 2016 aerial survey was flown to cover the same study area as the previous 2008 survey (Jenkins et al. 2011), excluding North Kent Island and Bailie Hamilton Island. We stratified the study area to allocate more effort to good habitat where caribou or muskoxen had previously been reported with a 5-km transect spacing and areas with moderate habitat that might have wildlife were survey with a 10-km spacing. We flew transects spaced 15 km apart over barren parts of the island that were unlikely to be occupied by caribou of muskoxen, but where animals could be travelling between suitable habitat patches (Figure1).

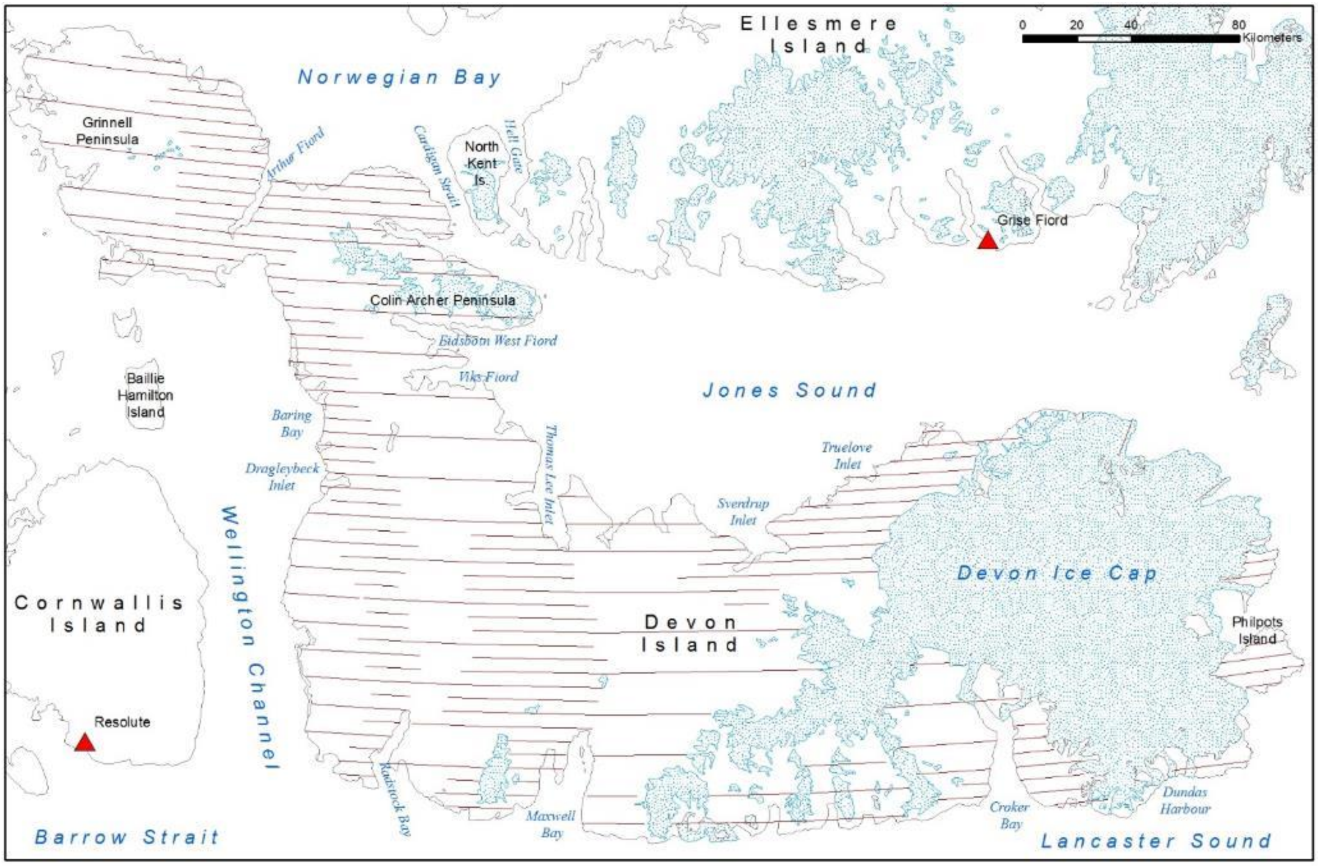


Figure 1. Major landmarks of the study area, with glaciers in stippled blue and 2016 transect lines in dark red running east-west.

## Methods

### *Aerial Survey*

Survey transects (n=166, Appendix 1) followed the transects established for the 2008 distance sampling helicopter survey, parallel to lines of latitude with 5, 10, or 15 km spacing and a 500 m strip on either side of the aircraft. Ice caps were excluded, and we did not detect any caribou, muskoxen, or their tracks on any ice caps during ferry flights. We stratified the study area to maximize survey effort in areas expected to have caribou or muskoxen, since much of Devon Island is barren gravel and till, unlikely to support wildlife. The high density (A) stratum was flown with transects spaced 5 km apart, the intermediate stratum (B) flown at 10 km spacing, and the low density stratum (C) was flown at 15 km spacing. Strata and transects are shown in Figure 2 and Table 1. Data used for delineation of the strata is provided in Appendix 2.

Table 1. Survey strata for Devon Island, March 22-30 2016.

| Block ID | Stratum | Strata Area, Z ($km^2$) | Transect Spacing (km) | Transects Surveyed | Survey Area, z ($km^2$) | Sampling Fraction, f (%) |
|---|---|---|---|---|---|---|
| A | High Density | 18438 | 5 | 117 | 3388 | 18.4% |
| B | Medium Density | 6360 | 10 | 21 | 581 | 9.1% |
| C | Low Density | 15076 | 15 | 28 | 1024 | 6.8% |

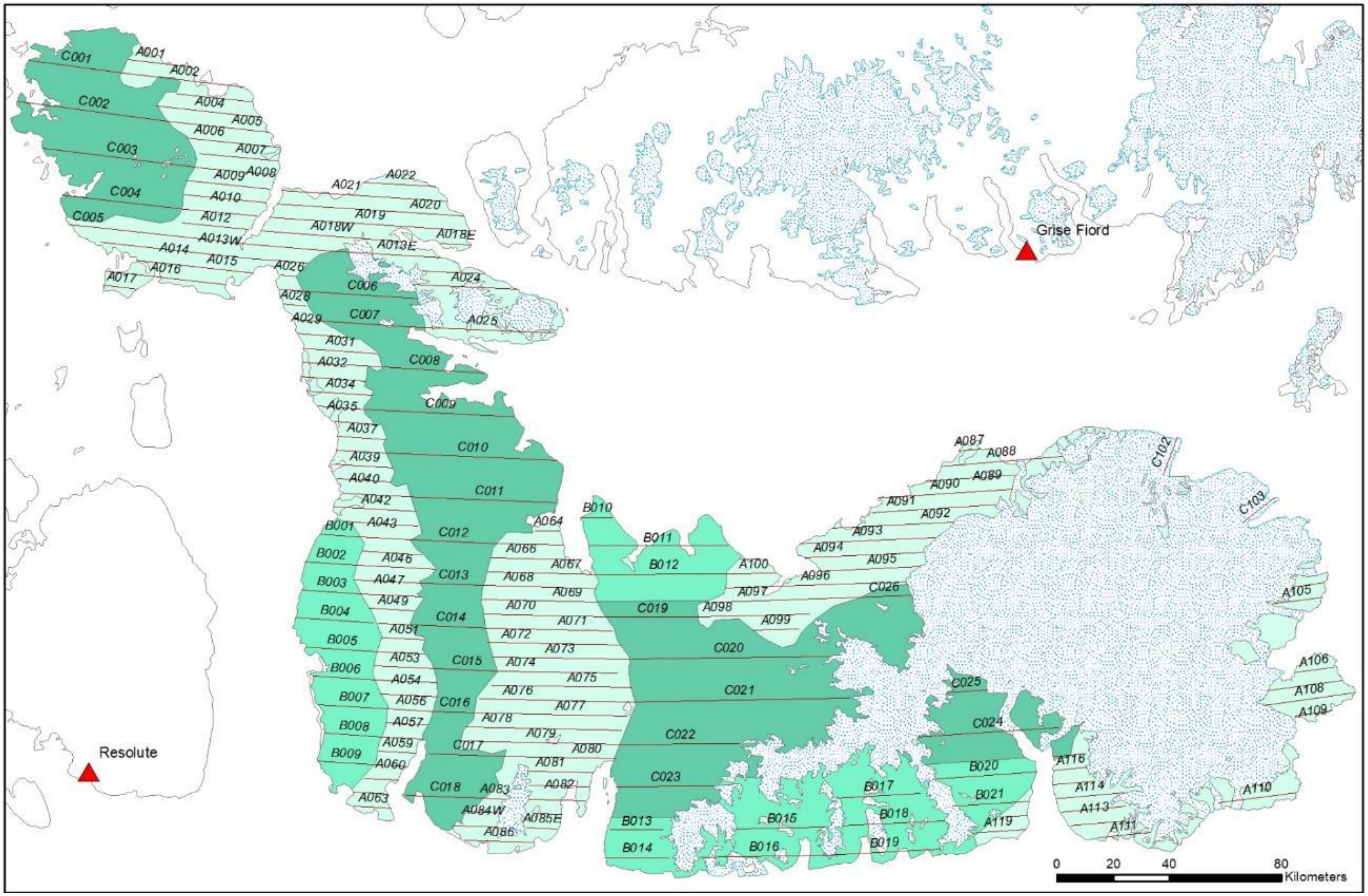


Figure 2. Transects and survey strata for Devon Island, March 22-30, 2016. A transects are the high density stratum flown with transects 5 km apart (pale green), B transects are the intermediate density stratum, flown with transects 10 km apart (bright green), and C transects are the low density stratum, flown with transects 15 km apart (dark green).

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 only used one mark representing 500 m marked on the wing strut. 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.

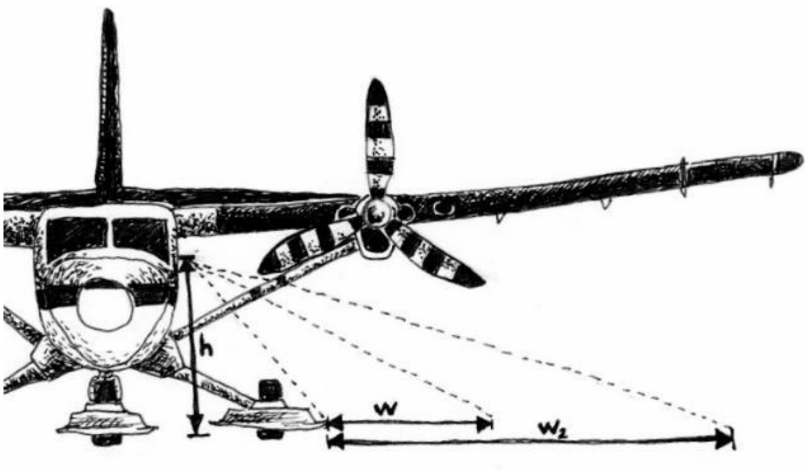


Figure 3. Derivation of wing strut marks for strip boundaries, where *w* and $w_2$ are calculated as described in the text, *h* is measured (2.2 m for Twin Otter on wheel-skis), and dotted lines indicate observer sightlines as modified from Norton-Griffiths (1978).

Transects were flown between 160-220 km/hr with a DeHavilland Twin Otter – higher speeds were used for uniform, snow-covered landscapes where visibility was excellent. Surveys were only conducted on good visibility days to facilitate detection of animals, tracks, and feeding craters, 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.

A Twin Otter with 4-6 passengers (2 front observers, 2-4 rear observers, one of whom was also data recorder) was used to follow the double-observer methodology, which has been successful in other muskox and caribou surveys in Nunavut (see Campbell et al. 2012 for an overview of the methodology) and specifically in the High Arctic on Bathurst and Ellesmere islands (Anderson 2014, Anderson and Kingsley 2015). 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. Estimates of group size are a potentially large source of error in calculating population estimates. However, Peary caribou and muskoxen are generally distributed in relatively small groups where observer fatigue is likely to be a more important source of error (A. Gunn, pers. comm.). We found obvious benefits of using the platform where having the added observers not only increased the accuracy of age and sex classification, but also allowed some crew members to classify with binoculars while others continued to scan for nearby groups and individuals.

All observations of wildlife and tracks were marked 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/short yearling (calves from the previous spring, i.e. 10-11 months old) determination was often straightforward for muskoxen and aided by binoculars. Muskoxen were frequently spotted more than a kilometer off transect due to their large aggregations and dark colour in contrast to the snowy background. Depending on distance and topography, an accurate count could not always be determined for these groups. Newborn muskoxen were obvious based on size, but their small size and close association with other animals in the herd made them difficult to count in larger groups or when muskoxen were tightly grouped. 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 (ESRI, Redlands, CA).

*Analysis*

Flights linking consecutive transects were removed for population analysis, although survey speed and height were maintained and all observations recorded as if on survey. Similarly, sections of transect crossing sea ice and ice fields were removed, as these areas were not included in the area used for density calculations.

Although Jolly's (1969) Method II is widely used for population estimates from surveys, it is designed for a simple random design, rather than for a systematic survey of a patchy population. For comparison, population calculations following Jolly's Method II are provided in Appendix 4, along with calculations following a systematic stratified survey design (Cochran 1977). The muskoxen and caribou 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 $\varepsilon_i$ 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 Devon Island 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. All distance measurements used North Pole Azimuthal Equidistant projection and area-dependent work used North Pole Lambert Azimuthal Equal Area, with central meridian at 88°W and latitude of origin at 76°N (centered over the study area for high precision).

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, $\lambda$. When $r$ >0 or $\lambda$ >1, the population is increasing; when $r$ <0 or $\lambda$ <1 the population is decreasing. Values of $r$ ~0 or $\lambda$ ~1 suggest a stable population.

**Results**

We flew surveys on March 22-30 for a total of 57.4 hours (43.2 h and 5162 km on transect). Incidental wildlife sightings are presented in Appendix 3 and daily flight summaries are presented in Appendix 4.

Visibility was excellent for all survey flights with clear skies (visual estimates of <20% cloud, except some low cloud over open water along the coasts) and high contrast. Temperatures were steady about -30°C during the survey. We saw 14 caribou and 830 muskoxen (plus 6 newborn calves) in total, including off transect sightings. This included 13 Peary caribou and 344 muskoxen on transect. Spatial data presented in Figure 4 represents waypoints taken during the survey along transects and includes on- and off-transect sightings. 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 500 m, some muskox groups off transect were more than 2 km away.

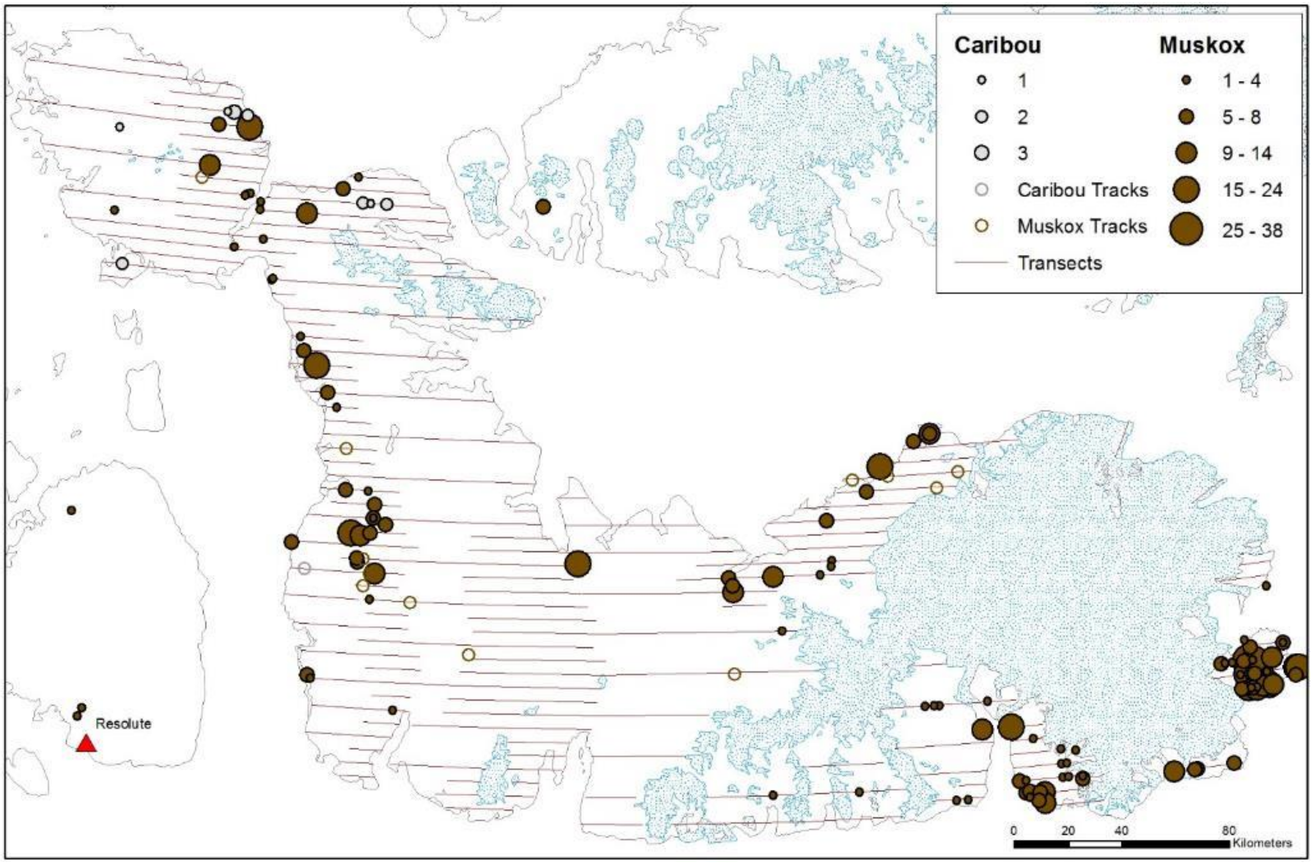


Figure 4. Observations of Peary caribou and muskoxen on Devon Island, March 2016, including observations on and off transect, and on ferry flights.

*Abundance Estimates*

The low number of observations in the intermediate density stratum B (9 muskoxen in 3 groups) and low density stratum C (1 group of 2 muskoxen) precluded calculation of precise population estimates for those areas, but they have been included in the overall population estimate for the island to reflect the low densities of muskoxen present in these strata. A population estimate was calculated for Peary caribou, but the few observations, which were spatially limited to the northwestern part of the study area, also prevent calculation of a precise estimate. Population estimates and variances are presented in Table 2 for muskoxen and Table 3 for caribou.

Table 2. Muskox population calculations for three strata on Devon Island with variance calculated by nearest neighbor methods and by deviations from the sample mean.

| Stratum | Stratum area Z ($km^2$) | Surveyed area z ($km^2$) | Count, y | Estimate, $\hat{Y}$ | Density, $\hat{R}$ | Nearest Neighbor | | | | Deviations from sample mean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV |
| High Density | 18438.26 | 3387.77 | 2 | 1865 | 0.002 | 168.718 | 117524.7 | 342.8 | 0.184 | 246.355 | 171604.6 | 414.3 | 0.222 |
| Medium Density | 6359.77 | 580.54 | 9 | 69 | 0.016 | 1.101 | 2217.7 | 47.1 | 0.684 | 0.954 | 1922.6 | 43.8 | 0.637 |
| Low Density | 15076.34 | 1023.81 | 344 | 30 | 0.101 | 0.050 | 371.9 | 19.3 | 0.655 | 0.075 | 556.5 | 23.6 | 0.801 |
| Total | 39874.37 | 4992.12 | 355 | **1963** | | | 120114.3 | 346.6 | 0.186 | | 174083.7 | 417.2 | 0.224 |

Table 3. Peary caribou population calculations for three strata on Devon Island with variance calculated by nearest neighbor methods and by deviations from the sample mean.

| Stratum | Stratum area Z ($km^2$) | Surveyed area z ($km^2$) | Count, y | Estimate, $\hat{Y}$ | Density, $\hat{R}$ | Nearest Neighbor | | | | Deviations from sample mean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV |
| High Density | 18438.26 | 3387.77 | 13 | 69 | 0.004 | 1.314 | 2658.0 | 51.6 | 0.751 | 1.380 | 930.7 | 30.5 | 0.445 |
| Medium Density | 6359.77 | 580.54 | 0 | 0 | 0 | | | | | | | | |
| Low Density | 15076.34 | 1023.81 | 0 | 0 | 0 | | | | | | | | |
| Total | 39874.37 | 4992.12 | 13 | **69** | | | 2658.0 | 51.6 | 0.751 | | 930.7 | 30.5 | 0.445 |

*Population Trends*

Muskoxen have increased since the last survey in 2008. Based on a population estimate of 1963±SE343 in 2016 and 513 in 2008 (302-864, 95%CI; Jenkins et al. 2011), the instantaneous growth rate $r$ is 0.16, and lambda λ is 1.18. More sophisticated analyses incorporating uncertainty in the estimates have not been undertaken.

A population estimate for caribou was not calculated in 2008 due to the small number of observations. If the groups observed in 2008 had been observed in 2016 with a fixed-width strip transect survey instead, then 3 of the 4 groups (13 of 17 individuals) would have been on transect in the high density stratum. The 2008 population estimate would have been 69±SE47, compared to the 2016 estimate of 69±SE52. The wide confidence interval and few observations in both years make these estimates questionable. Furthermore, neither survey detected caribou in the Truelove Lowlands, where they are known to occur. The 2016 survey also did not detect caribou around Baring Bay, another area where they are known to exist. Lack of observations could be due to movement of animals out of these areas, but it is also possible that they were present but not detected.

*Calf Recruitment*

Although we observed 119 groups of muskoxen, many of these were too far away or individuals were grouped too closely for sex/age identification, and 59 of these groups had at least some individuals with an unknown age. It is also likely that newborn calves were missed in tightly grouped herds, since they are still small and would be inconspicuous or deliberately hidden behind the adults. Newborns were identified in herds with 5, 7, 7, 8, and 15 1+-year-old muskoxen – larger or more tightly clumped groups could easily have concealed others. The distinct size difference between yearlings and adults would also be less obvious under these circumstances. Eleven yearlings were conclusively identified in groups without any unknown age class animals, making them 4.8% of the population. This is based on a biased sample of groups, however, since the larger groups which had animals of unknown age and sex class likely had more yearlings.

*Group Size*

We observed 119 groups of muskoxen, with group sizes ranging from single animals to a herd of 38, with an average of 7.0 muskoxen per group (SD=6.0). Caribou were seen in smaller groups of 1 to 4.

## Discussion

*Population Trends*

Previous surveys of Devon Island have used different survey platforms (Piper Super Cub and deHavilland Beaver, Tener 1963; ground surveys, Freeman 1971; Bell 206 helicopter, Case 1992, Jenkins et al. 2011; Twin Otter, this survey). They have also concentrated on different parts of the island, usually with the goal of estimating muskox populations and therefore focusing on the lowland areas of the north, west, and southeast coasts. The largely unsuitable habitat for caribou or muskoxen on the rest of the island minimizes the bias in estimates derived from these surveys however, especially compared to other island groups that have historically been partially surveyed. Case (1992) did note that muskoxen on the 1990 survey may have been missed inland from Baring Bay and a search of that area would have improved the survey results.

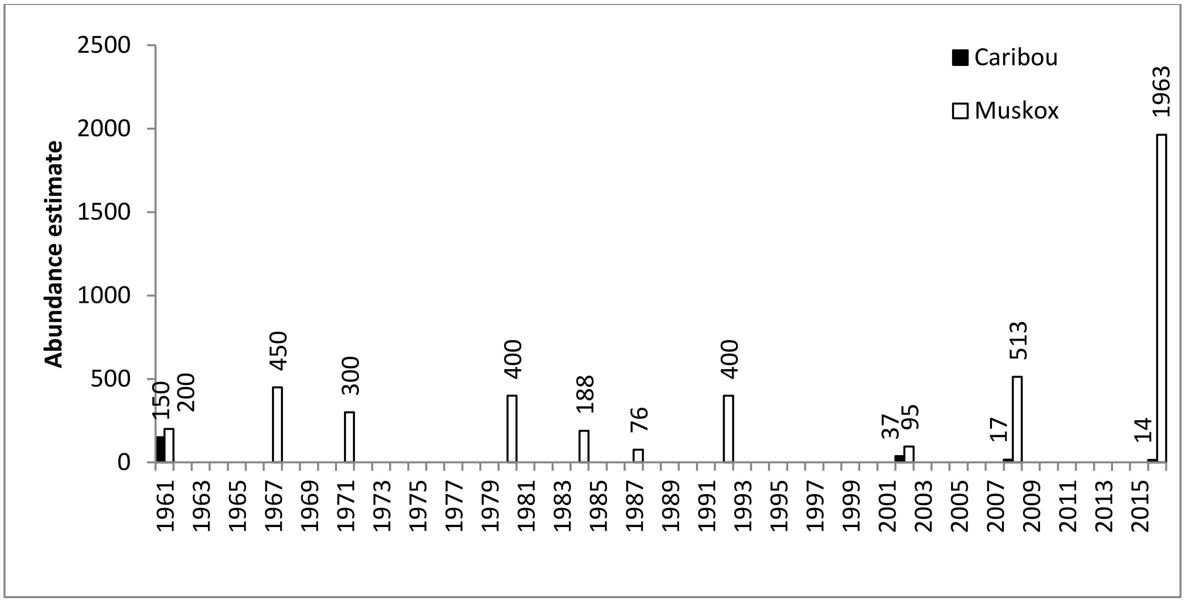


Figure 5. Population estimates for muskoxen and caribou on Devon Island. Muskox estimates prior to 1980 were extrapolations from minimum counts (Tener 1963, Freeman 1971, Hubert 1977, Decker in Urquhart 1982, Case 1992), followed by minimum counts (Pattie 1990, GN data unpublished for 2002) and then systematic surveys covering part (GN data unpublished for 2002) or all (Jenkins et al. 2011 and this survey) of Devon Island. Caribou estimates are guesses (Tener 1963) or minimum counts (Jenkins et al. 2011, this survey).

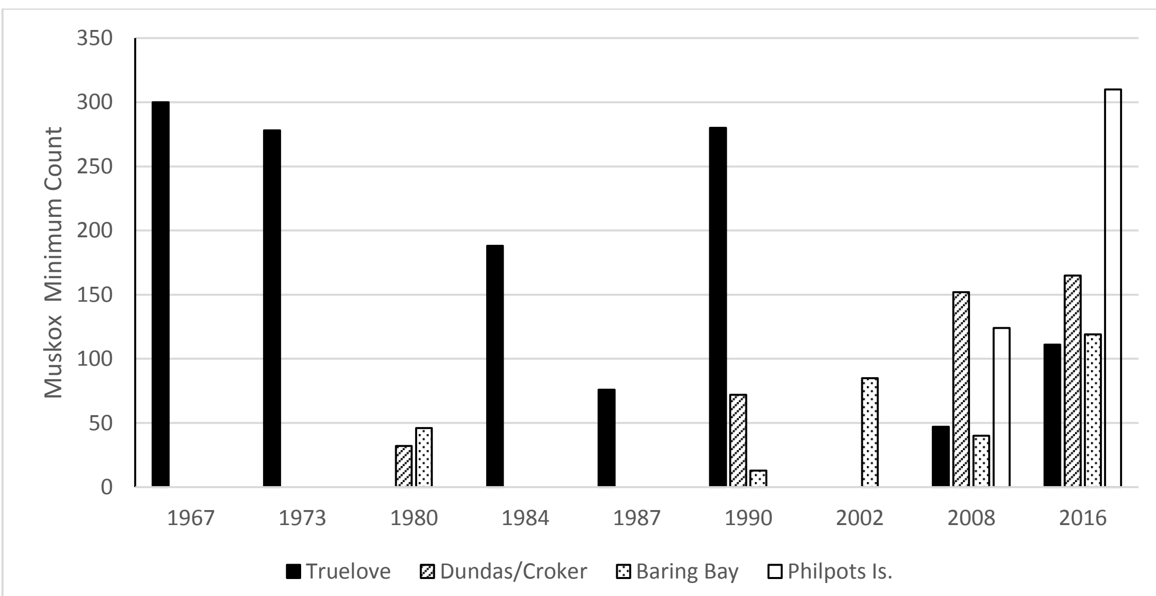


Figure 6. Minimum counts of muskoxen recorded on surveys of lowland areas where muskoxen congregate (Freeman 1971, Hubert 1977, Decker in Urquhart 1982, Pattie 1990, Case 1992, GN data unpublished for 2002 and 2008, Jenkins et al. 2011, and this survey). Not all areas were surveyed in all years.

*Muskox and Caribou Distribution*

Muskox concentrations have been reported consistently in the lowlands around Baring Bay, Truelove/Sverdrup Inlet, Dundas Harbour, and Philpots Island, and these continued to be places with high muskox densities. The area around Arthur Fiord on the Grinnell Peninsula also supported relatively high densities of muskoxen. Although the distribution has not changed dramatically, each of the lowland areas, and particularly Philpots Island, has experienced an increase in muskox population since the last survey in 2008. The Truelove Lowlands have historically supported larger muskox populations than the number observed during this survey, although more survey effort in these areas in the past compared to a systematic survey makes it difficult to directly compare this years' observations with historic counts. The increasing muskox population is still largely confined to discrete areas of suitable habitat, however, and the unsuitable habitat in the barren interior of the island remains largely unoccupied. Increasing populations on the Bathurst Island Complex and on southern Ellesmere Island indicate that muskox populations are increasing across the region. The increase on Devon Island may be due to recruitment within the population rather than large-scale movement of muskoxen from other neighboring island groups. High calf recruitment of 15-20% starting with a population of 531 muskoxen over the last 8 years could account for an increase to a 2016 population of 1600-2300 muskoxen, but this would be contingent on other factors like adult survival. Relatively little is known about muskox movements in the area.

Caribou distribution has apparently also remained similar to previous surveys and reports. We were unable to locate caribou in the Truelove Lowlands, despite local knowledge of their presence. This may not be surprising if the caribou persist at low densities in small isolated habitat patches. We were also unlikely to have found tracks across this part of the study area, since much of the lowlands were either windswept or had hard-packed snow, which was not conducive to track detection.

We also checked for tracks and animals along the sea ice and shorelines during short ferry flights between transects, allowing us to cover 50% of the shoreline. We did not see any caribou or muskox tracks on the sea ice that would suggest recent movement among islands, and no major movement to or from Devon Island was evident during the survey.

*Calf Recruitment*

The recorded proportion of muskox yearlings in the population (5%) was much lower than recorded for southern Ellesmere Island in summer 2014 (24%, Anderson and Kingsley 2015), and lower than the 10.5% calf production which Freeman (1971) estimated would be required to offset natural mortality based on observations in 1965 and 1967. Since no unusual mortality or calf crop losses have been noticed by harvesters, it is likely that the recorded proportion of yearlings represents biased sampling of small, dispersed, and often adult-dominated, muskox groups, without taking into account the proportion of yearlings in larger or tightly grouped herds. The proportion of newborn calves will be biased low due to detectability, and because the survey was at the beginning of calving season.

Lack of observations prevents any conclusions on calf recruitment for Peary caribou.

*Group Sizes*

Muskox groups are largest early in the spring and smaller as summer progresses (Freeman 1971, Gray 1973), with winter (including April and May) groups about 1.7 times larger than summer groups (Heard 1992). Muskoxen were encountered in herds of 2-38, with some lone adults seen as well, and averaged 7.0 muskoxen per herd. This is slightly smaller than the 10.0 muskoxen per herd encountered by Freeman (1971) 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), although the degree to which muskoxen move among the two islands is not clear and group size could be different for different populations.

Ferguson (1991) suggested that caribou groups are largest in August and smaller in late winter, and Fischer and Duncan (1976) noted that groups across the Arctic islands averaged 4.0 caribou in late winter, 2.8 caribou in early summer, and 8.8 caribou in mid-summer. Peary caribou were seen singly or in small groups of 2-4, but not enough groups were observed to make any meaningful conclusions on group sizes.

**Management Recommendations**

Peary caribou and muskoxen on Devon Island are an important source of country food and cultural persistence for Inuit. Consistent with the Nunavut Land Claim Agreement, and the Management Plan for High Arctic Muskoxen of the Qikiqtaaluk Region, 2012-2017 (DOE 2014), 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), Devon Island is considered a single management unit, MX-04, with a Total Allowable Harvest (TAH) of 15. The high numbers of muskox suggest that the TAH could be increased or removed, although with 3 communities harvesting from the island, maintaining a TAH might facilitate harvest management and co-ordination by the 3 HTAs (i.e. maintaining tags to track harvest, but setting the TAH high enough to ensure any interested hunter could receive a tag). The current TAH reflects a conservative harvest rate of 4% on a population of about 400 muskoxen, which is close to the population estimates from the 1970s until 2008. The 2016 population estimate, however, is close to four times the 2008 estimate. At the same harvest rate of 4%, 79 muskox tags could be issued. At a 5% harvest rate, 98 tags could be issued. Muskoxen do move across the barren interior of the island and among habitat patches (based on unpublished GN telemetry data, and local knowledge in Grise Fiord and Resolute), but dispersing harvest among several lowlands would prevent having to wait for muskoxen to re-establish themselves in areas that might be more isolated.

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. With muskoxen concentrated in discrete lowland habitats that can be reliably accessed for harvesting, it may be particularly useful to distribute harvest pressure among these areas or to target under-utilized areas for larger community hunts. 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 Grise Fiord and Resolute Bay harvest fewer muskoxen than in the 1990s (Anderson 2016), but changing the configuration of management zones may encourage more harvesting in areas that were previously accessible but not included in a management unit. The major decline in caribou on Baffin Island, and subsequent harvest restrictions, has also reduced the availability of country food for Baffin communities, including Arctic Bay, which has harvested muskoxen on Devon Island in the past. The community of Arctic Bay has been in discussions with Grise Fiord to determine whether they would be able to harvest several muskoxen to offset the lack of Baffin caribou, and this should be further considered given the healthy populations of muskoxen on southern Ellesmere and Devon islands.

Although we saw only 14 caribou during the survey, the results of previous surveys over the same areas suggest that caribou have persisted at relatively low densities on Devon Island. There may or may not have been a decline from the 2008 survey, the few observations recorded from both surveys make it difficult to tell. Most caribou harvest activity from Resolute Bay has been focused on Bathurst Island, reducing the available recent knowledge of caribou on Devon Island, although residents of Resolute still visit Devon Island for other harvesting activities and during travel. Hunters from Grise Fiord report seeing caribou fairly regularly in the Truelove Lowlands, and a few are caught there each year. It is unlikely that harvest restrictions on Peary caribou will result in any marked increase in the population, as harvest is restricted to a small human population with limited access to the caribou range, and lack of suitable habitat on Devon Island is likely a more important factor limiting caribou population growth in the area. Monitoring sightings and harvest will continue to provide a more complete picture of where caribou are on the landscape.

**ᐊᐅᓚᑕᐅᓂᕐᒧᑦ ᐊᑐᕐᑯᖅᐅᓯᒪᔪᑦ**

ᕐᑯᑦ ᑎᒃ ᑑᑉ ᑐᒃ ᑐᖕᕋ ᐅᒥᖕᒪᖕᕆ ᓗ ᑕᓪ ᓗᕉᑉ ᕿᑭᖅᑕᖓᓃᑦ ᑐᑦ ᓂᕿᑭᔭ ᐅᒻ ᒪᕆᖕᒪᑕ ᐃᓕᖅᑯᓯ ᑐᖃᕐ ᒥᖕᓂᒡ ᓗ ᐊᑐᕈᑎᒋᓪ ᓗᓂᐟ ᔪᒃ ᐃᓄᐃᑦ. ᑎᑎᕋᖅᑕᐅᓯᒪᔪᓂᒃ ᓄᓇᕘᒻᒥ ᓄᓇᑖᕐᓂᕐᒧᑦ ᐊᖏᖃᑎᖏᔪᑎᒥ, ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥ ᕐᑯᑦ ᑎᒃ ᑑᑉ ᐅᒥᖕᒪᖕᕆᓄᑦ ᕿᑭᖅᑖᖑᕐᒥ, 2012-2017 (DOE 2014)−ᒥ, ᑖᒃ ᑯᐊ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᕐᑯᖅᐅᓯᒪᔪᑦ ᓇᓗᓇᐃᖅᓯᖕᒪᑕ ᐱᒻ ᒪᕆᐅᓂᖕᖏᓂᒃ ᖃᓄᐃᖕᕋ ᑎᐊᖅᑎᑦ ᑎᓇᓯ ᐊᕐ ᓂᖅ ᐊᒥᓲᓂᖕᖏ ᓂᒃ ᑐᒃ ᑐᐃᑦ ᐅᒥᖕᒪ ᐃᓪ ᓗᓯᕐ ᕋᕐᑯᓇᒍ ᐊᖑᓇᓯᖕ ᓂᐅᕝᕕᒃ ᑐᖅ.

ᑕᐃᑲᓂ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥ ᕐᑯᑦ ᑎᒃ ᑑᑉ ᐅᒥᖕᒪᖕᕆ ᕿᑭᖅᑖᖑᕐᒥ, 2013-2018 (DOE 2014)−ᒥ, ᑖᓐᓇ ᑕᓪ ᓗᕉᑦ ᐃᑳᒃ ᑰᖅᔪᓂ ᐊᐅᓚᑕᐅᔭ ᖃᐊᖅᑲᖅᔪᓂ ᐋᖅᑭᒃ ᑕᐅᓯᒪᖕᒪᑦ, (MX-04)−ᒥ, ᑲ ᑎᓕᒫᖅᔪᕆᑦ ᐱᔭ ᐅᔪᓐᓇᖅᑐᑦ (TAH)−ᒥ 15−ᖑᓪ ᓗᑎᒃ. ᐊᒥᓲᓂᖕᖏᓄᑦ ᐅᒥᖕᒪᐃᑦ ᓇᓗᓇᕈᓐᓃᖅᐳᖅ ᐅᒥᖕᒪᖕᓂᒃ ᐊᖑᓇᓱᒍᓐᓇᕐᓂᕐᒧᑦ (TAH)−ᖑᔪᖅ ᐃᓚᒋᐊᖅᑕᐅᔪᓐᓇᕐᓯᔪᑦ ᐂᖅᑕᐅᑦ ᑎᐊᒻ ᒪᓇᒡ ᓗᓂᓘᓐ ᓃᑦ, ᑖᒃ ᑯᐊ ᐱᖕᖑᕈᕕ ᓗᐊᖅᔪᑎᒃ ᓄᓇᓖᑦ ᑕᑉ ᐹᖖᒐ ᐊᖑᓇᓱᒍᓐᓇᖅᑐᑦ ᑕᓪ ᓗᕉᒻ ᒥᑦ, ᐊᑐᕐ ᓗᑎᒃ ᖃᒡ ᓯᓂᒃ ᐊᖑᓇᓱᒍᓐᓇᕐᒪᖕᑖ ᑎᑎᖅᑲᑦ (TAH)−ᖑᔪᑦ ᐃᑲᔫᑕᐅᔪᓐᓇᑐᐃᓐ ᓇᑎᐊᖅᑲᖅᐳᑦ ᐊᖑᓇᓯᒃ ᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᐅᓚᑕᐅᓗᑎᒡ ᓗ ᐱᖕᖑᓄᑦ ᐊᖑᓇᓯᒃ ᑐᓕᕆᐅᒃ ᑯᓐ ᓄᑦ (ᓲᕐ ᓗ. ᓂᕗᙳᖅᑖᕐᓂᒃ ᐱᓯᒪᒃ ᓚᕐ ᓗᑎᒃ ᖃᒡ ᓯᓂᒃ ᐊᖑᔪ ᕕᓂᐅᖕ ᒪᖖᑖ, ᑭᓯᐊᓂ ᓗ ᓈᒻ ᒪᒃ ᓯᑎᑦ ᑎᓯ ᔪᑎᒃ ᐊᖑᔭ ᐅᔪᓐᓇᖅᑐᑦ ᖃᒡ ᓯᐅᓂᖕᖏᓂᒃ ᐊᒥᓲᓂᖕᖏ ᓈᒻ ᒪᒡ ᓗᑎᒃ ᐱᔪᒪᔭ ᐅᔪᓐᓇᕐ ᓗᑎᒃ ᐊᖑᓇᓯᒃ ᑎᓄᑦ ᓂᕗᙳᖅᑖᑦ). ᑖᓐᓇ ᒫᓐᓇ ᐋᖅᑭᒃ ᓯᒪᔪᖅ ᐊᖑᔭ ᐅᔪᓐᓇᖅᑐᑦ ᖃᒡ ᓯᐅᓂᖕᖏᓂᒃ ᓇᓗᓇᐃᖅᓯᓯᒪᔪᖅ ᐋᖅᑭᒃ ᓯᒪᖕᒪᑦ ᓲᕐ ᓗ 4%−ᐳᓴᓐ ᖑᔪᖅ ᑖᒃ ᑯᓐᓃᑦ 400−ᓂᑦ ᐅᒥᖕᒪᖕᓂᑦ, ᑖᒃ ᑯᐊᓗ ᓈᒻ ᒪᒃ ᓯᓯᒪᑲᓵᒃ ᐳᑦ ᐊᒥᓲᓂᖏᓚᐅᖅᓯᒪᔭᖕᖏᓄᑦ ᓈᓴᖅᑕᐅᓯᒪᓂᒃ ᑯᑦ ᒥᒃ ᓴᐅᓴᒃ ᑕᐅᓚᐅᖅᓯᒪᔪᕕᓃᑦ 1970−ᒥᑦ 2008−ᒧᑦ. ᑖᓐᓇ 2016−ᒥ ᐊᒥᓲᓂᖕᕋ ᒥᒃ ᓴᐅᓴᒃ ᑕᐅᓯᒪᓂᓇᔭᖕᖑ ᐃᒪᐃᑉᐳᖅ, ᖃᓪ ᓕᓯᒪᓪ ᓗᓂ ᑎᓴᒪᐃᖅᓲᑎᓪ ᓗᐊᖕᖏᓂᒃ 2008−ᒥ ᒥᒃ ᓴᐅᓴᒃ ᑕᐅᓯᒪᓚᐅᕐ ᓂᖕᖏᓂ. ᑕᐃᒪᓐ ᓇᑦ ᑕᐃᓐ ᓇᖅ ᐊᖑᓇᓯᒍᓐ ᓇᕐ ᔪᑎᒃ 4%−ᐳᓴᓐ ᓗᐊᒥᒃ, 79−ᓂᒃ ᐅᒥᖕᒪᖕᓄᑦ ᓂᕗᖕᖓᑖᓂᒃ ᑐᓂᔭᒃ ᓴᖅᑕᖅᑲᖅᔪᓂ. 5%−ᐳᓴᓐ ᖑᑉ ᐸᑕ ᐊᖑᔭ ᐅᔪᓐᓇᖅᑐᑦ, 98−ᖑᓇᔭᖅᔪᑎᒃ ᓂᕗᖕᖓᑖᑦ ᑐᓂᖅᑯᑕᐅᒍᓐᓇᖅᑐᑦ. ᐅᒥᖕᒪᐃᑦ ᓄᒃ ᑕᖅᐸᓪ ᓕᐊᖕᕆ ᓇᐅᔭᕐᒪᑕ ᑕᐃᑲᓂ ᕿᑭᖅᑕᒥ ᓂᕿᑭᕝᕙᒃ ᑕᒥᖕᓂᒃ ᒪᓕᒃ ᔪᑎᒃ (ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑎᒍᑦ ᓴᖅᑭᑎᑕᐅᓯᒪᖕᕆ ᔪᓂ ᓄᓇᕘᑦ ᒐᕙᒪᒃ ᑯᖕᕆ ᓂᐅᓂᒃ ᑳᓂ ᑐᖅᑯᖅᑕᐅᓯᒪᔪᓂ, ᐊᒻᒪᓗ ᓄᓇᓕᖕᓂᑦ ᖃᐅᔨᒪᔭᐅᔪᓂᑦ ᐊᐅᓯᐃᑦᑐᒥ ᖃᐅᓯᐃᑦᑐᒥᓗ), ᑭᓯᐊᓂ ᐊᖑᓇᓯ ᖃᑦ ᑕᖅᐸᑕ ᓇᑎᐅᓂᖅᓴᒥ ᐊᑦ ᑎᖕᓂᖕᖏ ᓂ ᓄᓇᐅᑉ ᐅᑕᖅᑭᔭ ᓇᐊᖅᑲᖅᑲᑦ ᑕᕋᔭᖕᕋ ᑐᑦ ᐅᒥᖕᒪᖕᓂᒃ ᐃᓂᑦ ᑎᐊᕝᕗᒃ ᑖᓇᐊᕐ ᓗᑎᒃ ᐃᓄᖃᖕᖏ ᔩᒥᔩᒥ.

ᑕᒪᓐᓇ ᐱᒻ ᒪᕆᐅᑉᐳᖅ ᓂᕐ ᔪᑎᑦ ᐱᔭ ᐅᔪᑦ ᐅᖃᐅᓯᐅᖕᖏᓇᖅᐸᓪ ᓗᑎᒃ ᑕᐃᓐᓇ ᐊᖑᓇᓯᒃ ᑕᐅᔪᓐᓇᖅᑐᑦ ᖃᒡ ᓯᐅᖕᒪᖕᑖ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᖅ (TAH)−ᖑᔪᖅ ᐂᖅᑎᑕᐅᓚ ᓗᐊᕐ ᓂᖅᐸᑦ. ᑕᐃᒪ ᐃᐸᑕ ᓂᕐ ᔪᑎᓂᒃ ᖃᐅᔨᓴᖅᑎᓄᑦ, ᓄᓇᓕᖕᒥ ᐅᓄᑦ, ᐊᒻᒪᓗ ᐃᓱᒪᓕᐅᕆᕝᕕᒃ ᑐᑦ ᖃᐅᔨᒪᓂᖅᓴᐅᔪᓐᓇᖅᓯᒪᕐᒪᑕ ᐊᖑᑕᐅᕝᕕᒃ ᑐᑦ ᖃᐅᓈᖅᑲᑦ ᑕᕐᒪᖕᖑᑖ ᓇᓗᖕᕌ ᐸᓕᕈᓐ ᓇᖅᓴᖅᐳᑦ ᐊᐅᓚᑦᑎᓃᑦ ᐊᖑᓇᓯᒍᓐᓇᕐ ᓃᓪ ᓗ ᐊᑲ ᐅᓂᕐ ᓴᒧᑦ ᐊᑐᕐ ᓂᖅᑯᕈᓐ ᓇᖅᓴᕐ ᒪᑕ. ᑕᒪᒃ ᑯᐊ ᐅᒥᖕᒪᐃᑦ ᑲᑎᙵᔪᓲᖑᒪᑕ ᓄᓇᐃᑦ ᐊᑦ ᑎᖕᓂᖕᖏ ᓂ ᓂᕿᖅᑲᔪᒃ ᔪᑎᒃ ᐱᓇᓯᒐᒃ ᓴᐅᓂᖅᓴᐅᔪᓐᓇᕐ ᒪᑕ, ᑕᒪ ᐃᑲᔪᕐ ᓂᖅᑲᕐ ᓂᖅᓴᐅᔪᓐᓇᖅᐳᖅ ᐊᖑᓇᓯᒡ ᕕᒋ ᓗᕆᑦ ᐊᑲᐅᓇᔭᖅᑐᑦ ᐅᕝᕗᓘᓐᓃᑦ ᑲᒪᒋᔭᐅᖕᕋ ᑎᐊᒻ ᒪᓇᖕᓂᐅᔪᓂ ᐊᖑᓇᓯᒡ ᕖᑦ ᑎᐊᕝᕙᐅᓇᔭᖅᑐᖅ ᐊᖕᒋᓂᕐ ᓴᐅᔪᓄᑦ ᓄᓇᓕᖕᓄᑦ. ᐊᖕᒋᓂᖅ ᓴᐃᑦ, ᐊᐅᓚᑕᐅᓂᕐ ᓴᐅᔪᑦ ᓄᓇᓖᑦ ᐊᖑᓇᓯᖕ ᓂᕐ ᒧᑦ ᑐᓂᔭᐅᕝᕗᑦ ᑐᑦ ᐊᖑᓇᓯᓪ ᓚᒃ ᓴᖕᕆ ᓂᒃ ᐃᓄᒋᐊᖕ ᓂᖅ ᓴᓃᑦ ᑐᑦ ᐃᓱᒪᒋᔭᐅᔭ ᓇᐊᖅᑲᖅᓴᔭ ᖅᑰᕚᔪᑦ 2016-17−ᒧᑦ ᐊᖑᓇᓯᒃ ᑕᕕᓂᖕᕋ ᓇᐅᑦ ᑎᖅᓱᖅ ᑕᐅᓕᕐ ᓗᑎᒃ ᐊᑐᕆᓐ ᑲ ᓗᐊᕐ ᓗᑎᒃ (TAH)−ᖕᓂᒃ. ᒪᓕᒡ ᓗᑎᒃ ᑖᓯᒥᖕᖑ ᑕᐃᓐᓇ (TAH)−ᖑᔪᖅ 100−ᓂᒃ ᐊᖑᓇᓯᒃ ᑕᐅᔭ ᓇᐊᖅᑯᕐ ᓂᕋᐃᓯᒪᓪ ᓗᓂ ᐃᓱᒪᒋᔭ ᐅᔪᓐᓇᖅᐳᖅ ᐊᕐ ᖄᔫᓂᐊᖅᑐᓄᑦ, ᑲᔪᓯᕗᓪ ᓕᐊᖕᕆ ᓇᐅᔭᖅᑎᓪ ᓗᒍ ᖃᒡ ᓯᐅᓕᕐ ᓂᖕᖏᓂᒃ ᖃᐅᔨᓴᕐᓂᐅᕝᕕᒃᑐᖅ ᖃᖕᖁᓕᖖᖑᑦ. ᓄᓇᓂᖕᒥ ᐅᓂᑦ ᖃᐅᔨᒪᔭᐅᔪᖅᑯᖅ ᐊᒻᒪᓗ ᓕᓐᓇᕈᓗᒃ ᖃᐅᔨᓴᕐ ᓂᒃ ᑯᑦ ᑐᑭᓯᔭᐅᔪᑦ, ᓂᕐ ᔪᑏᑦ ᐊᒥᓲᓂᖕᕋ ᒥᒃ ᓚᕗᓪ ᓕᐊᔪᓐ ᓇᖅᐳᖅᑦ ᕿᓚᒻ ᒥᐅᔪᒃ ᑯᑦ ᐃᓱᒪᖕ ᓇᖕᕋ ᑐᒃ ᑯᓪ ᓘᓐ ᓃᑦ ᓯᓚ ᐊᓯ ᔭ ᖅᑎᓪ ᓗᒍ ᓄᓇᒋᔭᖕᖑ ᓂ ᐱᕐ ᓕᕋᖅᑐᓄᓪ ᓗ ᓄᒃ ᑕᖅᑐᓄᓪ ᓘᓐ ᓃᑦ, ᑕᐃᒪ ᐃᒻ ᒪᑦ ᖃᐅᔨᓴᖅᐸᓪ ᓕᐊᖅᑲᑦ ᑕᕐ ᓂᖅ ᐊᐅᓚᑦᑎᓂᕐ ᓗ ᐱᑕᖅᑲᓇᐊᖅᑲᖅᐳᖅ ᐊᒥᓲᒐ ᓗᐊᖅᐸᑕ ᓂᕐ ᔫᑦ.

ᐊᖑᓇᓯᖕ ᓂᐅᕝᕕᒃ ᑐᖅ ᐅᒥᖕᒪᖕᓂᒃ ᑭᖕᖑᓪ ᓕᖅᐹᓂ ᐊᕐ ᖄᔫᓂ ᕐᑯᓕᓂᒃ ᓇᓗᓇᐃᖅᓯᔾᔪᖅ ᐊᐅᓯᐃᑦᑐᒥ ᖃᐅᓯᐃᑦᑐᒥᓗ ᐅᒥᖕᒪᖃᑦ ᑕᖕᖏ ᓂᕐ ᓴᐅᓕᖅᓯᒪᔾᔪᑦ 1990−ᐅᓚᐅᖅᑐᓂᑦ (ᐋᓐ ᑐᓴᓐ 2016), ᑭᓯᐊᓂᓕ ᐊᓯᔾᔨᖅᑕᐅᒃ ᐸᑦ ᐊᐅᓚᑦᑎᓂᐊᕝᕗᒃ ᑐᖅ ᐊᖑᓇᓯᖕ ᓂᖅᓴᐅᓕᑐᐃᓐ ᓇᓄᐊᖅᑲᖅᐳᑦ ᑕᐅᕙᓂ ᑲᒪᒋᔭᐅᓯᒪᖕᖏᓐᓂᐅᔪᓂ. ᐊᖕᒋᓗᐊᖅᑐᒥᒃ ᐊᒥᓲᓐᓂᑳᓪᓚᖕᓂᖕᖏᑦ ᑐᒃᑐᐃᑦ ᕿᑭᖅᑖᖑᕐᒥ, ᐱᕐᑯᔭᐅᔪᓐᓂᑳᓪᓚᖕᓂᖕᖏᓐᓄᓪᓗ, ᒥᒃᓵᓂᐊᖅᑎᑦᑎᓯᒪᕕᒃᓴᐊᕐᒥᖕᒪᑦ ᓄᓇᒥᖕᓂᑦ ᓂᕿᑭᕝᕙᒥᖕᓄᑦ ᓄᓇᓕᖕᓂ ᕿᑭᖅᑖᖑᕐᒥ, ᐃᓚᐅᓪᓗᓂ ᐃᒃᐱᐊᕐᔪᖕᒥ,

ᐅᒥᖕᒪᒃᐸᓚᐅᕋᓗᐊᖅᑎᓪᓗᒋᑦ ᑕᓪᓗᕈᒻᒥᑦ ᐊᓂᒍᖅᑐᒥ ᐊᕿᒍᒥ. ᑖᒃᑯᐊ ᓄᓇᓖᑦ ᐃᒃᐱᐊᕐᔪᖕᒥ ᐅᖃᖅᑎᖃᖅᑕᖅᓯᒪᓕᖅᑐᑦ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᓂᒃ ᐊᒥᓯᓂᒃ ᐅᒥᖕᒪᔫᓇᕐᒪᖔᑕ ᐃᓇᖏᕐᔪᑎᒋᓗᓂᕐᔪᒃ ᕿᖅᑖᓗᖕᒥ ᑐᒃᑐᖏᓐᓄᑦ, ᐊᒻᒪᓗ ᑕᒪᓐᓇ ᐃᓱᒪᒋᔭᐅᔪᓐᓇᕐᓂᖅ ᓈᒻᒪᑦᑎᐊᕐᓂᖏᓐᓂᒃ ᐅᒥᖕᒪᐃᑦ ᐊᒥᒌᓂᖏᑦ ᓂᒋᐊᓂ ᐊᐅᓯᐃᑦᑑᑉ ᕿᑭᖅᑖᓗᐊᑕ ᐊᒻᒪᓗ ᑕᓪᓗᕈᑦ ᕿᑭᖅᑕᖏᓐᓂ.

ᑕᑯᓚᐅᕋᓗᐊᖅ ᓄᑕ 14−ᖏᓐ ᓇᕐᓂᒃ ᑐᒃᑐᓂᒃ ᓈᓴᐃᑎᓪᓗᑕ, ᖃᓄᐃᓕᖕᒪᓇᓚᐅᖅᑕᖏᑦ ᓈᓴᐃᓂᐅᓚᐅᖅᓯᒪᔫᑉ ᑕᐅᑦᓴᓂᔅ ᓴᐃᓐᓇᖅ ᓇᓗᓇᐃᖅᓯᕚᑦ ᑕᐃᒃᑯᐊ ᑐᒃᑐᖏᑦ ᑕᐃᒪ ᐃᖏᓐᓇᕈᔪᒃᑐᑦ ᐊᒥᓲᓗᐊᖏᓐᓄᑎᒃ ᑕᓪᓗᕈᒻᒥ. ᐊᒥᓲᔪᓐᓃᖅ ᐹᓪᓕᖏᑦ ᑐᕞᓂᐅᑐᐃᓐᓇᑎᐊᓖᑦ 2008−ᒥ ᓈᓴᖅᑕᐅᓚᐅᖅᓯᒪᓂᖏᑦ ᒪᓕᒃᓄᒋᑦ, ᑕᐃᒃᑯᐊᒃ ᑕᒪᕐᒥᒃ ᓈᓴᐃᓂᐅᓚᐅᖅᓯᒪᔩᒃ ᒪᓕᒃᓄᒋᒃ ᐊᓯᕝᔮᕐᓯᒪᖕᒪᖖᑕ ᓇᓗᓇᕈᔪᒃᑐᖅ. ᑐᒃᑐᑕᐅᖃᑦᑕᖅᓯᒪᔪᑦ ᖃᐅᓯᐃᑦᑐᕐᒥ ᑐᒃᑐᒥ ᐅᕐᕗᐅᑉ ᕿᑭᖅᑕᖕᓂᑦ ᑐᒃᑐᓐᓂᖅᓴᐅᖃᑦᑕᖅᓯᒪᖕᒪᑕ, ᑕᐃᒃᑯᐊ ᒥᒃ ᓀᕆᐊᕈᑕᐅᕚᓪᓕᖅᓯᒪᖕᒪᑕ ᑕᓪᓗᕉᑉ ᑐᒃᑐᖏᓐᓄᑦ, ᑭᓯᐊᓂ ᖃᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᐊᖑᓇᓱᒃᑎᖏᑦ ᑕᓪᓗᕈᒻᒧᐊᖅᐸᒃ ᑑᓚᓗᐊᑦ ᓯᓕ ᐊᓯᖏᓐᓂᒃ ᐊᖑᓇᓱᑭᐊᖅᓄᑎᒃ ᐊᖅᑯᓵᑐᐃᓐᓇᖅᓄᑎᓪᓘᓐᓅᑦ ᑕᐃᑰᓇ. ᑕᐃᒃᑯᐊ ᐊᐅ)ᐃᑦᑐᒥᑦ ᐊᖑᓇᓱᒃᑏᑦ ᐅᖃᐅᓯᖃᖃᑦᑕᖅᓯᒪᔩᕙᓗᐊᑦ ᑕᑯᖃᑦᑕᕐᓂᕐᒥᖕᓂᒃ ᑐᒃᑐᓂᒃ ᓯᓕ ᑕᐃᒪᓐᓇ ᑕᐃᑲᓂ ᖃᓪᓗᓈᑦ ᑲᖏᖅᓄᐊᓂ ᐊᑦᑎᒃ ᑑᑕᐅᓂᖏᓐᓂ ᓄᓇᖕᒋᑕ, ᐊᒻᒪᓗ ᐊᒥᓲᖏᑦ ᑑᖕᒐᓗᐊᓂᒃ ᑐᒃᑐᑉᐸᒃ ᓄᑎᒃ ᑕᐃᑲᖖᒍ ᐊᕐᕋᒍ ᑕᓖᑦ. ᑕᐃᒃᑯᐊ ᑐᒃᑐᑕᐅᔪᓐᓇᕐᓂᖕᑕ ᐊᒥᓲᓂᖏᑦ ᖁᑦᑎᒃᑐᕐᒥᐅᑦ ᑐᒃᑐᖕᑕ ᐊᑑᑎᖃᕐᓂᐊᖅᑐᑦ ᐊᒥᓲᓕᒃᑲᓐᓂᕐᓂᕋᖅᑕᐅᑐᐊᖅᐸᑕ ᑐᒃᑐᖏᑦ, ᓖᓐᓇ ᑐᒃᑐᑦ ᑐᓐᓇᖖᑎᑕᐅᖕᒪᑕ ᐊᒥᓲᖏᓐ ᒪᓄᒃ ᑲᓗᐊᖅᑎᓪᓗᒋᑦ ᐃᓄᖏᑦ ᑕᐸᓘᓂ, ᐊᒻᒪᓗ ᐱᔪᒪᔭᐅᔫᓗᐊᓂᒃ ᓂᕐᔪᑎᖃᑦᑎᐊᖏᓐᓄᓂ ᐱᕈᖅᑐᖃᓗᐊᕋᓂᓗ ᑕᓪᓗᕈᒻᒥ ᐱᔾᔪᑕᐅᓗᐊᒃᑲᓐᓂᖅ ᑐᒃᓴᐅᖕᒪᑦ ᑐᒃᑐᑦ ᐊᒥᓯᑭᒃᑲᓐᓂᕈᓐᓇᓇᐊᒃᓴᖏᑦ ᑕᐅᕙᓂ. ᖃᐅᔾᓴᐃᓐᓇᕐᓗᒋᑦ ᑕᑯᔭᐅᔪᑦ ᐊᖑᑦᑕᐅᔭᕕᓃᓗ ᓇᓗᓇᕈᓐᓃᖅᓯᒪᔾᔭᐅᔪᓐᓇᕐᒪᑦ ᓇᓃᖃᑦᑕᕐᒪᖕᒋᑕ ᓄᓇᐅᑉ ᑭᑐᑯᑦᑎᖏᓐᓂ.

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**Appendix 1. Devon Island survey transects, 2016.**

Table 4. Transect end points and strata on Devon Island for a fixed-wing survey, March 2016.

| Transect | Stratum | Lon (West) | Lat (West) | Lon (East) | Lat (East) |
|---|---|---|---|---|---|
| A001 | High | -95.4515 | 76.9729 | -94.5496 | 76.9736 |
| A002 | High | -95.5004 | 76.9283 | -93.7822 | 76.9278 |
| A003 | High | -94.7150 | 76.8833 | -93.6314 | 76.8824 |
| A004 | High | -94.9700 | 76.8372 | -93.5000 | 76.8371 |
| A005 | High | -94.7862 | 76.7916 | -93.3761 | 76.7913 |
| A006 | High | -94.5015 | 76.7461 | -93.1818 | 76.7466 |
| A007 | High | -94.3147 | 76.7014 | -93.2004 | 76.7013 |
| A008 | High | -94.2895 | 76.6557 | -93.2195 | 76.6559 |
| A009 | High | -94.4366 | 76.6110 | -93.2781 | 76.6106 |
| A010 | High | -94.4592 | 76.5652 | -93.3219 | 76.5653 |
| A011 | High | -94.4104 | 76.5201 | -93.4145 | 76.5200 |
| A012 | High | -94.4379 | 76.4753 | -93.5371 | 76.4743 |
| A013 | High | -95.5015 | 76.4292 | -90.8734 | 76.4297 |
| A014 | High | -95.5037 | 76.3837 | -92.6704 | 76.3843 |
| A015 | High | -95.0002 | 76.3382 | -93.4020 | 76.3383 |
| A016 | High | -95.4086 | 76.2931 | -93.7747 | 76.2934 |
| A017 | High | -95.3984 | 76.2480 | -94.9366 | 76.2486 |
| A018 | High | -93.3600 | 76.4744 | -90.4714 | 76.4742 |
| A019 | High | -93.2573 | 76.5203 | -90.5103 | 76.5198 |
| A020 | High | -93.1695 | 76.5650 | -90.5891 | 76.5652 |
| A021 | High | -92.2238 | 76.6103 | -90.8334 | 76.6108 |
| A022 | High | -91.9925 | 76.6557 | -90.9958 | 76.6558 |
| A023 | High | -91.1194 | 76.3840 | -90.2572 | 76.3837 |
| A024 | High | -91.2429 | 76.3394 | -89.8187 | 76.3386 |
| A025 | High | -91.0414 | 76.2040 | -89.3047 | 76.2023 |
| A026 | High | -93.0451 | 76.3390 | -92.8219 | 76.3387 |
| A027 | High | -93.0268 | 76.2946 | -92.7023 | 76.2936 |
| A028 | High | -92.9776 | 76.2478 | -92.6527 | 76.2479 |
| A029 | High | -92.7997 | 76.2024 | -92.4764 | 76.2025 |
| A030 | High | -92.7452 | 76.1573 | -92.0528 | 76.1574 |
| A031 | High | -92.6659 | 76.1118 | -91.6568 | 76.1119 |
| A032 | High | -92.6472 | 76.0663 | -91.8596 | 76.0690 |
| A033 | High | -92.6542 | 76.0211 | -91.7933 | 76.0209 |
| A034 | High | -92.5567 | 75.9763 | -91.6839 | 75.9766 |
| A035 | High | -92.4049 | 75.9306 | -91.7767 | 75.9314 |
| A036 | High | -92.1608 | 75.8853 | -91.6562 | 75.8857 |
| A037 | High | -92.1191 | 75.8399 | -91.4810 | 75.8389 |
| A038 | High | -92.1076 | 75.7946 | -91.4616 | 75.7956 |
| A039 | High | -92.1276 | 75.7492 | -91.3693 | 75.7499 |
| A040 | High | -92.0838 | 75.7040 | -91.3943 | 75.7037 |

| Transect | Stratum | Lon (West) | Lat (West) | Lon (East) | Lat (East) |
|---|---|---|---|---|---|
| A041 | High | -92.0019 | 75.6590 | -91.0036 | 75.6591 |
| A042 | High | -92.0969 | 75.6130 | -91.0329 | 75.6135 |
| A043 | High | -91.9416 | 75.5678 | -91.0005 | 75.5677 |
| A044 | High | -91.7431 | 75.5229 | -91.0916 | 75.5224 |
| A045 | High | -91.6967 | 75.4771 | -90.9195 | 75.4770 |
| A046 | High | -91.7627 | 75.4319 | -90.7419 | 75.4321 |
| A047 | High | -91.7767 | 75.3852 | -90.9011 | 75.3865 |
| A048 | High | -91.6819 | 75.3410 | -90.9186 | 75.3418 |
| A049 | High | -91.5624 | 75.2962 | -90.9901 | 75.2959 |
| A050 | High | -91.5011 | 75.2503 | -91.4406 | 75.2504 |
| A051 | High | -91.3900 | 75.2043 | -90.8364 | 75.2054 |
| A052 | High | -91.4369 | 75.1599 | -90.8372 | 75.1600 |
| A053 | High | -91.4721 | 75.1145 | -90.6935 | 75.1145 |
| A054 | High | -91.4349 | 75.0696 | -90.6713 | 75.0696 |
| A055 | High | -91.3613 | 75.0243 | -90.6430 | 75.0249 |
| A056 | High | -91.2629 | 74.9785 | -90.7010 | 74.9785 |
| A057 | High | -91.2693 | 74.9338 | -90.7616 | 74.9338 |
| A058 | High | -91.3129 | 74.8880 | -90.8166 | 74.8878 |
| A059 | High | -91.3528 | 74.8429 | -90.8916 | 74.8427 |
| A060 | High | -91.4164 | 74.7973 | -90.9834 | 74.7973 |
| A061 | High | -91.5014 | 74.7520 | -91.0738 | 74.7524 |
| A062 | High | -91.6261 | 74.7065 | -91.1911 | 74.7067 |
| A063 | High | -91.6055 | 74.6614 | -91.1491 | 74.6611 |
| A064 | High | -89.4999 | 75.5675 | -89.1716 | 75.5679 |
| A065 | High | -89.9996 | 75.5219 | -89.1295 | 75.5227 |
| A066 | High | -90.0587 | 75.4768 | -88.9798 | 75.4771 |
| A067 | High | -90.0836 | 75.4316 | -88.6913 | 75.4319 |
| A068 | High | -90.1396 | 75.3866 | -88.7039 | 75.3865 |
| A069 | High | -90.1529 | 75.3415 | -88.6963 | 75.3418 |
| A070 | High | -90.1137 | 75.2960 | -88.5720 | 75.2960 |
| A071 | High | -90.0533 | 75.2507 | -88.4995 | 75.2504 |
| A072 | High | -90.0618 | 75.2053 | -88.3821 | 75.2051 |
| A073 | High | -89.9997 | 75.1599 | -88.3181 | 75.1599 |
| A074 | High | -89.9242 | 75.1146 | -88.4192 | 75.1148 |
| A075 | High | -89.9997 | 75.0694 | -88.2573 | 75.0698 |
| A076 | High | -90.1350 | 75.0240 | -88.2871 | 75.0240 |
| A077 | High | -90.1881 | 74.9784 | -88.3126 | 74.9785 |
| A078 | High | -90.2849 | 74.9335 | -88.3626 | 74.9326 |
| A079 | High | -90.3433 | 74.8877 | -88.3949 | 74.8878 |
| A080 | High | -89.7865 | 74.8426 | -88.4362 | 74.8430 |
| A081 | High | -89.5025 | 74.7966 | -88.7032 | 74.7974 |
| A082 | High | -89.5010 | 74.7520 | -88.7710 | 74.7525 |

| Transect | Stratum | Lon (West) | Lat (West) | Lon (East) | Lat (East) |
|---|---|---|---|---|---|
| A083 | High | -90.0525 | 74.7068 | -88.8018 | 74.7066 |
| A084 | High | -90.2588 | 74.6614 | -89.1049 | 74.6617 |
| A085 | High | -90.3994 | 74.6157 | -89.1419 | 74.6158 |
| A086 | High | -90.2637 | 74.5705 | -89.4294 | 74.5707 |
| A087 | High | -84.0040 | 75.7944 | -83.7115 | 75.7945 |
| A088 | High | -84.2406 | 75.7490 | -82.6540 | 75.7493 |
| A089 | High | -84.4573 | 75.7043 | -83.2935 | 75.7036 |
| A090 | High | -85.0695 | 75.6586 | -83.3435 | 75.6585 |
| A091 | High | -85.1656 | 75.6136 | -83.5736 | 75.6132 |
| A092 | High | -85.6929 | 75.5679 | -84.1179 | 75.5682 |
| A093 | High | -86.1124 | 75.5229 | -84.3768 | 75.5222 |
| A094 | High | -86.0504 | 75.4775 | -84.5217 | 75.4767 |
| A095 | High | -85.8495 | 75.4322 | -84.5947 | 75.4319 |
| A096 | High | -87.0686 | 75.3870 | -84.7760 | 75.3866 |
| A097 | High | -87.3422 | 75.3412 | -85.4043 | 75.3412 |
| A098 | High | -87.4193 | 75.2959 | -86.0030 | 75.2958 |
| A099 | High | -86.7360 | 75.2507 | -86.1493 | 75.2508 |
| A100 | High | -86.9984 | 75.4318 | -86.4147 | 75.4318 |
| A101 | High | -86.8880 | 75.4776 | -86.6370 | 75.4777 |
| A104 | High | -79.9315 | 75.2511 | -79.5140 | 75.2505 |
| A105 | High | -80.2150 | 75.2056 | -79.5756 | 75.2049 |
| A106 | High | -80.0445 | 74.9786 | -79.5506 | 74.9782 |
| A107 | High | -80.4098 | 74.9334 | -79.4804 | 74.9333 |
| A108 | High | -80.4593 | 74.8879 | -79.3482 | 74.8880 |
| A109 | High | -80.1173 | 74.8423 | -79.6645 | 74.8426 |
| A110 | High | -81.1654 | 74.5974 | -80.2187 | 74.5974 |
| A111 | High | -82.6603 | 74.5250 | -81.9998 | 74.5251 |
| A112 | High | -82.9629 | 74.5704 | -82.2931 | 74.5706 |
| A113 | High | -83.0611 | 74.6157 | -82.2674 | 74.6165 |
| A114 | High | -83.1139 | 74.6612 | -82.2818 | 74.6615 |
| A115 | High | -83.1294 | 74.7063 | -82.6106 | 74.7063 |
| A116 | High | -83.1117 | 74.7522 | -82.6943 | 74.7522 |
| A117 | High | -83.1035 | 74.7973 | -82.6953 | 74.7969 |
| A118 | High | -83.8110 | 74.6163 | -83.4697 | 74.6147 |
| A119 | High | -84.1586 | 74.5706 | -83.4989 | 74.5710 |
| B001 | Medium | -92.2611 | 75.5225 | -91.7431 | 75.5229 |
| B002 | Medium | -92.4253 | 75.4319 | -91.7627 | 75.4319 |
| B003 | Medium | -92.4319 | 75.3413 | -91.6819 | 75.3410 |
| B004 | Medium | -92.4867 | 75.2507 | -91.5011 | 75.2503 |
| B005 | Medium | -92.3308 | 75.1599 | -91.4369 | 75.1599 |
| B006 | Medium | -92.2119 | 75.0691 | -91.4349 | 75.0696 |
| B007 | Medium | -92.1187 | 74.9786 | -91.2629 | 74.9785 |

| Transect | Stratum | Lon (West) | Lat (West) | Lon (East) | Lat (East) |
|---|---|---|---|---|---|
| B008 | Medium | -92.0224 | 74.8882 | -91.3129 | 74.8880 |
| B009 | Medium | -92.0776 | 74.7972 | -91.4164 | 74.7973 |
| B010 | Medium | -88.9181 | 75.6133 | -88.4986 | 75.6130 |
| B011 | Medium | -88.8185 | 75.5222 | -87.0187 | 75.5222 |
| B012 | Medium | -88.6913 | 75.4319 | -86.9984 | 75.4318 |
| B013 | Medium | -88.5004 | 74.6154 | -87.8639 | 74.6159 |
| B014 | Medium | -88.5684 | 74.5253 | -87.7900 | 74.5256 |
| B015 | Medium | -86.9721 | 74.6158 | -85.8925 | 74.6148 |
| B016 | Medium | -87.4396 | 74.5258 | -85.8803 | 74.5241 |
| B017 | Medium | -85.7538 | 74.7063 | -84.7336 | 74.7067 |
| B018 | Medium | -85.6999 | 74.6155 | -84.4595 | 74.6160 |
| B019 | Medium | -85.8803 | 74.5241 | -84.5302 | 74.5254 |
| B020 | Medium | -84.5960 | 74.7519 | -83.3208 | 74.7524 |
| B021 | Medium | -84.3724 | 74.6606 | -83.4318 | 74.6597 |
| C001 | Low | -96.8561 | 76.9279 | -95.5004 | 76.9283 |
| C002 | Low | -96.9199 | 76.7922 | -94.7862 | 76.7916 |
| C003 | Low | -96.4657 | 76.6559 | -94.2895 | 76.6557 |
| C004 | Low | -96.1059 | 76.5168 | -94.4104 | 76.5201 |
| C005 | Low | -95.9554 | 76.4259 | -95.5015 | 76.4292 |
| C006 | Low | -92.7023 | 76.2936 | -91.1545 | 76.2941 |
| C007 | Low | -92.4764 | 76.2025 | -91.2682 | 76.2033 |
| C008 | Low | -91.8596 | 76.0690 | -90.2112 | 76.0666 |
| C009 | Low | -91.7767 | 75.9314 | -89.8083 | 75.9305 |
| C010 | Low | -91.4616 | 75.7956 | -89.2222 | 75.7949 |
| C011 | Low | -91.0036 | 75.6591 | -89.2157 | 75.6586 |
| C012 | Low | -91.0916 | 75.5224 | -89.9996 | 75.5219 |
| C013 | Low | -90.9011 | 75.3865 | -90.1396 | 75.3866 |
| C014 | Low | -91.0024 | 75.2506 | -90.0533 | 75.2507 |
| C015 | Low | -90.6935 | 75.1145 | -89.9242 | 75.1146 |
| C016 | Low | -90.7010 | 74.9785 | -90.1881 | 74.9784 |
| C017 | Low | -90.7393 | 74.8424 | -89.7865 | 74.8426 |
| C018 | Low | -90.9777 | 74.7063 | -90.0525 | 74.7068 |
| C019 | Low | -88.5720 | 75.2960 | -87.4193 | 75.2959 |
| C020 | Low | -88.3181 | 75.1599 | -85.7670 | 75.1600 |
| C021 | Low | -88.2871 | 75.0240 | -85.5456 | 75.0245 |
| C022 | Low | -88.3949 | 74.8878 | -86.9173 | 74.8876 |
| C023 | Low | -88.4291 | 74.7518 | -87.2422 | 74.7531 |
| C024 | Low | -84.7369 | 74.8883 | -83.0024 | 74.8876 |
| C025 | Low | -84.3593 | 75.0242 | -83.8459 | 75.0245 |
| C026 | Low | -85.4042 | 75.3443 | -84.7132 | 75.3416 |
| C102 | Low | -81.3948 | 75.6551 | -81.1461 | 75.7744 |
| C103 | Low | -80.4653 | 75.4746 | -80.0000 | 75.5419 |

**Appendix 2. Delineation of survey strata for Devon Island.**

The following figures show the boundaries for high, intermediate, and low density strata for caribou and muskoxen. Both species were considered together, since much of the information indicated overlapping ranges and both species were targeted for the survey. In addition to the maps provided below, we used maps provided in Case (1992) of high muskox density areas and locations indicated by community members (summarized in Taylor 2005 and Johnson et al. 2016, but also indicated by elders and hunters prior to and during the survey).

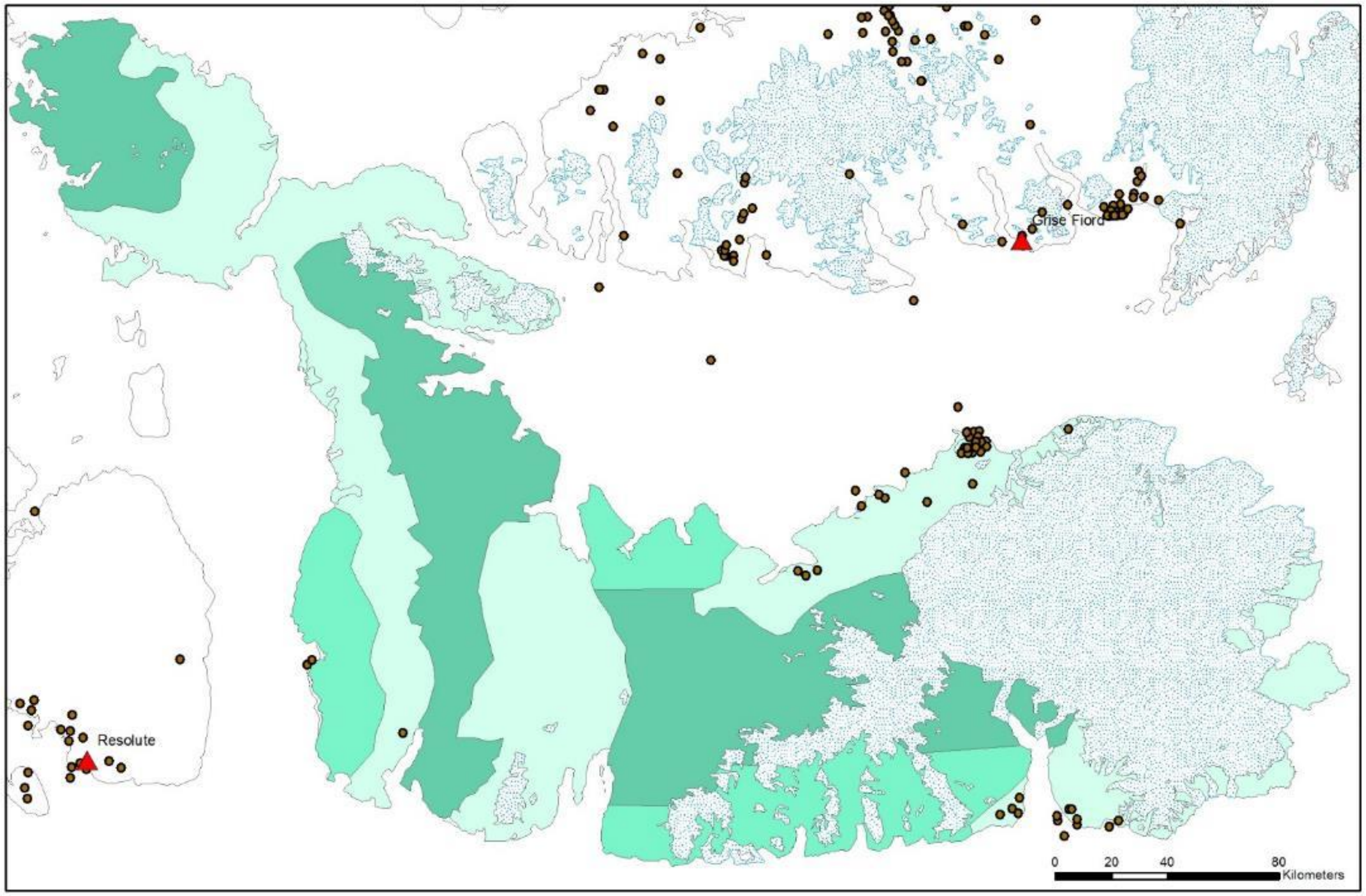


Figure 7. Locations of muskox harvest from Grise Fiord, Resolute Bay, and Arctic Bay, 1990-2015. Survey strata are indicated by shaded green – high density (pale green), intermediate density (bright green), low density (dark green).

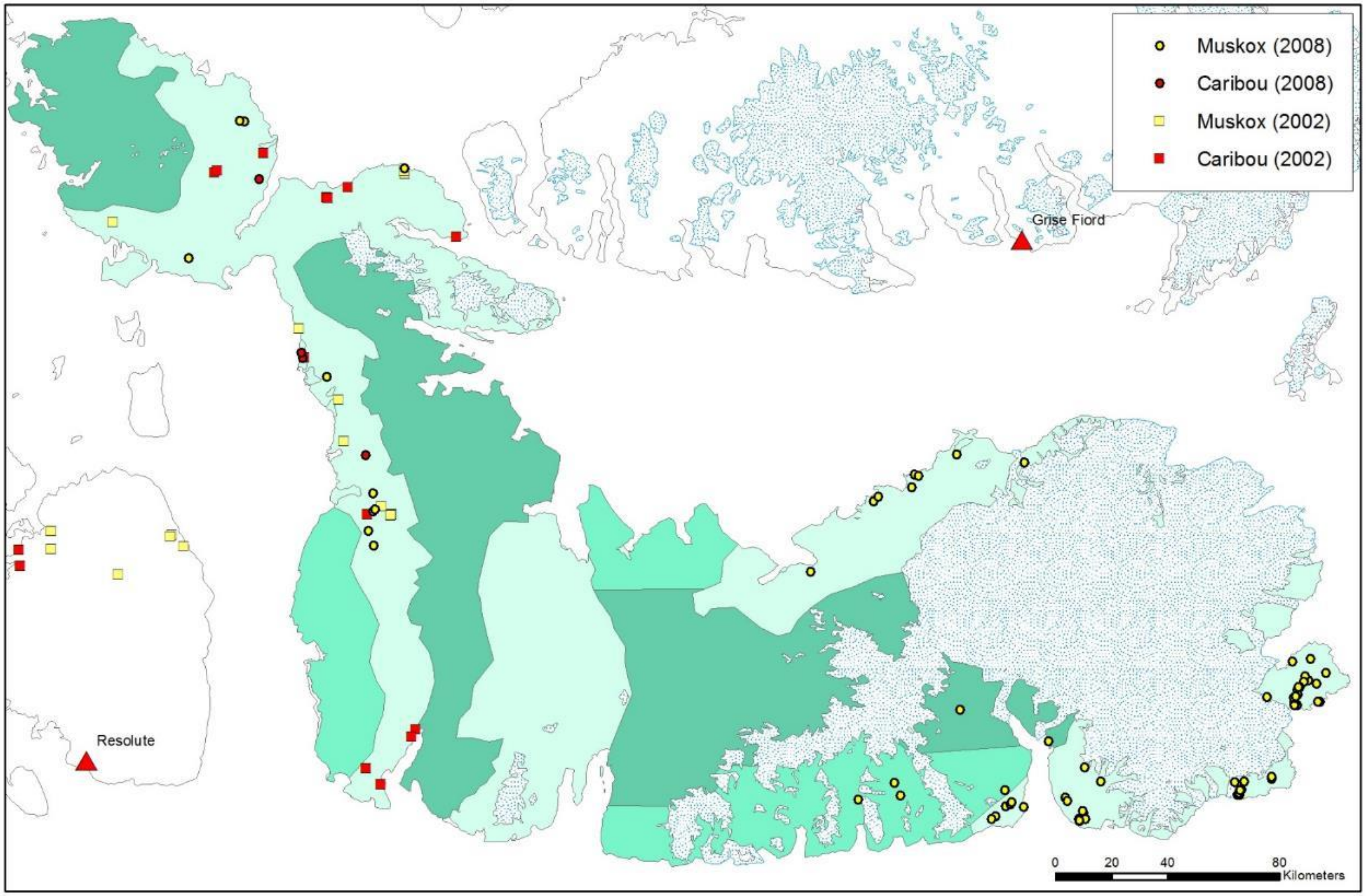


Figure 8. Locations of caribou and muskoxen seen on aerial surveys in 2002 and 2008. Survey strata are indicated by shaded green – high density (pale green), intermediate density (bright green), low density (dark green).



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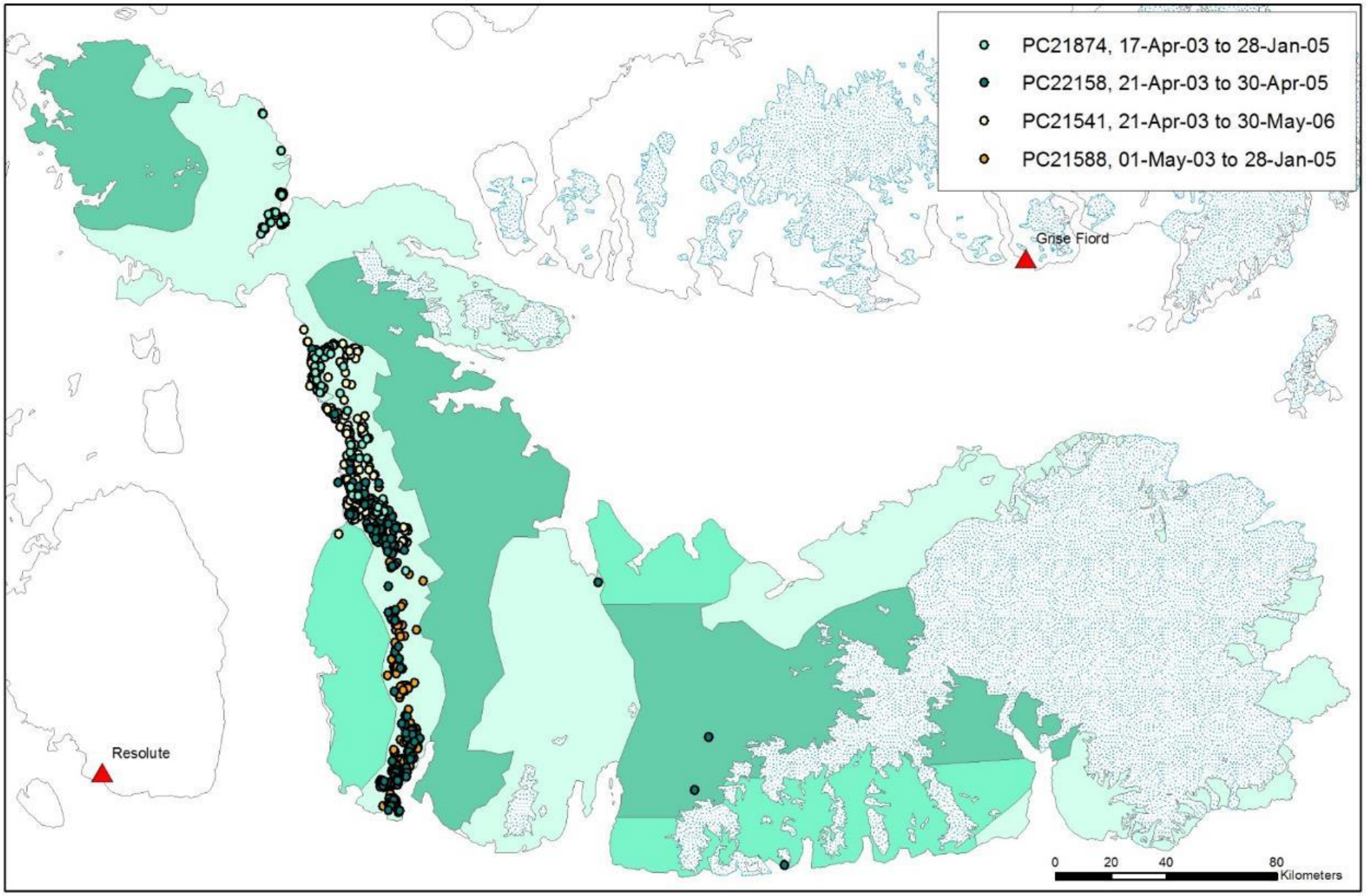


Figure 9. Telemetry locations of 4 collared female caribou, 2003-2006, on Devon Island. Survey strata are indicated by shaded green – high density (pale green), intermediate density (bright green), low density (dark green).

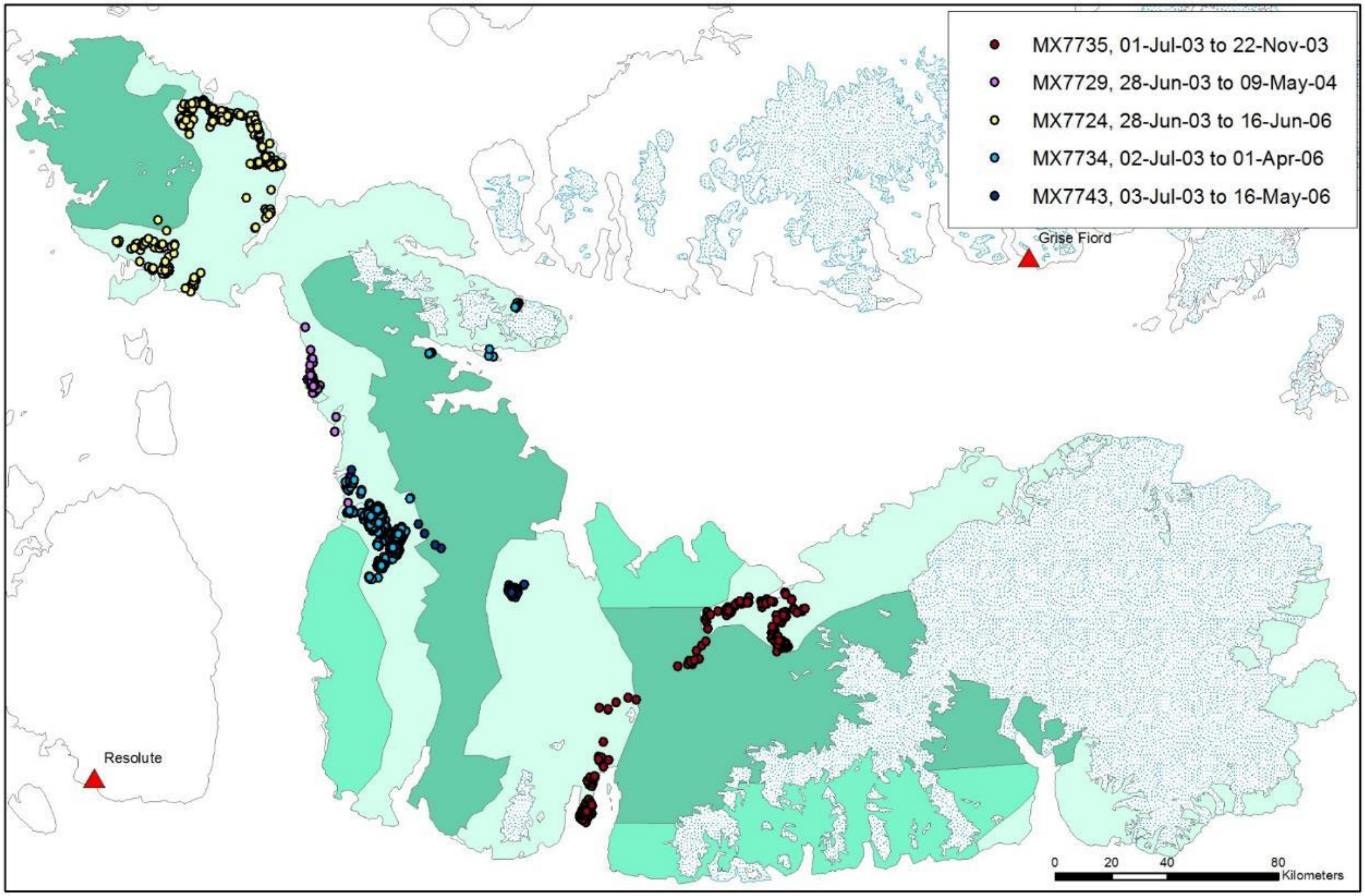


Figure 10. Telemetry locations of 5 collared female muskoxen, 2003-2006, on Devon Island. Survey strata are indicated by shaded green – high density (pale green), intermediate density (bright green), low density (dark green).

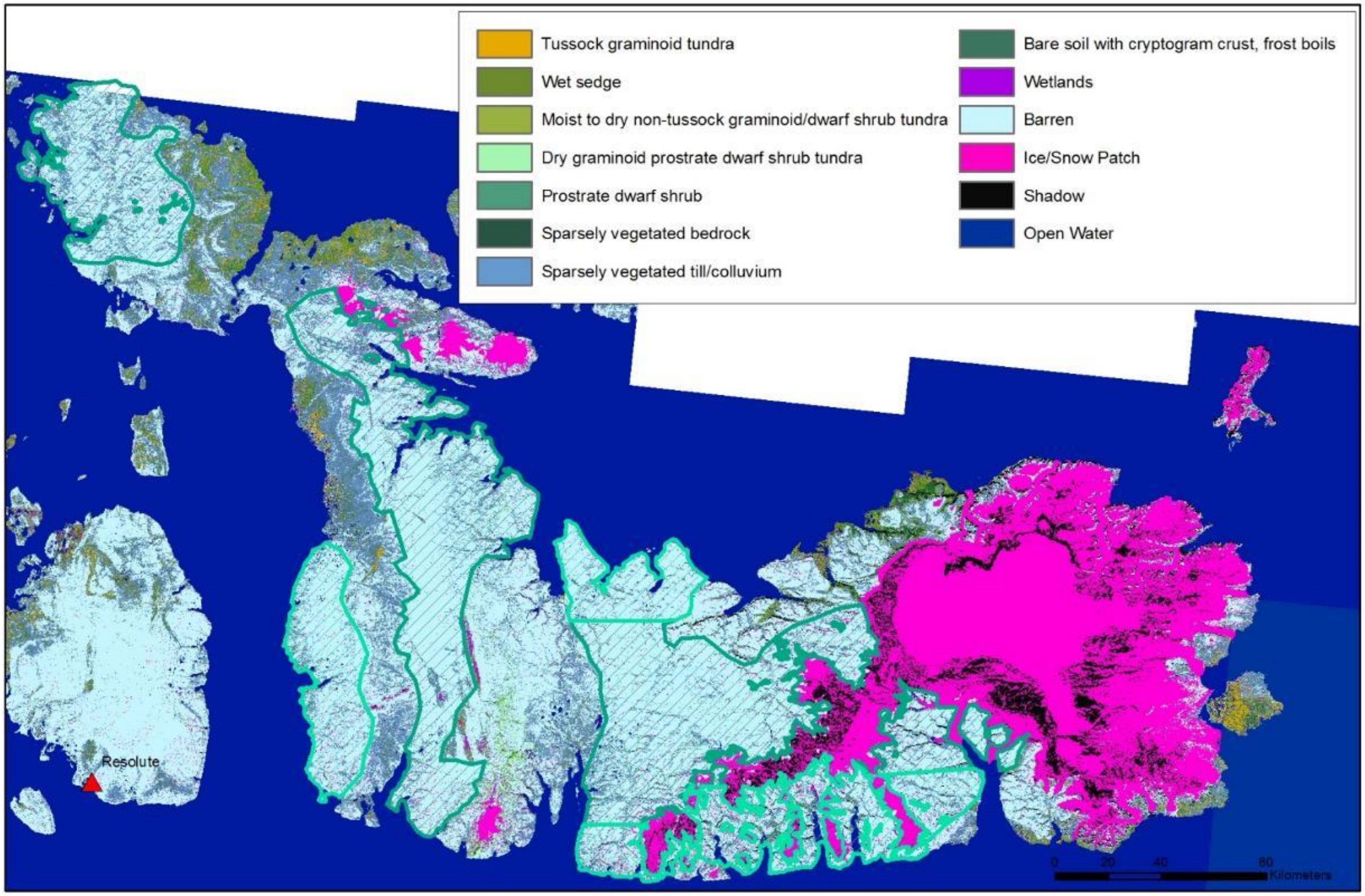


Figure 11. Land cover classification developed from Landsat imagery 1999-2002 (Olthof et al. 2008; available online through Natural Resources Canada). Survey strata are outlined and hatched by light green (intermediate density) or dark green (low density), with remaining non-icecap areas as high density strata.

**Appendix 3. 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 5. 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** |
|---|---|---|---|---|---|---|---|---|---|
| A | 1815.81 | 39767.06 | 117 | 18438.26 | 3479.02 | 288 | 344 | 0.098 | 0.110 |
| B | 95.85 | 847.56 | 21 | 6359.77 | 597.17 | 138 | 9 | 0.015 | 0.400 |
| C | 27.77 | undefined | 28 | 15076.34 | 1085.68 | 288 | 2 | 0.002 | |
| Total | 1939.43 | | 166 | 39874.37 | 5161.87 | 288 | 355 | | |

Table 6. Abundance estimates (Jolly 1969 Method II) for Peary caribou 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 caribou, *Y* is the estimated caribou 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** |
|---|---|---|---|---|---|---|---|---|---|
| A | 70.46 | 1806.83 | 117 | 18438.26 | 3479.02 | 288 | 13 | 0.004 | 0.603 |
| B | 0 | | 21 | 6359.77 | 597.17 | 138 | 0 | 0 | |
| C | 0 | | 28 | 15076.34 | 1085.68 | 288 | 0 | 0 | |
| Total | 70.46 | | 166 | 39874.37 | 5161.87 | 288 | 13 | | |

*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 7. Abundance estimates for a stratified systematic survey (Cochran 1977) of muskoxen on Devon Island, March 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 km²)** | **CV** |
|---|---|---|---|---|---|---|---|---|
| A | 1720 | 67436.38 | 117 | 5 | 1 | 344 | 0.098 | 0.151 |
| B | 90 | 2740.50 | 21 | 10 | 1 | 9 | 0.015 | 0.582 |
| C | 30 | 871.11 | 28 | 15 | 1 | 2 | 0.002 | 0.984 |
| Total | 1840 | 71047.99 | 166 | | | 355 | | |

Table 8. Abundance estimates for a stratified systematic survey (Cochran 1977) of Peary caribou on Devon Island, March 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 km²)** | **CV** |
|---|---|---|---|---|---|---|---|---|
| A | 65 | 67436.38 | 117 | 5 | 1 | 13 | 0.004 | 0.557 |
| B | 0 | 2740.50 | 21 | 10 | 1 | 0 | 0 | |
| C | 0 | 871.11 | 28 | 15 | 1 | 0 | 0 | |
| Total | 65 | 71047.99 | 166 | | | 13 | | |

**Appendix 4. Daily flight summaries for Devon Island survey flown by Twin Otter, March 2016.**

Table 9. Summary by day of survey flights and weather conditions for March 2016 Peary caribou and muskox survey, Devon Island.

| Date | Time Up | Time Down | Time Up 2 | Time Down 2 | Time Up 3 | Time Down 3 | Flying Time | Transect Time | Area | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 22-Mar-16 | 9:35 | 13:15 | 13:54 | 17:15 | | | 7:01 | 4:18 | Grinnell Peninsula | Clear, calm, -31°C, light wind ~20 kph at Arthur Fiord for fuel; right engine 'hiccup' but likely just water/ice in fuel line and fixed itself |
| 23-Mar-16 | 10:00 | 13:45 | | | | | 3:45 | 1:03 | Grinnell Peninsula | Sunny clear calm -32°C except severe/moderate turbulence in hills s of Arthur Fiord; left generator not working so only one flight |
| 24-Mar-16 | 9:05 | 13:20 | 14:25 | 17:35 | | | 7:25 | 4:59 | Colin Archer Peninsula; west coast | Clear -32°C slight wind N/NW ice crystals |
| 25-Mar-16 | 8:45 | 13:00 | 13:41 | 17:34 | | | 8:08 | 5:17 | West coast | Clear -32°C with ice crystals/fog along south shore (unable to fly below 3000' so moved north); burning off in pm |
| 26-Mar-16 | 9:08 | 13:35 | 14:15 | 18:11 | | | 8:23 | 5:28 | West central | -29°C clear some cloud/ice crystals/foggy cover at south end but burned off in pm. Late start/one flight since autofeather not engaging. |
| 27-Mar-16 | 10:07 | 12:41 | | | | | 2:34 | 0:51 | YRB-YGF, some lines in between | -29°C clear, some low cloud west of transects |
| 28-Mar-16 | 8:34 | 12:46 | 13:26 | 13:56 | 14:41 | 17:30 | 7:31 | 3:27 | Truelove and east coast | -30°C calm clear, landed at Truelove cache and scraped teflon off the left ski, so no more offstrip until its back to YRB for repair |
| 29-Mar-16 | 7:50 | 12:00 | 12:46 | 16:25 | | | 7:49 | 16:13 | Dundas Harbor and south coast | -30°C clear calm, some cloud south over Lancaster Sound |
| 30-Mar-16 | 9:54 | 13:05 | | | | | 3:11 | 1:35 | YGF-YRB, some lines in between | -30°C clear calm |

Pilots – Phil Amos, Reagan Schroeder; Navigator - Morgan Anderson

Observers:
Mar 22 – Morgan Anderson, Saroomie Manik, PJ Attagootak, James Iqaluk, Oolat Iqaluk
Mar 23 – Morgan Anderson, Saroomie Manik, PJ Attagootak, James Iqaluk, Oolat Iqaluk
Mar 24 – Morgan Anderson, Saroomie Manik, PJ Attagootak, James Iqaluk, Oolat Iqaluk
Mar 25 – Morgan Anderson, PJ Attagootak, Debbie Iqaluk, Oolat Iqaluk
Mar 26 – Morgan Anderson, PJ Attagootak, Debbie Iqaluk, Oolat Iqaluk
Mar 27 – Morgan Anderson, PJ Attagootak
Mar 28 – Morgan Anderson, Jopee Kiguktak, Aksakjuk Ningiuk, Frankie Noah, Simon Singoorie, Olaph Christianson
Mar 29 – Morgan Anderson, Jopee Kiguktak, Aksakjuk Ningiuk, Frankie Noah, Simon Singoorie, Junior Kakkee
Mar 30 – Morgan Anderson, PJ Attagootak

**Appendix 5. Incidental wildlife observations.**

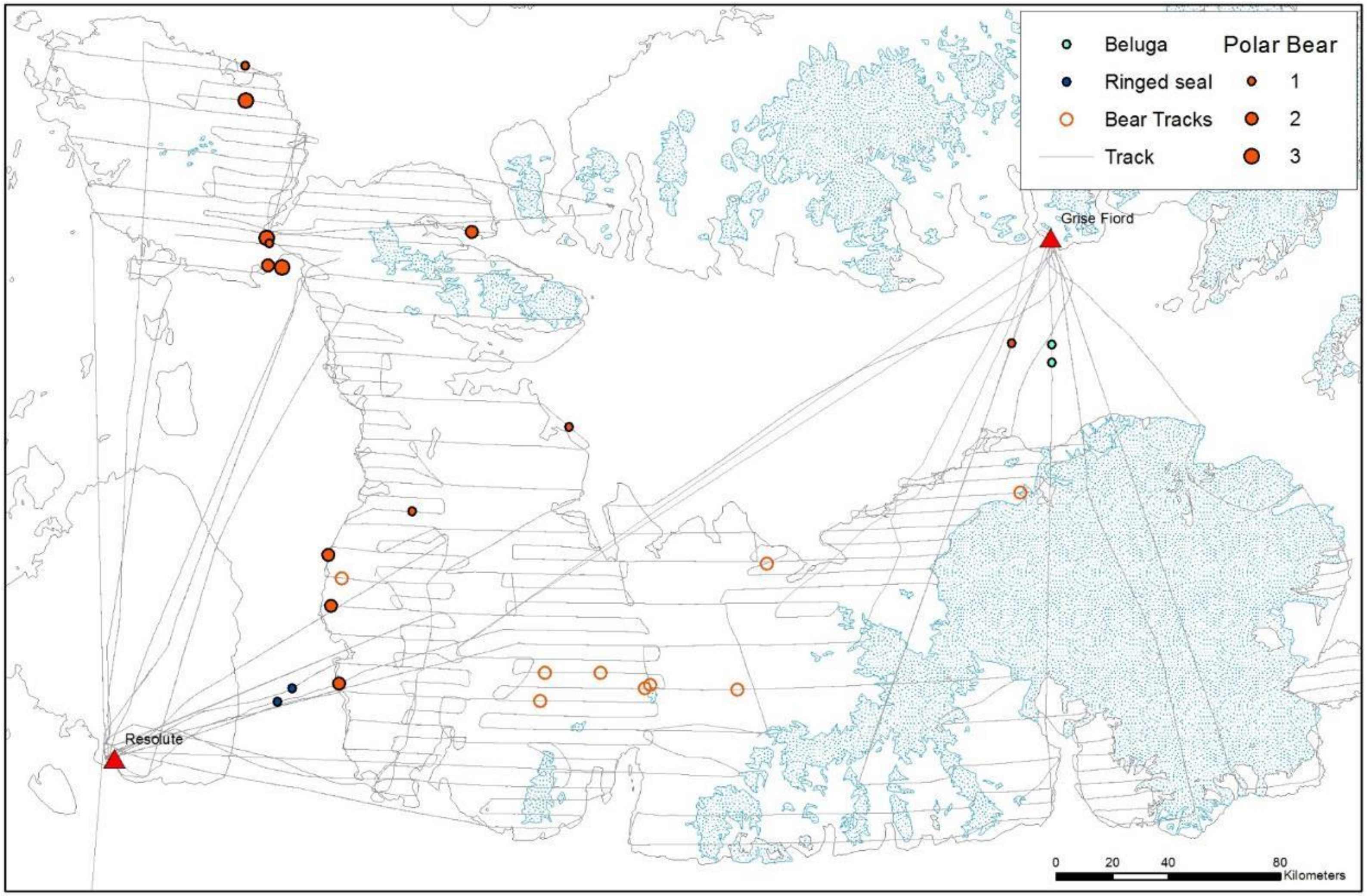


Figure 12. Incidental observations, Mar 22-30 2016, and flight lines for an aerial survey of Devon Island. Some track lines are incomplete due to loss of satellite coverage. A total of 37 polar bears were observed, as well as 5 ringed seals basking on the sea ice in Wellington Channel, and 2 groups of beluga (6 and 7 individuals) along the floe edge south of Grise Fiord. Polar bear family groups included very small cubs recently emerged from dens, and one den was seen with tracks, 40 km northwest of Maxwell Bay.

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

MORGAN ANDERSON[1]

Version: 13 September 2016

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Wildlife Research Section, Government of Nunavut Box 209 Igloolik NU X0A 0L0

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.



**ᐅᓂᒃᑳᖅᓯᒪᓂᖏᑦ**

ᖁᑖᒨᓚᐅᕋᑦᑕ ᕿᙵᐃᑖᑉ, ᑰᖓᓇᔩᑉ, ᐃᓐᓂᓕᖅᓯᒪᔩᑉ, ᐊᕿᑦᑐᓕᐅᑉ ᕿᑭᖅᑕᐅᑉ, ᐊᒻᒪᓗ ᕿᑭᖅᑕᕈᓘᑉ ᓇᐅᔭᓕᐅᑉ ᖁᑖᒎᑦ (ᐅᒥᖕᒪᖕᓂᒃ ᐊᐅᓚᑎᕝᕕᐅᓂᐅᔪᖅ ᐃᓂᐅᔪᖅ MX-06), ᐊᑕᐅᓯᓕᒃᑰᖅᑯᑕ 82-ᓄᑦ ᐃᑲᕐᕋᓄᑦ ᐅᑯᐊ ᐅᑦᑐᑦ ᐊᑯᓂᖏᓐᓂ ᐊᐅᒍᓯ 5 ᐊᒻᒪᓗ 23, 2016-ᒥ, ᒫᓇᓕᓴᙳᖅᑎᓐᓇᓱᐊᖅᑯᑎᑦ ᐅᓄᕐᓂᔪᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᔪᑦ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᑦ ᐊᒻᒪᓗ ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᖃᐅᔨᓴᕐᕕᐅᔪᒥ. ᓯᕗᓂᐊᒍᑦ ᖃᐅᔨᓴᕐᓂᐅᓚᐅᖅᓯᒪᔪᖅ, 2004-ᒥ, ᖃᐅᔨᕝᕕᐅᓚᐅᙱᑦᑐᖅ ᑐᒃᑐᑕᕐᑲᕐᓂᖓᓂᒃ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᓐᓂᒃ, ᐊᕐᕌᒍᑎᓪᓗᒍ ᑭᓯᐊᓂ ᒪᓂᕐᑲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᕐᒥ ᒪᕐᕈᐃᓂᒃ ᑐᒃᑑᖅᑲᑎᒌᓂᒃ 7 ᐅᓪᓗᑎᒃ ᓇᓂᓯᓚᐅᖅᓯᒪᔩᓪᓗᐊᑦ ᑕᐅᕙᓂ ᑰᒐᓇᔩᑉ ᕿᑭᖅᑕᖓᓂ. ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᖃᐅᔨᔭᐅᔪᑦ ᐅᓄᕐᓂᐅᔪᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᔪᑦ 3,052± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖓᓂ 440-ᐅᓪᓗᑎᒃ ᐅᒥᖕᒪᑦ ᑕᐅᕙᓂ ᕿᙵᐃᑖᑉ ᐊᒻᒪᓗ ᑰᒐᓇᔩᑉ ᕿᑭᖅᑕᖓᓂ (ᐱᖃᓯᐅᑎᓪᓗᒋᑦ ᒥᑭᓐᓂᖅᓴᐅᔪᑦ ᕿᑭᖅᑕᒐᓇᐃᑦ), ᐃᒪᓐᓇᐅᑎᒋᓪᓗᑎᒃ 1,569 ± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖓᓂ 267-ᖑᓪᓗᑎᒃ ᑕᐅᕙᓂ ᕿᙵᐃᑖᑉ, ᐊᕿᑦᑐᓕᐅᑉ ᕿᑭᖅᑕᐅᑉ, ᕿᑭᖅᑕᕈᓘᑉ ᓇᐅᔭᓕᐅᑉ, ᐊᒻᒪᓗ ᐃᓐᓂᓕᖅᓯᒪᔩᑉ ᕿᑭᖅᑕᖓᓂ, ᐊᒻᒪᑦᑕᐅᖅ 1,483 ± ᓂᒋᐅᓪᓗ ᑲᓇᖕᓇᐅᓪᓗ ᐊᑯᓂᖓᓂ 349-ᖑᓪᓗᑎᒃ ᐅᒥᒻᒪᑦ ᑕᐅᕙᓂ ᑰᒐᓇᔩᑉ ᕿᑭᖅᑕᖓᓂ. 2016-ᒥ ᖃᐅᔨᓴᕐᓂᕕᓂᕐᓂᑦ ᐱᓯᒪᔪᑦ ᓇᓗᓇᐃᖅᓯᓯᒪᖕᒪᑕ ᐅᓄᕈᓐᓃᖅᐸᓪᓕᐊᔪᓂᒃ ᑕᐃᒪᖓᑦ 1990-ᖏᓐᓂᑦ, ᑭᓯᐊᓂ ᐅᓄᕈᓐᓃᖅᐸᓪᓕᐊᓂᕋᐃᓯᒪᓇᑎᒃ ᓇᓗᓇᐃᖅᓯᒪᔪᒃᑯᑦ ᑕᐃᑲᙵᓂᑦ 2004-ᒥᑦ ᒥᒃᓴᐅᑕᐅᓯᒪᔪᑦ 2,086 ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᕿᙵᐃᑖᑉ/ᐃᓐᓂᓕᖅᓯᒪᔩᑉᓗ ᕿᑭᖅᑕᖏᓐᓂ (1,582-2,746, 95% CI) ᐊᒻᒪ 1,910 ᐅᒥᖕᒪᐃᑦ ᑕᐅᕙᓂ ᑰᒐᓇᔩᑉ ᕿᑭᖅᑕᖓᓂ (962-3,792 95% CI; Jenkins et al. 2011). ᑕᑯᔭᖃᓚᐅᙱᑦᑐᖅ ᖁᑦᑎᒃᑑᑉ ᑐᒃᑐᖏᓐᓂᒃ ᐊᖑᓇᓱᒃᑎᓂᑦ ᕿᓂᖅᑐᓂᑦ ᒪᓃᑐᕈᔪᖕᒥ ᐅᐊᖕᓇᖅᐸᓯᐅᔪᒥ ᓯᓪᓴᖅᐸᓯᖕᒥ ᑰᒐᓇᔩᑉ ᕿᑭᑖᓂ ᓂᒋᐊᓂ Aston ᑲᖏᕐᓗᐊᓂ. ᓇᐅᑦᑎᖅᓱᖅᑕᐅᑦᑎᐊᖏᓐᓂᖏᓐᓄᑦ ᖁᑎᒃᑑᑉ ᑐᒃᑐᖏᑦ ᓇᓗᓇᖏᓚᑦ ᑕᐃᒃᑯᐊ ᐅᓄᕐᓂᐅᔪᑦ ᖃᓄᐃᓕᕙᓪᓕᐊᓗᐊᖏᑦᑐᑦ ᐅᓄᕈᓐᓃᓗᐊᓚᐅᖅᓯᒪᓪᓗᑎᒃ ᑕᐅᕙᓂ 1980-ᖏᓐᓂ ᐊᒻᒪᓗ 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.

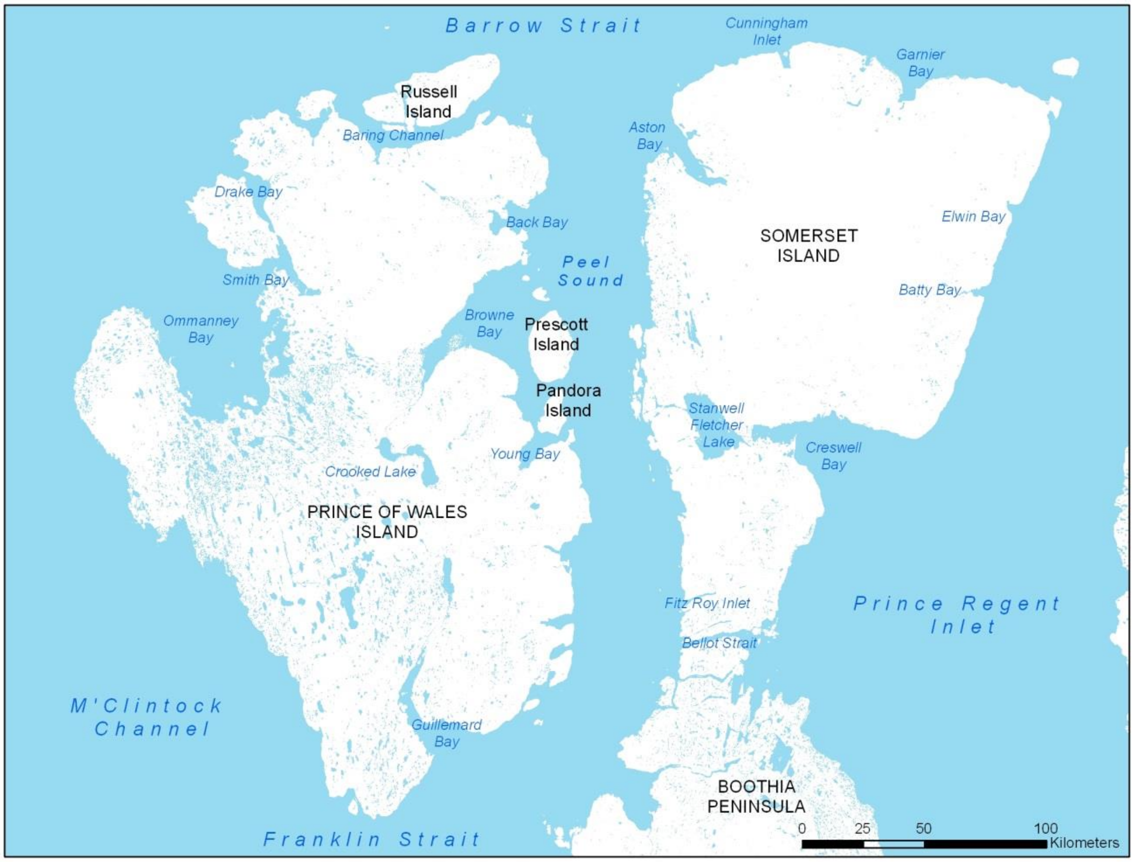


Figure 1. Major landmarks of the study area.

## 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.

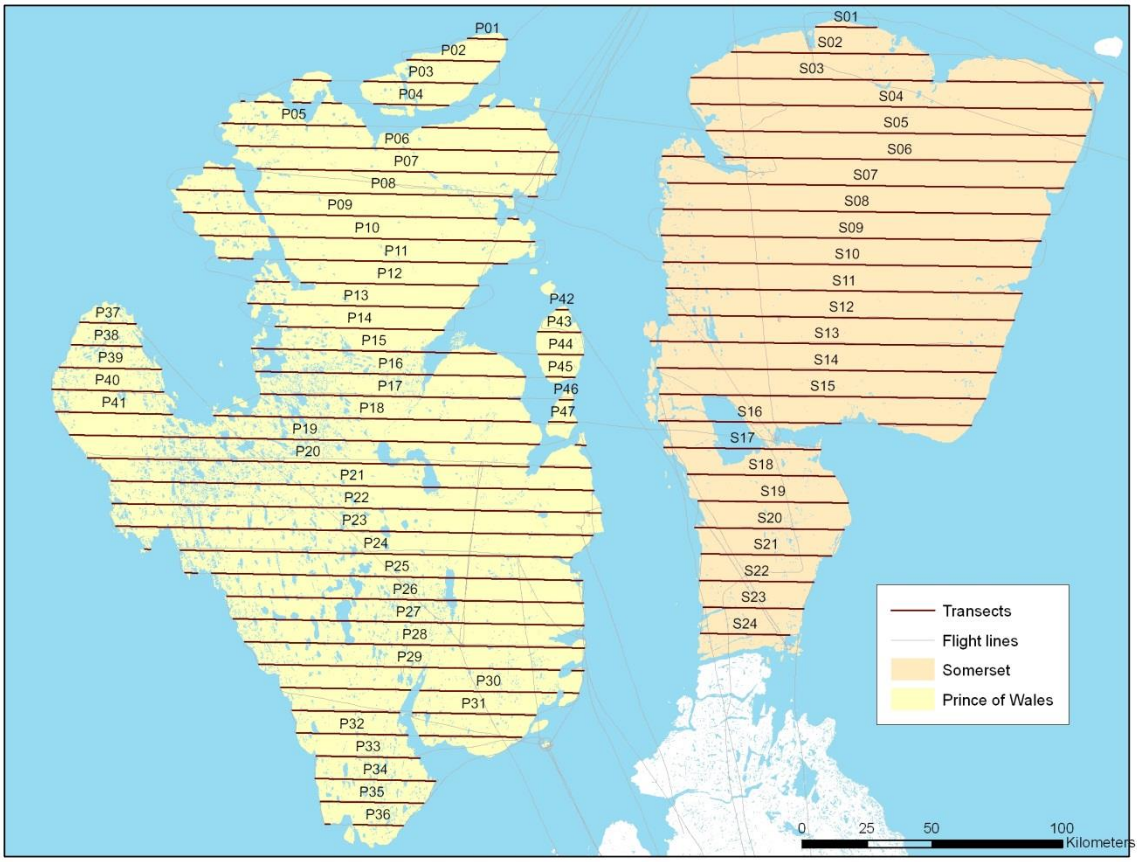


Figure 2. Transects and survey strata for Prince of Wales and Somerset islands, August 5-23, 2016. Transects on Prince of Wales are 8.64 km apart and transects on Somerset are 10.16 km apart.

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).

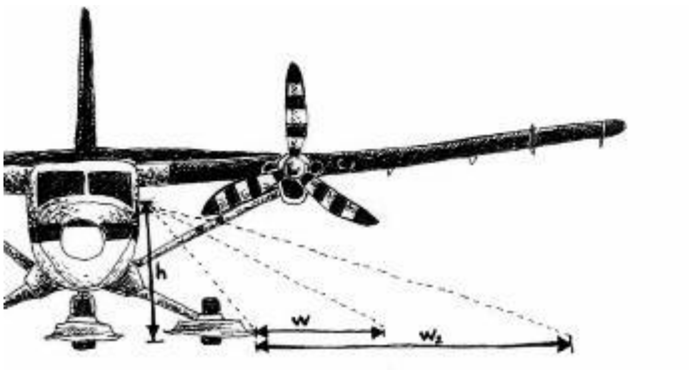


Figure 3. Derivation of wing strut marks for strip boundaries, where *w* and $w_2$ are calculated as described in the text, *h* is measured, and dotted lines indicate observer sightlines as modified from Norton-Griffiths (1978).

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 $\varepsilon_i$ 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, $\lambda$. When $r$ >0 or $\lambda$ >1, the population is increasing; when $r$ <0 or $\lambda$ <1 the population is decreasing. Values of $r$ ~0 or $\lambda$ ~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.

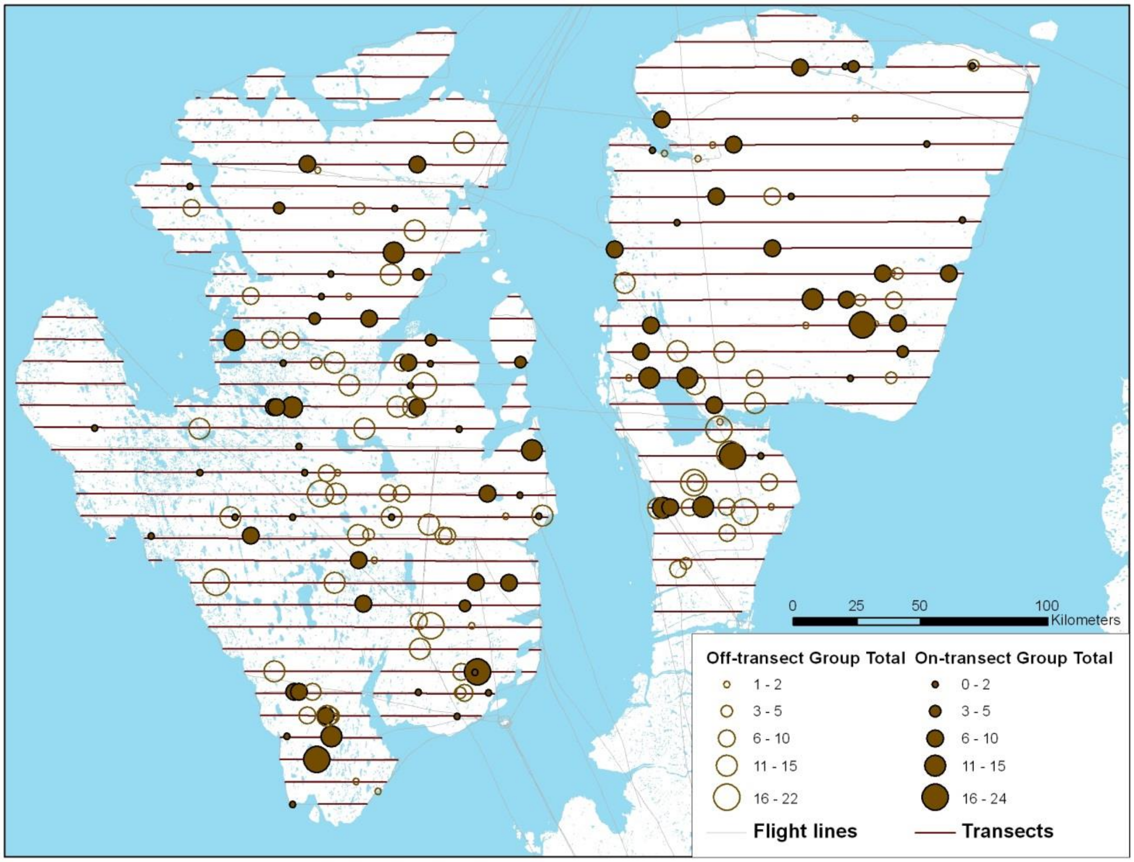


Figure 4. Observations of muskoxen on Prince of Wales and Somerset islands, August 2016, including observations on and off transect, and on ferry flights.

*Abundance Estimates*

Muskox population estimates and variances are presented in Table 1.



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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.

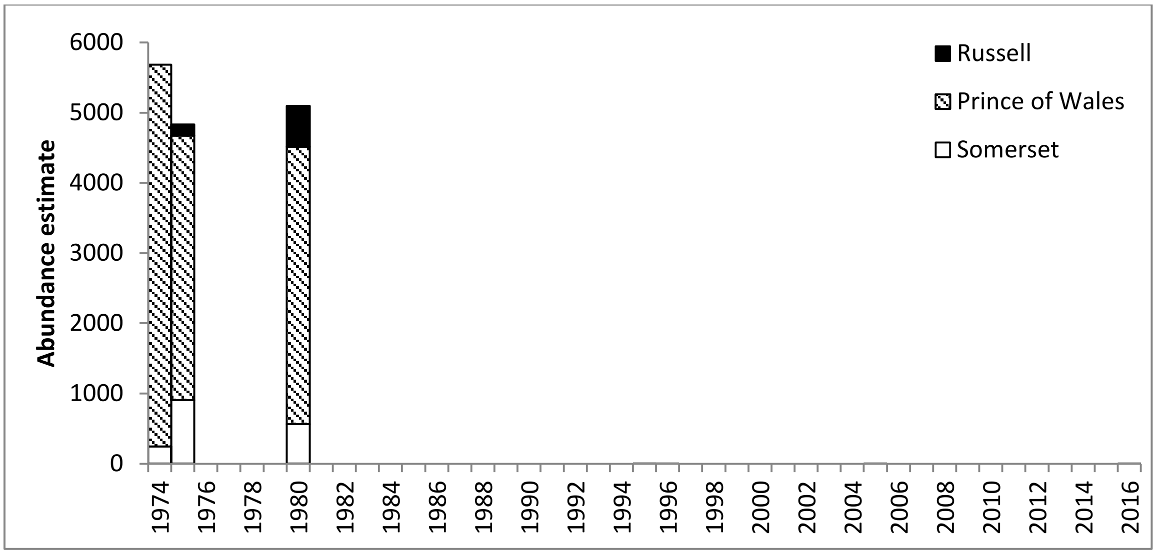


Figure 5. Population trends for Peary caribou on Prince of Wales, Somerset, and Russell islands, showing a catastrophic decline between 1980 and 1995. Surveys were conducted in June-July1974 and 1975 (Fischer and Duncan 1976), July 1980 (Gunn and Decker 1984), July-August 1995 (Gunn and Dragon 1998), 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.

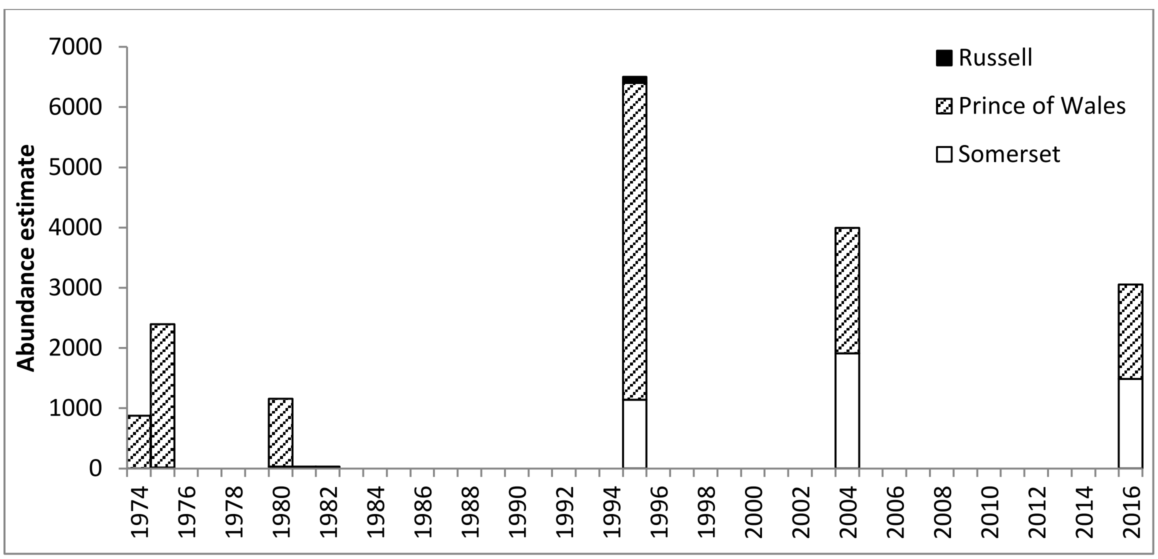


Figure 6. Population trends for muskoxen on Prince of Wales, Somerset, and Russell islands, showing an increase from the 1970s and a gradual decline since the mid-1990s.Surveys were conducted in June-July1974 and 1975 (Fischer and Duncan 1976), July 1980 (Gunn and Decker 1984), July-August 1995 (Gunn 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.

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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.**

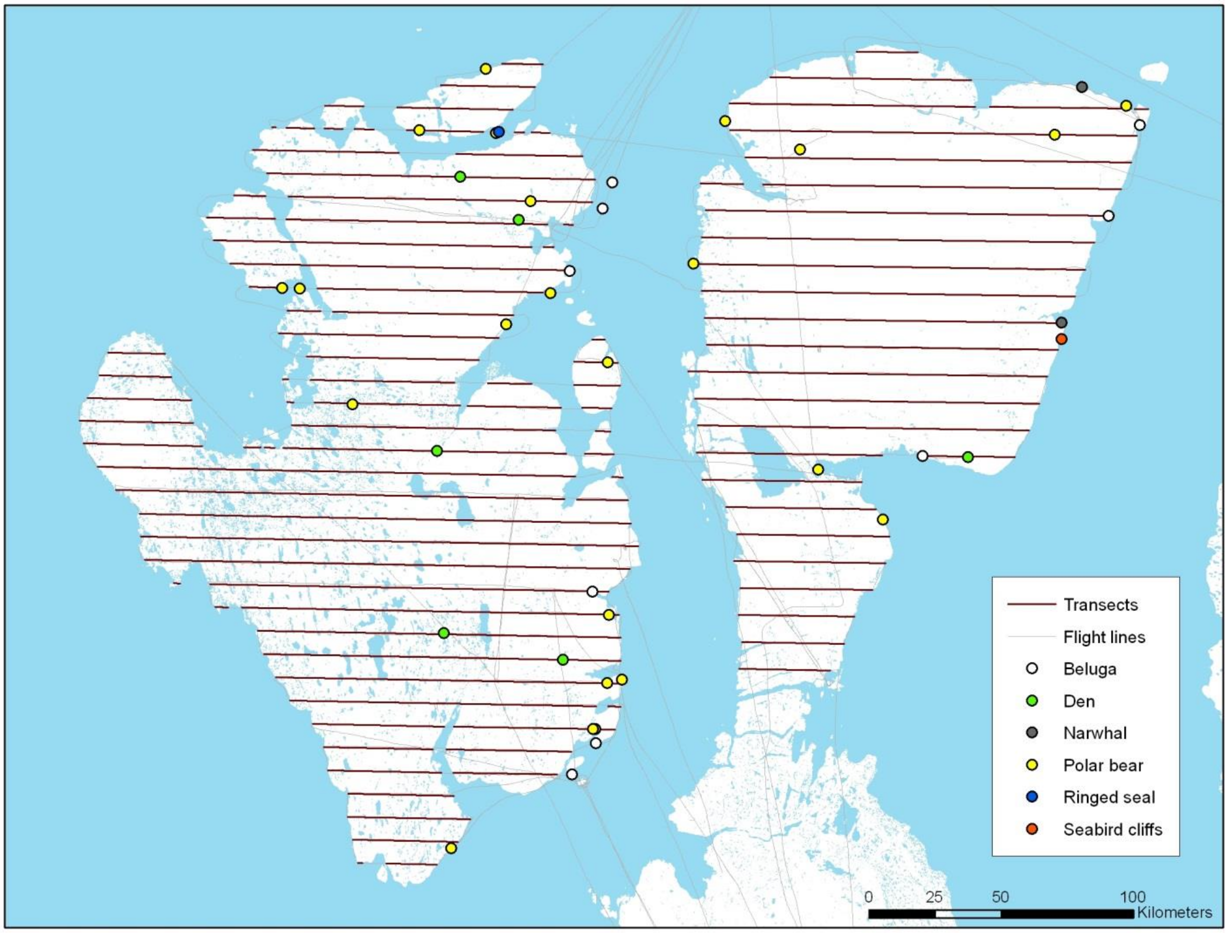


Figure 7. Incidental observations, Aug 5-23 2016, and flight lines for an aerial survey of Prince of Wales and Somerset islands. Some track lines are incomplete due to loss of satellite coverage. A total of 34 polar bears were observed, including 5 family groups. Some beluga pods were more than 60 individuals 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.

**DISTRIBUTION AND ABUNDANCE OF PEARY CARIBOU (*Rangifer tarandus pearyi*) ON LOUGHEED ISLAND, JULY 2016**

MORGAN ANDERSON[1]

Version: 13 August 2016

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STATUS REPORT 2016-02
NUNAVUT DEPARTMENT OF ENVIRONMENT
WILDLIFE RESEARCH SECTION
IGLOOLIK, NU

**ᓯᐊᒻ ᒪᑦᓯᒪᓂᖏᓐ ᐊᒥᓰᓂᖏ ᓄ ᐱᐅᕆᑐᒃ ᑐᐃᑦ (PEARY CARIBOU) (*Rangifer tarandus pearyi*)**
**LOUGHEED ISLAND (ᕿᑭᖅᑕᒥ), ᔪᓚᐃ 2016**

ᒧᐊᕐ ᑲᓐ ᐋᓐ ᑐᓴᓐ[1]

ᐱᓯᒪᔪᖅ: 13 ᐊᐅᒡ ᒍᓯ 2016

[1]ᐆᒪᔪᓕᕆᔨ ᖁᑦᓯᑦᑐᒧᑦ, ᒥᓂᔅ ᑕᐅᕕᖕᒋᓂᒃ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ
ᐆᒪᔪᕐᓂᒃ ᖃᐅᔨᓴᕐᓂᓕᕆᔩᑦ, ᑲᕙᒪᒃ ᑯᖕᒋᓂ ᓄᓇᕗᑦ ᑎᑎᖅᑲᒃ ᑯᕕᐊ 209 ᐃᒡ ᓗᓕᒃ, ᓄᓇᕗᑦ X0A 0L0

ᖃᓄᐃᓕᖓᓂᐅᔪᓄᑦ ᐅᓂᒃ ᑳᑦ 2016-02
ᓄᓇᕗᒻ ᒥ ᒥᓂᔅ ᑕᐅᕕᖕᒋᑦ ᐊᕙᑎᓕᕆᓂᕐ ᒧᑦ
ᐆᒪᔪᕐ ᓂᒃ ᖃᐅᔨᓴᖅᑏᑦ
ᐃᒡ ᓗᓕᒃ, ᓄᓇᕗᑦ

Anderson, M. 2016. Distribution and abundance of Peary caribou (*Rangifer tarandus pearyi*) on Lougheed Island, July 2016. Nunavut Department of Environment, Wildlife Research Section, Status Report 2016-02, Igloolik, NU.

ᐋᓐᑐᓴᓐ, ᒫ. 2016. ᓯᐊᒻᒪᖅᓯᒪᓂᖏᑦ ᐊᒥᓲᓂᖏᓪᓗ ᑐᒃᑐᐃᑦ ᐱᐅᖅᑐᒃᑐᐃᑦ (Peary caribou) (*Rangifer tarandus pearyi*) Lougheed ᕿᑭᖅᑕᓂᒃ, ᔪᓚᐃ 2016. ᓄᓇᕗᒻᒥ ᒥᓂᔅᑕᐅᕕᖓᐊᕙᑎᓕᕆᓂᕐᒧᑦ, ᐆᒪᔪᓕᕆᓂᕐᒧᑦ ᖃᐅᔨᓴᖅᑎᑦ, ᖃᓄᐃᓕᖓᓂᕐᒧᑦ ᐅᓂᒃᑳᑦ 2016-02, ᐃᒡᓗᓕᒃ, ᓄᓇᕗᑦ.


**Summary**

We flew a survey of Lougheed Island on July 28, 2016, as reconnaissance to find caribou groups for collection of fecal pellets. We encountered enough caribou groups to allow us to calculate a population estimate for the island, which had been last surveyed in 2007. We observed 61 caribou, 26 of which were on transect, during the flight. The estimate of 140±SE33 Peary caribou indicates a decline from the 2007 survey, which estimated 205-672 caribou on the island (95% CI, Jenkins et al. 2011). We did not see any muskoxen on Lougheed Island, but we did see 2 wolves last summer and wolf tracks this summer. Lougheed Island too remote to be regularly accessed for harvesting.



**ᓇᐃᓈᖅᑎᖅᓯᒪᔪᑦ**

ᖃᐅᔨᓴᕐᓂᖃᔪᔪ iii ᖁᓚᐅᑦᓱᑕ Lougheed ᕿᑭᖅᑕᒥᒃ ᔪᓚᐃ 28, 2016, ᑲᑎᖅᓱᐃᔪᒪᓪᓗᑎᒃ ᑲᑎᒪᐅᖅᑐᓂᒃ ᑐᒃᑯᓂᒃ ᓄᐊᑦᓯᔪᒪᓪᓗᑎᒃ ᐊᓇᖏᓂᒃ. ᑕᑯᔪᔪᑦ ᓈᒻᒪᑦᑐᓂᒃ ᑐᒃᑐᓂᒃ ᑲᑎᒪᐅᖅᑐᓂᒃ ᐱᕕᖃᕈᑎᒋᓪᓗᒍ ᓈᓴᐃᔪᓐᓇᕐᓂᕐᒥᒃ ᐊᒥᓲᓂᖏᑕ ᓇᓚᐅᑦᓵᖅᑕᐅᖏᓐᓂᓂᒃ ᕿᑭᖅᑕᒥ, ᑭᖑᓪᓕᖅᐹᒥ ᖃᐅᔨᓴᖅᑕᒥ ᓂᐅᑦᓯᓂ 2007−ᒥ. ᑕᑯᔪᔪᑦ 61−ᓂᒃ ᑐᒃᑐᓂᒃ, 26−ᖑᑦᓯᑎᒃ ᓅᐸᓪᓕᐊᔪᑦ, ᖃᖓᑕᓂᑦ ᑎᓐ ᓂ. ᒥᑦᓴᐅᓯᔭᐅᓂᖏᑦ 140±SE33 ᐱᐅᖅ ᑐᒃᑐᐃᑦ ᓇᑐᓇᐃᖅᓯᒍᑕᐅᔪᖅ ᐃᓄᐃᓴᓪᓕᕚᓪ ᓕᖓᐊᖏᑦ 2007−ᒥ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᓯᒪᑎᓪᓗᒋᑦ, ᑕᐃᑦᓯᒪᓂᓕ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᔪᑦ 205-672 ᑐᒃᑐᐃᑦ ᕿᑭᖅᑕᒥ (95% CI, Jenkins et al. 2011). ᑕᑯᔪᓐᖏᑦᑐᒍᑦ ᐅᒥᒻᒪᓐᓂᒃ Lougheed ᕿᑭᖅᑖᖓᓂ, ᑭᓯᐊᓂ ᑕᑯᔪᒐᓗᐊᖅᑐᒍᑦ ᒪᕿᓐᓂᒃ ᐊᒪᕿᓐᓂᒃ ᐊᕐᕌᓂ ᐊᐅᔭᒃ ᑯᑦ ᐊᒪᕈᕐ ᓄᓪᓗ ᑐᒥᓂᒃ ᑕᕝᕙᓂ ᐊᕐᕌᒍᕐᒥ. Lougheed ᕿᑭᖅᑖᖓ ᐅᖓᓯᒃᑐᐊᕐᒪᑦ ᐊᖑᓇᓱᖕᕕᐅᓕᐅᒥᔫᕐᑐᓂ.

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## Introduction

Peary caribou (*Rangifer tarandus pearyi*) are a small, light-coloured subspecies of caribou/reindeer inhabiting the Canadian Arctic Archipelago in the Northwest Territories and Nunavut from the Boothia Peninsula in the south to Ellesmere Island in the north. They are sympatric with muskoxen (*Ovibos moschatus*) over much of their range although diet, habitat preferences, and potentially interspecific interactions separate the two species at a finer scale (Resolute Bay Hunters and Trappers Association [HTA] and Iviq HTA, pers. comm.). Arctic wolves (*Canis lupus arctos*) occur at low densities throughout Peary caribou range, but the most significant cause of population-wide mortality appears to be irregular die-offs precipitated by severe winter weather and ground-fast ice that restricts access to forage (Miller et al 1975, Miller and Gunn 2003, Miller and Barry 2009).

Peary caribou have been surveyed infrequently and irregularly on the Canadian Arctic Archipelago since Tener's 1961 survey, which counted 232 caribou and calculated 4.2 caribou per square mile on Lougheed Island. This density was surprising for such a small, isolated island, but similar to western Mackenzie King Island, which was surveyed the same year (Tener 1963). Subsequent surveys indicated far lower densities of caribou, however - the most recent survey estimated 205-672 caribou on the island (95% CI, Jenkins et al. 2011).

Although there is no harvest currently reported of Peary caribou on Lougheed Island, there is some connectivity between the Findlay Group and the Bathurst Island Group, which is largely relied up on by Resolute for caribou harvesting, since the caribou population on Somerset and Prince of Wales islands has not yet recovered. Changes in distribution and abundance between Lougheed and Bathurst islands could indicate movements among the islands or a change in population across all islands.

## **ᓇᓗᓇᐃᔭᐃᓂᖅ**

ᐱᐅᕆ ᑐᒃᑐᐃᑦ (Peary caribou) (*Rangifer tarandus pearyi*) ᒥᑭᔪᐃᑦ, ᑕᐅᑦᑐᖏᑦ ᖃᑯᐊᖑᕐᑦᓱᑎᒃ ᑐᒃᑐᓃᖕ ᖏᒌᖅᑐᑦ/ᑑᒃ ᑑᔭᕐᓂᒃ ᓇᔪᒐᖅᑐᓂᒃ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᒥ ᕿᑭᖅᑕᖕᓂᒃ ᓄᓇᑦᓯᐊᕐᒥ ᓄᓇᕗᒻᒥᓗ ᐊᓚᕐ ᓈᕐ ᔪᒻᒥ ᓂᒋᐊᓂ ᐊᐅᔪᐃᑦ ᑑᑉ ᖃᖅᑕᙳᓂᑦ ᐅᐊᓐ ᓇᒥ. ᓄᓇᖅᑲᑎᓖᑦ ᐅᒥᒻᒪᓐᓂᒃ (*Ovibos moschatus*) ᐃᓗᓐ ᓇᓚ ᓚᙳᓂ ᓇᔪᒐᕐᒥᓂ ᓂᕆᔭᙱᑦ, ᓇᔪᒐᕆᔪᒪᔭᙱᑦ, ᐊᒻᒪᓗ ᑲᓲᒪᖃᑎᖃᕐᓂᙱᑦ ᐃᒥᒃ ᑰᙹ ᓗᐊᖅᓱᑎᒃ ᑖᒃ ᑯᐊ ᐆᒪᔫᒃ (ᖃᐅᔨᐃᑦᑐᕐᒥ ᐊᖑᓇᓱᑦᑏᑦ ᑲᑎᒪᔩᙱᑦ (HTA) ᐊᒻᒪᓗ ᐊᐃᕕᖅ HTA, pers.comm.). ᐅᑭᐅᖅᑕᖅᑐᒥ ᐊᒪᕈᐃᑦ (*Canis lupus arctos*) ᐱᑕᖃᖅᐸᑦᑐᑦ ᐊᒥᓱᓈᖅᓯᒪᒐᑎᒃ ᐱᐅᕆ ᑐᒃᑐᑕᓕᓐᓂ, ᑭᓯᐊᓂ ᐊᓚᒃᑲ ᐃᓄᖕᐸᐅᔫᖅᑐᖅ ᐊᒥᓱᓄᑦ ᑐᒃᑐᓄᑦ ᑐᖁᑦᓕᐅᕆᔫᕈᑕᐅᔪᖅ ᐊᐅᓚᔅ ᔭᑦ ᑕᐅᕙᑦᑐᖅ ᐅᑭᐅᒃᑯᑦ ᓯᓚᕐ ᓗᓂᕐᒍᑦ ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᖁᐊᖅᐸᓪ ᓕᐊᓂᙳᓂᑦ ᓂᓚᕈᖅᓯᓂ ᓂᕿᑦ ᓴᙵ ᓄᑦ ᖁᐊᕈ ᑕᐅᓕᖅᓯᓂ (Miller et al 1975, Miller and Gunn 2003, Miller and Barry 2009).

ᐱᐅᕆ ᑐᒃᑐᐃᑦ ᖃᐅᔨᓴᖅᐅᖃᑦᑕᖅᓯᒪᔪᖅ ᐅᕙᑦᓯᐊᐹᓕᕋᐃᒪᑦ ᓈᓴᖅᑕᐅᓕᒫᑐᐃᓐ ᓇᖅᓯᑎᒃ ᑲᓇᑕᒥ ᐅᑭᐅᖅᑕᖅᑐᒥ ᕿᑭᖅᑕᙳᓂ ᑕᐃᒪᓐ ᖏᓐᓂᑦ 1961 ᑕᓄᕐ ᖃᐅᔨᓴᕐ ᓂᐅᓯᒪᔪᒥ, ᓈᓴᐃᑦ ᓯᑎᒃ 232−ᓂᒃ ᑐᒃᑐᓂᒃ ᓇᓴᐃᓕᖅᓯᑎᒃ 4.2 ᑐᒃᑐᓂᒃ ᐊᑐᓂᑦ ᑭᐸᓐᓇᑦ ᑐᒥ ᒪᐃᓕᒥ Lougheed ᕿᑭᖅᑕᒥ. ᑕᐃᒫᒃ ᐊᒥᓱᓂᖅᑲᓇᐊᙱᑦ ᑲᒪᓂᐊᕆᔭ ᐅᓯᒪᔪᑦ ᕿᑭᖅᑕᓪ ᓚᑐᐊᓗᒻ ᒥ ᐅᖓᑦ ᑐᒦᑦ ᑐᒥ, ᑭᓯᐊᓂ ᐊᔾ ᓴᒐᓚᕆᓪ ᓗᓂᐅᒃ ᐱᖑ ᓇᒥ ᒪᒃ ᑲᓐᓴ ᑭᖕ ᕿᑭᖅᑕᒥ, ᖃᐅᔨᓴᖅᑕᐅᓯᒪᑦᓯᓂᑦ ᑕᐅᖅ ᑕᐃᑲ ᓂᑦ ᓴᐃᓐ ᓇᖅ ᐊᕐ ᕼᒍᒥ (Tener 1963). ᑭᖑᓪᕐ ᖓᑦ ᖃᐅᔨᓴᕐ ᓂᐅᓯᒪᔪᑦ ᓇᓗᓇᐃᖅᓯᓯᒪᔪᑦ ᐃᓄᐃᓴᓐ ᓂᖅᓴᐹᓗᓐ ᓂᒃ ᑐᒃᑐᓂᒃ, ᑭᓯᐊᓂᓕ – ᓖᓐ ᓇᖃᕐ ᒥᐅᓂᖅᐹᖅ ᖃᐅᔨᓴᕐ ᓴᓂᐅᓯᒪᔪᖅ ᓇᓚᐅᑦᓵᖅᓯᒪᔪᑦ 205-672 ᑐᒃ ᑯᓂᒃ ᕿᑭᖅᑕᒥ (95% CI, Jenkins et al. 2011).

ᒫᓐ ᓇᕐ ᓂᑕᕐ ᓂᒃ ᑐᒃᑐᑕᒥ ᓂᐅᔪᓂᒃ ᐅᖃᖅᓯᒪᔪᖃᙱᒃ ᑲᓗᐊᖅᑎᓪ ᓗᒍ ᐱᐅᕆ ᑐᒃᑐᓂᒃ Lougheed ᕿᑭᖅᑕᙳᓂ, ᑲᑎᒪᓂᖅᑕᖃᖅᑐᖅ ᐊᑯᕐ ᖑᓂ Findlay Group ᑲᑎᒪᐅᖅᑐᑦ ᐊᒻᒪᓗ ᑭᙵᐅᒻ ᒥ ᑲᑎᒪᐅᖅᑐᖅ, ᓯᖏᖅᑑᑕᐅᓚᔪᑦᓯᑎᒃ ᖃᐅᔨᐃᑦᑐᕐᒥᒃ ᑐᒃᑐᓚᐊᖅᓯᑎᒃ, ᑐᒃᑐᐃᑦ ᐊᒥᓲᓂᙱᑦ ᐅᑎᖅᓯᒪᓐ ᖏᑦ ᒪᑕ ᖃᐅᔨᐃᑦᑑᑉ ᕿᑭᖅᑕᙳᓂ ᐊᒻᒪᓗ Wales Islands ᕿᑭᖅᑕᓂ. ᐊᓯᔾ ᔨᖅᓯᒪᓂᙱᑦ ᓯᐊᒻᒪᖅᓯᒪᓂᙱᑦ ᑕ ᐊᒥᓲᓂᙱᑦ ᑕᓗ ᐊᑯᕐ ᖑᓂ Lougheed ᐊᒻᒪᓗ ᑭᙵᐅᒻ ᒥ ᕿᑭᖅᑕᐃᑦ

ᓇᓗᓇᐃᖅᓯᒍᑕᐅᒍᓐ ᓇᖅᑐᑦ ᓄᑦ ᑕᑎᐊᖏᓕ ᐊᑯᕐ ᖕᒐ ᓂ ᕿᑭᖅᑕᐃᑦ ᐅᕝ ᕙᓗ ᐊᓯᔾ ᔨ ᐸᓪ ᓕᐊᔪᑦ ᐊᒥ ᓰᓂᖏᓕ ᐃᓘᓐ ᓇᖏᓐ ᓂ ᕿᑭᖅᑕᐃᑦ.

## Study Area

The survey area is predominantly polar desert and semi desert, with rolling topography, highest on the north of the island at 150 m, and a flat coastal plain in the south. Cushion forb barrens dominate the island, with some areas of graminoid-forb tundra, usually at <5% cover and <100 g/m$^2$ biomass, with isolated patches of 5-50% vegetation cover and biomass increases to 100-500 g/m$^2$ (Gould et al. 2003, Walker et al. 2005). Mean July temperatures are <3°C (Gould et al. 2003 and references therein).

## Methods

*Aerial Survey*

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. For this survey we only used one mark representing 500 m marked on the wing strut.

Four transects parallel to the long axis of the island were flown at 90 kts with a DeHavilland Twin Otter (Table 1). Weather was clear and sunny although fog banks were present offshore. Flight height was set at 152 m (500 ft) using a radar altimeter. We had one dedicated observer on each side, as well as a navigator/recorder. All observations were marked 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 straightforward for groups on transect. 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 (ESRI, Redlands, CA).

Table 1. Transects on Lougheed Island for a fixed-wing survey, July 28, 2016.

| Transect | Length (km) | Lon (North) | Lat (North) | Lon (South) | Lat (South) |
|---|---|---|---|---|---|
| 1 | 58.22 | -105.5344 | 77.7193 | -104.3511 | 77.1957 |
| 2 | 76.80 | -105.8722 | 77.7620 | -104.4662 | 77.1456 |
| 3 | 76.59 | -106.0556 | 77.7399 | -104.6470 | 77.1261 |
| 4 | 40.52 | -105.6982 | 77.4915 | -104.9597 | 77.1668 |

*Analysis*

Flights linking consecutive transects were removed for population analysis, although survey speed and height were maintained and all observations recorded as if on survey. Similarly, sections of transect crossing water were removed.

Although Jolly's (1969) Method II is widely used for population estimates from surveys, it is designed for a simple random design, rather than for a systematic survey of a patchy population. For comparison, population calculations following Jolly's Method II are provided in Appendix 4, along with calculations following a systematic stratified survey design (Cochran 1977). The muskoxen and caribou 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 $\varepsilon_i$ 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:

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

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

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

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 Devon Island 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. All distance measurements used North Pole Azimuthal Equidistant projection and area-dependent work used North Pole Lambert Azimuthal Equal Area, with central meridian at 88°W and latitude of origin at 76°N (centered over the study area for high precision).

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, $\lambda$. When $r$ >0 or $\lambda$ >1, the population is increasing; when $r$ <0 or $\lambda$ <1 the population is decreasing. Values of $r$ ~0 or $\lambda$ ~1 suggest a stable population.

## Results

We flew the survey on July 28, 2016 with 252 km on transect, equating to 18.5% coverage of Lougheed Island. The primary intent of the survey was to locate caribou groups for ground sampling efforts July 28-31, so Edmund Walker, Grosvenor, and Patterson islands were not covered. We saw 61 caribou (26 on transect) and no muskoxen. Although we saw no wolves during the survey, fresh tracks at the airstrip confirmed that they are still present on the island (2 wolves were seen on the south end of the island in July 2015). Spatial data presented in Figure 4 represents waypoints taken during the survey along transects and includes on- and off-transect sightings. Except for groups observed on the transect line, waypoints have error associated with the group's distance from the plane.

## ᖃᐅᔨᔭᐅᔪᑦ

ᖃᖓᓚᔪᔪᑦ ᖃᐅᔨᓴᕐᓂᖃᖅᓯᑕ ᔪᓚᐃ 28, 2016 252 km−ᓂᒃ ᑲᓯᕐᕕᖃᖅᓯᑎᒃ, ᐊᔾ ᔨᒋᓪᓗᓂᐅᒃ 18.5%−ᖓ ᐊᑕᖏᖅᓯᓂ Lougheed ᕿᑭᖅᑕᐅᑉ. ᑐᕌᒐᓪᓗᐊᑕᐅᓯᒪᔪᖅ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᓇᐃᐱᑦᓯᒍᒪᓪᓗᑎᒃ ᑐᒃ ᑐᓂᒃ ᑲᑎᒪᐅᖅᑐᓂᒃ ᓄᓇᒥ ᖃᐅᔨᓴᖅᑕᐅᓂᖃᕐᓯᐊᓚᖕᒋᓪ ᓗᒋᑦ ᑐᒃ ᑐᐃᑦ ᓄᓇᒥ ᖃᐅᔨᓴᖅᑕᐅᓂᖃᕐᓯᐊᕈᒪᑦᓯᑎᒃ ᔪᓚᐃ 28-31, ᑕᐃᒪ ᐃᒻᒪᑦ ᕿᑭᖅᑕᐃᑦ Edmund Walker, Grosvenor, ᐊᒻᒪᓗ Patterson ᓈᓴ ᐃᕙᐅᓯᒪᓐᖏᑐᑦ. ᑕᑯᔪᔪᑦ 61−ᓂᒃ ᑐᒃ ᑐᓂᒃ (26 ᑲᓯᖅᓯᒪᔪᓂ) ᐅᒥᒻᒪᑦ ᑕᖃᕋᓂᓗ. ᑕᑯᓚᐅᓐᖏᒃ ᑲᓗᐊᖅᑐᒧᑦ ᐊᒪᕈᕐᓂᒃ ᖃᐅᔨᓴᕐᓂᑎᓐᓂ, ᑐᒥᓂᒃ ᓄᑖᓂᒃ ᓇᓗᓇᐃᖅᑕᐅᔪ ᖃᔪᔪᖅᒥᕝᕕᒻᒥ ᓯᓕ ᐱᑕᖃᓄᐊᖏᓪ ᕿᑭᖅᑕᒥ (ᒪᕐᕉᒃ ᐊᒪᕉᒃ ᑕᑯᔭᐅᔫᒃ ᓂᒋᖅᐸᓯᓂᐊ ᕿᑭᖅᑕᐅᑉ ᔪᓚᐃ 2015−ᒥ). ᑲᑎᖅᓯᖅᑕᐅᓯᒪᔪᑦ ᑕᑯᑦᓴᐅᑎᑕᐅᔪᑦ ᑎᑎᖅᑑᔭᖅᓯᒪᔪᒥ 4−ᒥ ᑕᑯᑦᓴᐅᑎᑦᓯᔪᑦ ᑲᓯᕐᕕᐅᔪᓂᒃ ᖃᐅᔨᓴᕐᑕᕐᓂᐅᔪᓂ ᐱᖃᓯᐅᔾ ᔨᑦᓯᑎᒃ

ᑕᑯᓐᓴᓂᒃ ᑲᓯᖅᓯᒪᕖᓐᓂᓗ ᑕᑯᔭᐅᔪᓂᒃ. ᐋᒻ ᒐᐅᒐ ᓗᐊᖅ ᑐᒃ ᑐᐃᑦ ᑲᑎᒪᐅᖅᑐᑦ ᑲᓯᕐ ᓂᐅᓯᒪᔪᒥ, ᐊᖅᑯᑎᒦᑦᑐᑦ ᑖᒻ ᒪᖅᓯᒪᓂᖃᖅᑐᑦ ᐊᑦᑐᐊᔪᓄᑦ ᑲᑎᒪᐅᖅᑐᑦ ᐅᖕᒐᔾᓂᖕᖏᓄᑦ ᖃᖕᒐᑕᔫᕐᒥᒃ.

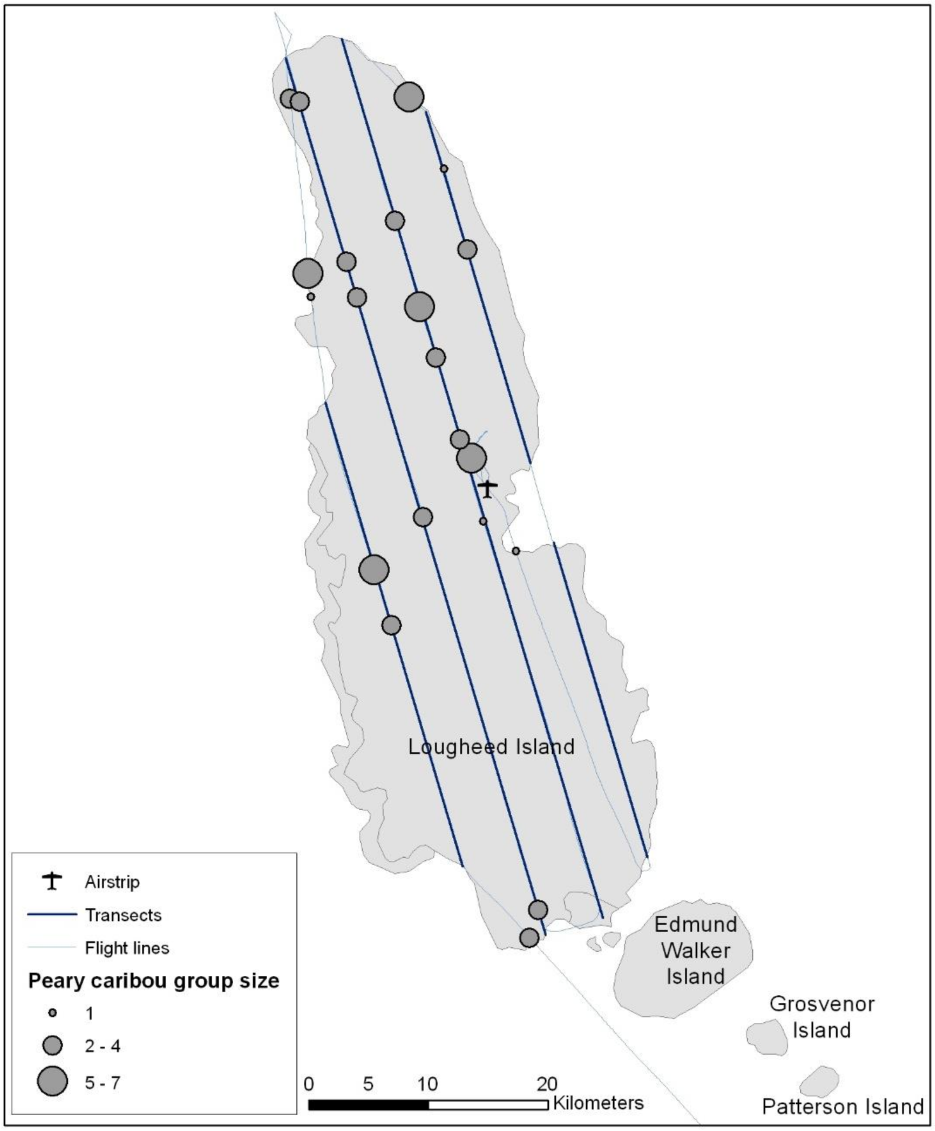


Figure 1. Observations of Peary caribou on Lougheed Island, July 2016, including observations on and off transect, and on ferry flights. ᑎᑎᖅᑑᔭᖅᓯᒪᔭᖅ 2. ᑕᑯᔭᐅᔪᑦ ᐱᐅᓚᑐᒃ ᑐᐃᑦ Lougheed ᕿᑭᖅᑕᖕᒐᓂ, ᔪᓚᐃ 2016-ᒥ, ᐱᖃᓯᐅᑎᑦ ᓯᑎᒃ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᑲᓯᕐ ᕖᒻ ᒥ ᓯᓚᑖᓂᓗ. ᐊᒻ ᒪᓗᐅᒥ ᐊᕐ ᔪᐊᒻ ᒪᓇᒃ ᑰᖅᑐᓂ.

A population estimate was calculated for Peary caribou, but the few observations limit the precision of the estimate. Population estimates and variances are presented in Table 2.

ᐊᒥᓲᓂᖕᖏᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐱᐅᓇ ᑐᒃ ᑐᓄᑦ, ᑭᓯᐊᓂ ᐊᒥᓲᓐᖏᑦ ᑐᓂᒃ ᑕᑯᑦᓯᑎᒃ, ᐊᐳᖅᓯᒪᒍᑕᐅᒻ ᒪᑦ ᓈᓴᐃᑦᓯᐊᕐ ᓂᐅᓯᒪᒐᕚᖅᑐᒥᒃ. ᐊᒥᓲᓂᖏᓂᒃ ᓇᓚᐅᑦᓵᖅᑐᑦ ᐊᔾ ᔨᖕᖏᖏᓂᐅᔪᓪᓗ ᐊᑐᐃᓐ ᓇᐅᑎᑕᐅᔪᑦ ᑎᑎᖅᑑᔭᖅᓯᒪᔭᖅ 2–ᒥ.



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Table 2. Peary caribou population calculations Lougheed Island with variance calculated by nearest neighbor methods and by deviations from the sample mean.

| | Stratum area Z (km²) | Surveyed area z (km²) | Count, y | Estimate, $\hat{Y}$ | Density, $\hat{R}$ (per km²) | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV |
|---|---|---|---|---|---|---|---|---|---|
| Nearest-Neighbor Difference | 1359.6 | 252.1 | 26 | **140** | 0.103 | 0.713 | 1064.78 | 32.63 | 0.232 |
| Sample Mean Difference | 1359.6 | 252.1 | 26 | **140** | 0.103 | 0.449 | 670.57 | 25.90 | 0.185 |

ᑎᑎᖅᑑᔭᖅᓯᒪᔪᖅ 2. ᐱᐅᖅ ᑐᒃ ᑐᐃᑦ ᐊᒥᓲᓂᖏᓂᒃ ᓈᓴ ᐃᓂᐅᓯᒪᔪᑦ Lougheed ᕿᑭᖅᑕᖓᓂ ᐊᑉ ᔨᒦᓐᖏᓂᐅᔪᑦ ᓈᓴᖅᑕᐅᓯᒪᑦᓯᑎᒃ ᓴᓐ ᓂᓚᕆᓂᖅᐹᖏᓂᒃ ᐊᑐᖅᓯᑎᒃ ᐊᑐᖅᑕᐅᓕᖅᓯᑎᒃ ᓈᓴ ᐅᑏᑦ ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᒦᓐᖏᖅᑐᑦ.

| | ᖁᓕᓃᓚᖅᓯᒪᔪᑦ ᐊᖏᓂᖏᑦ Z (km²) | ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᖅ z (km²) | ᓈᓴᖅᑕᐃᑦ, y | ᓇᓚᐅᑦᓵᖅᑕᐃᑦ, $\hat{Y}$ | ᐊᒥᓲᓂᖏᑦ, $\hat{R}$ (ᐊᑐᓂᑦ km²) | ᑕᒻᒪᖅᑕᐅᑐᐃᓐ ᓇᓄ ᐊᓖᑦ ᖃᑦᓯᐅᓂᖏᑦ ᑭᑉ ᐹᓄᑦ ᑐᓂ | ᐊᔾᔨᒌᓐᖏᓐᓂᖅ ($\hat{Y}$) | SE | CV |
|---|---|---|---|---|---|---|---|---|---|
| ᓴᓂᐊ ᓚᓄᔭ ᐅᓂᖅᐹᓃᖓ ᔪᑦ ᐊᔾᔨᒌᓐᖏᓃᑦ | 1359.6 | 252.1 | 26 | **140** | 0.103 | 0.713 | 1064.78 | 32.63 | 0.232 |
| ᖃᐅᔨᓴᖅᑕᐅᓂᖓᑕ ᐊᔾᔨᒌᓐᖏᓂᖓ | 1359.6 | 252.1 | 26 | **140** | 0.103 | 0.449 | 670.57 | 25.90 | 0.185 |

Caribou have declined since the last survey in 2007. Based on a population estimate of 140±SE33 in 2016 and 372 in 2007 (205-672, 95%CI; Jenkins et al. 2011), the instantaneous growth rate $r$ is -0.11, and lambda λ is 0.90. More sophisticated analyses incorporating uncertainty in the estimates have not been undertaken.

ᑐᒃᑐᐃᑦ ᐃᓄᐃᓴᓪᓚᕝᕕᓪᓚᖅᓯᒪᔪᑦ ᑭᖑᓪᓚᖅᐹᒥ ᖃᐅᔨᓴᖅᑕᐅᔪᒪᑕᓂᑦ 2007–ᒥ. ᑐᓐᖓᕕᐅᑦᓯᑎᒃ ᐊᒥᓲᓂᖏᑦᑕ ᖃᐅᔨᓴᖅᑕᐅᓂᕋᔭᖏᑦ 140±SE33 2016–ᒥ ᐊᒻᒪ 372 2007–ᒥ (205-672, 95%CI; Jenkins et al. 2011), ᑕᕝᕙᐃᓐᓇᖅ ᐱᕈᖅᐸᓪᓕᐊᓂᖏᑦ $r$ is -0.11, ᐊᒻᒪ lambda λ is 0.90. ᐃᓗᓕᖅᑐᓂᖅᓴᐃᑦ ᖃᐅᔨᓴᕐᓂᐅᔪᑦ ᐃᓚᒍᑦᓯᐅᑦᔨᔪᑦ ᓇᓗᓇᖅᑐᓂᒃ ᒥᑦᓴᐅᓯᔭᐅᔪᓂᒃ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᓐᖏᑦᑐᑦ.

## Discussion

Previous surveys of Lougheed Island have used different survey platforms (Piper Super Cub and deHavilland Beaver, Tener 1963; Helio-courier, Gunn and Dragon 2002; Bell 206 helicopter, Jenkins et al. 2011; Twin Otter, this survey) with different coverage and at different times of the year (spring, Miller et al. 1977, Jenkins et al. 2011; summer, Tener 1961, Miller et al. 1977, Miller 1987, Gunn and Dragon 2002, this survey). In 1974 and 1985, only a few caribou were seen on the island. In 1997, the presence of 28±29 caribou carcasses suggested that a die-off had occurred on the island – weather-related die-offs had occurred in 1997 and for 3 years prior on the Bathurst Island Complex as well (Gunn and Dragon 2002).

Widespread weather-related die-offs recorded elsewhere in the Arctic Archipelago in the 1970s may have been responsible for the lack of caribou observed on the island in 1973 and 1974, either due to die-offs or movement off the island. Population densities equivalent to the 1961 survey have not been observed on Lougheed Island in the last 50 years of sporadic survey work. Lougheed Island caribou were impacted by the mid-1990s die-offs related to severe winter weather at least in 1996-97, an estimated 28±SE19 caribou carcasses on the island (Gunn and Dragon 2002). The 2007 survey recorded an increase in caribou numbers on Lougheed Island following die-offs in the 1990s, but the population appears to be lower now than 9 years ago. Higher caribou populations on both Melville Island and Bathurst Island could account for some of the 'missing' caribou. In October 1995, one satellite-collared female caribou crossed to Lougheed

Island, at least 110 km across the sea ice from Bathurst Island (Poole et al. 2015). She then continued 110 km across the ice to Borden Island, where she died in December 1995 (Poole et al. 2015).

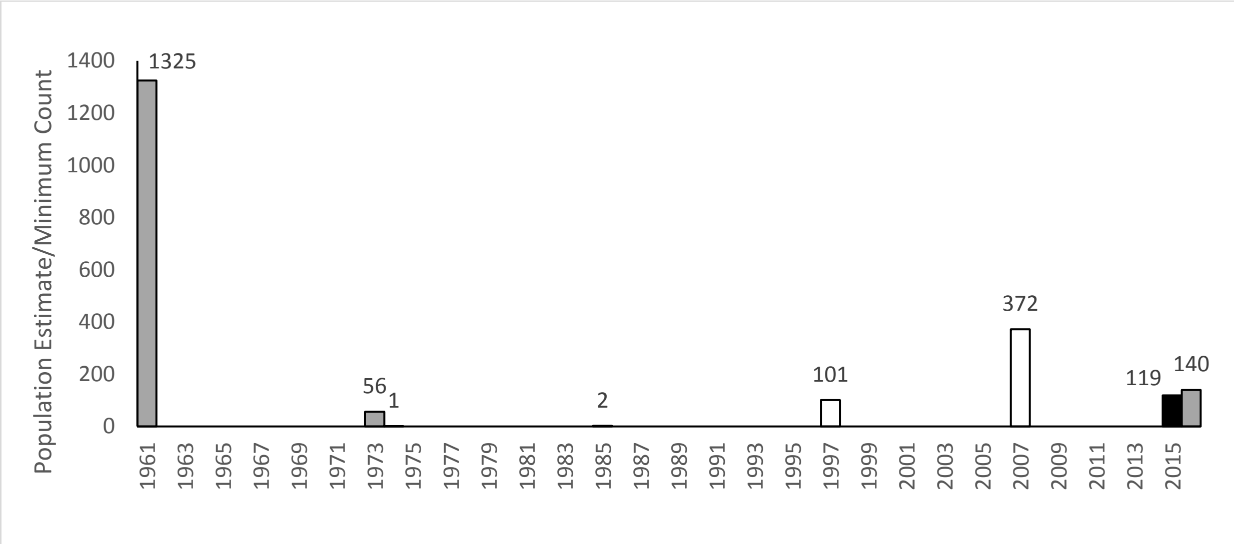



Figure 3. Population estimates for Peary caribou on Lougheed Island. Grey bars indicate estimates including calves (Tener 1963, Miller et al. 1977, this report), black bars are minimum counts (Miller et al. 1977, Miller 1987, this report for 2015), and white bars are population estimates of 1+-year-old caribou (Gunn and Dragon 2002, Jenkins et al. 2011).

Although not conducted as a survey, we did fly over Lougheed Island in 2015 to determine whether we could collect pellet samples using a Twin Otter drop-off and pick-up, or whether a helicopter would be required. We counted at least 119 Peary caribou during the flight, including some groups of 15-20 individuals (in which case the lower value was added for the minimum count of 119; Figure 4). Flight height was 90-150 m above ground and conditions were clear and sunny, with one observer each side of the plane and a navigator/recorder. No marks were made on the wing struts to define a survey strip.

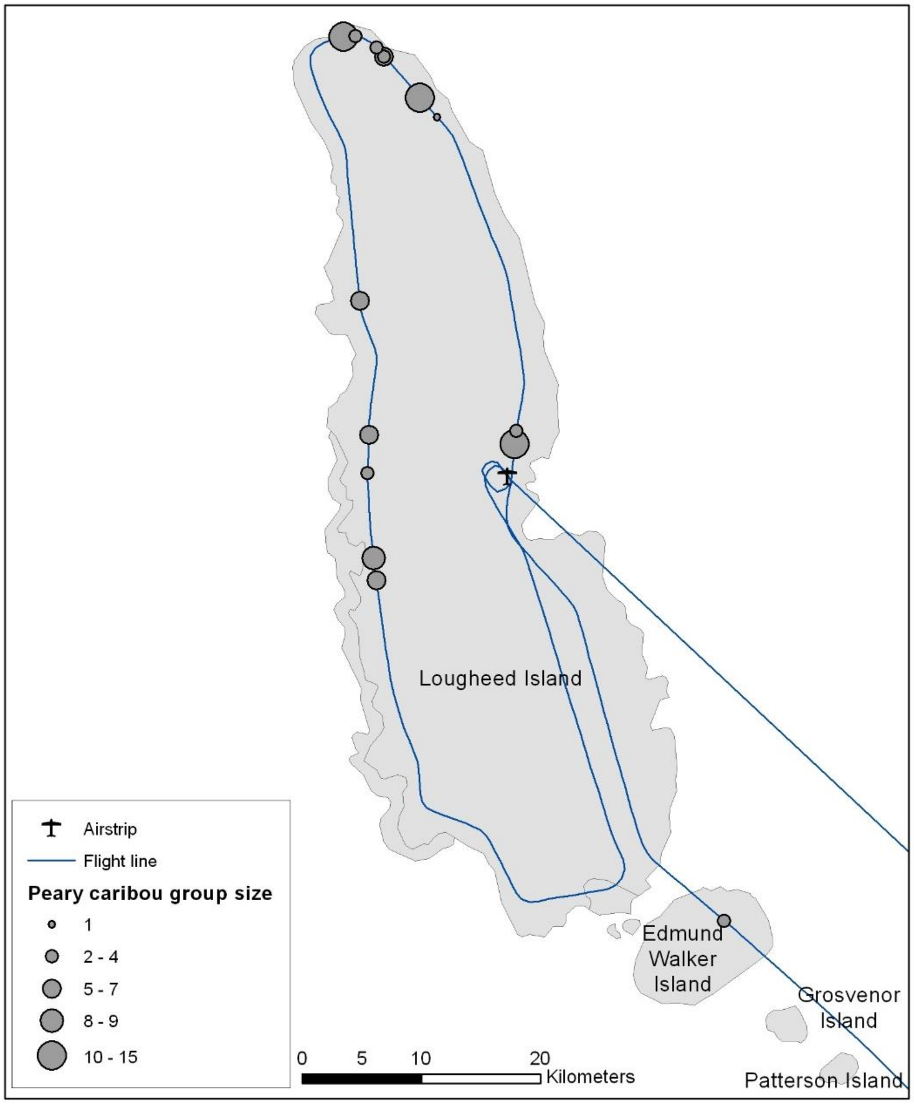


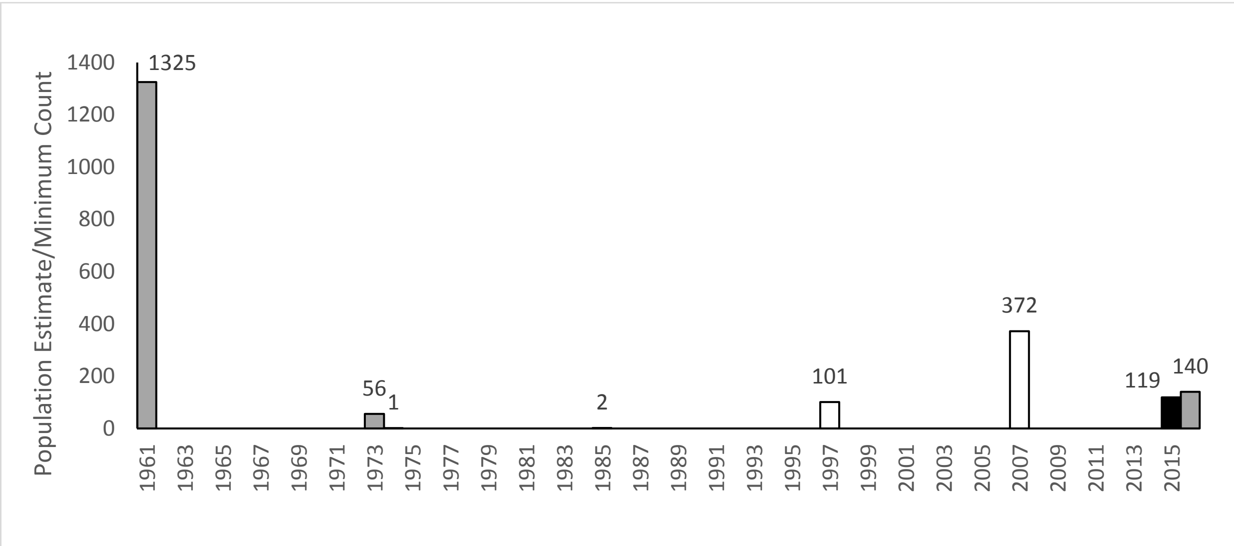

Figure 4. Locations of Peary caribou groups seen on a July 23, 2015 Twin Otter flight over Lougheed Island.

**ᐅᖃᖅᑎᒌᓐᓂᖅ**

ᓯᕗᕐ ᖑᓂ ᖃᐅᔨᓴᕐ ᓂᐅᓯᒪᔪᑦ Lougheed ᕿᑭᖅᑕᖑᓂ ᐊᑐᖅᓯᒪᔪᑦ ᐊᔾ ᔨᒌᓐᖏᓐ ᑐᓂᒃ ᖃᐅᔨᓴᕐ ᓂᕐ ᒧᑦ ᑐᓐ ᖕᕕᐅᔪᓂᒃ (Piper Super Cub ᐊᒻ ᒪᓗ deHavilland Beaver, Tener 1963; Helio-courier, Gunn ᐊᒻ ᒪᓗ Dragon 2002; Bell 206 ᖁᓛᒨᓕᒃ, Jenkins et al. 2011; ᒪᕐ ᕈᓕᒃ ᑕᕝ ᕙᓂ ᖃᐅᔨᓴᕐ ᓂᕐ ᒥ) ᐊᔾ ᔨᒌᓐᖏᑐᓂᒃ ᖃᐅᔨᓴᖅᓯᑎᒃ ᑕᕝ ᕙᓂᑦ ᓴᐃᓐ ᓇᐅᓐᖏᓐ ᑐᖅ ᐊᕐ ᕿᒨ< ᐃᓗᐊᓂ (ᐅᐱᕐ ᖔᒡ ᑯᑦ, Miller et al. 1977, Jenkins et al. 2011; ᐊᐅᔭᒃ ᑯᑦ, Tener 1961, Miller et al. 1977, Miller 1987, Gunn ᐊᒻ ᒪᓗ Dragon 2002, ᐅᕙᓂ ᖃᐅᔨᓴᕐ ᓂᕐ ᒥ). 1974 ᐊᒻ ᒪᓗ 1985, ᐃᓄᐃᓵᑦ ᑐᐹᓗᐃᑦ ᑐᒃ ᑐᐃᑦ ᑕᑯᔭ ᐅᓯᒪᔪᑦ. 1997−ᖑᑎᓪ ᓗᒍ, ᑕᕝ ᕙᐅᔪᑦ 28±29 ᑐᒃ ᑐᒥ ᓅᑦ ᓇᓗᓇᐃᖅᓯᒍᑕᐅᓯᒪᔪᑦ ᑐᖁᕋᖅᓯᒪᔪᖃᕆᐊᖓ ᕿᑭᖅᑕᒥ − ᓯᓚᒥᒃ ᐱᔾ ᔪᑎᖃᖅᓯᑎᒃ ᑐᖁᕋᖅᓯᒪᔪᑦ 1997−ᒥ ᐊᒻ ᒪᓗ ᐊᕐ ᕿᒍᐃᑦ ᐱᖓᔪᑦ ᓯᕗᕐ ᖑᓂ ᕿᖓᐅᑦ ᕿᑭᖅᑕᖑᓂ ᐊᒻ ᒪᓗ gunn ᐊᒻ ᒪᓗ Dragon 2002).

ᓯᐊᒻ ᒪᑦᓯᒪᔪᑦ ᓯᓚᒥᒃ ᐱᔾ ᔪᑎᖃᖅᓯᑎᒃ ᑐᖁᕋᖅᓯᒪᔪᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑦ ᐊᓯᖕᖏ ᓂ ᐅᑭ ᐅᖅᑕᑐᒥ ᕿᑭᖅᑕᓂ 1970−ᖕᖏ ᓂ ᐱᔾ ᒨᑕᐅᓯᒪᑐᐃᓐ ᓇᑎᐊᓕᒃ ᑐᒃ ᑐᖃᑦᓯ ᐊᖕᖏ ᓂᖕᖓᓄᑦ ᕿᑭᖅᑕᒥ 1973 ᐊᒻ ᒪᓗ 1974, ᑐᖁᕋᕐ ᓂᖅ ᐱᔾ ᔪᑕᐅᓪ ᓗᓂ ᐅᕝ ᕙᓘᓐ ᓅᑦ ᓅᓯᒪᓕᑐᐃᓐ ᓇᑎᐊᓖᑦ ᕿᑭᖅᑕᒥ. ᐊᒥᔫᓂᖕᖏ ᐊᔾ ᔨᐸᓗᖕᖏ 1961−ᒥ ᖃᐅᔨᓴᖅᑕᐅᓯᒪᔪᑦ ᑕᑯᔭ ᐅᓯᒪᓐᖏᓐ ᑐᑦ Lougheed ᕿᑭᖅᑕᖑᓂ ᐊᕐ ᕿᒍᓂ 50−ᓂ ᐊᓂᒍᖅᑐᓂ ᖃᐅᔨᓴᕐ ᓂᐅᓕᐅᒥᔮᖅᓯᒪᔪᓂ. Lougheed ᕿᑭᖅᑕᒥ ᑐᒃ ᑐᐃᑦ ᐊᑦ ᑐᖅᑕᐅᓯᒪᔪᑦ ᕿᑎᖕᖓᓂ 1990 ᐊᕐ ᕿᒍᖕᖏ ᑕ ᑐᖁᕋᖅᓯᒪᔪᑦ ᐊᑦ ᑐᐊᔪᑦ ᐅᑭ ᐅᒃ ᑯᑦ ᓯᓚᕐ ᓂᓗᕐ ᓂᕐ ᔪᐊᕐ ᓄᑦ ᑕᐃᑲᓂ 1996-97, ᓇᓚᐅᑦ ᔮᖅᑕᐅᓯᒪᔪᑦ 28±SE19 ᑐᒃ ᑐᒥ ᓅᑦ ᕿᑭᖅᑕᒥ (Gunn and Dragon 2002). 2007−ᒥ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᑦ ᐊᒥᓲᓐ ᖑᐹᓪ ᓕᕈᑕᐅᔪᔪ 13 ᑐᒃ ᑐᓄᑦ Lougheed ᕿᑭᖅᑕᖑᓂ ᑭᖑᕐ ᖓᑦ ᑐᖁᓚᐅᖅᑎᓪ ᓗᒋᑦ 1990−ᖕᖏ ᓂ, ᑭᓯᐊᓂ ᐊᒥᔫᓂᖕᖏ

ᐃᓄᐃᓴᓐᓂᖅᓴᕐ ᔩᔮᓕᖅᑐᖅ ᐊᕐᕌᒍᐃᑦ 9 ᐊᓂᒍᖅᓯᒪᓕᖅᑎᓪᓗᒋᑦ. ᐊᒥᓲᓂᖅᓴᕈᖅᓯᒪᔪᑦ ᑐᒃᑐᐃᑦ Melville ᕿᑭᖅᑕᖕᓂ ᐊᒻᒪᓗ ᕿᖕᖓᒻᒥ ᑭᐅᔾ ᔪᑕᐅᒍᓐᓇᑐᐃᓐ ᓇᕆᐊᓖᑦ 'ᑭᓐᖑᖅᑕᐅᓯᒪᔪᓄᑦ" ᑐᒃᑐᓄᑦ. ᐅᑦᑑᕝᕙ 1995-ᖑᑎᓪᓗᒍ, ᖃᖕᒋᑕᖅᑎᑕᐅᓯᒪᔪ ᒨᖕᖓᓂᒃ ᖁᖕᖓᕈᑎᓛᑦ ᐊᕐᓇᖅ ᑐᒃᑐᐃᑦ ᐃᑳᖅᓯᒪᔪᑦ Lougheed ᕿᑭᖅᑕᖕᒪᓄᑦ, 110 ᑭᓗᒦᑕᓂᒃ ᐃᑳᖅᓱᓂ ᑕᕆᐅᒃ ᑯᑦ ᓯᑯᒃ ᑯᑦ ᐊᑯᕐ ᖕᒋᓂ ᕿᖕᖓᐅᑦ ᕿᑭᖅᑕᖕᑕ (Poole et al. 2015). ᑲᔪᓯᒋᐊᒃ ᑲᓐᓂᖅᓱᓂ 110 ᑭᓗᒦᑕᓂᒃ ᐃᑳᖅᓱᓂ Borden ᕿᑭᖅᑕᖕᒪᓄᑦ, ᐃᓅᒍᓐ ᓃᖅᓱᓂ ᑕᐃᑲᓂ ᑏᓴᕝᕙ 1995 (Poole et al. 2015).




ᑎᑎᖅᑑᔭᖅᓯᒪᔪᖅ 5. ᐊᒥᓲᓂᖕᖏᓂᒃ ᓇᓚᐅᑦᓵᕐᓂᖅ ᐱᐅᓇ ᑐᒃᑐᓂᒃ Lougheed ᕿᑭᖅᑕᖕᓂ. ᐃᓱᖅᑐᑦ ᐃᑳᖕᖔᑦ ᓇᓗᓇᐃᖅᓯᔪᖅ ᓇᓚᐅᑦᓵᖅᑕᐅᔪᑦ ᐱᖃᓯ ᐅᑎᑦᓱᑎᒃ ᓄᕐ ᕋᐃᑦ (Tener 1963, Miller et al. 1977, ᐅᑯᐊ ᐅᓂᒃ ᑳᑦ), ᕿᕐ ᓂᖅᑐᑦ ᐃᑳᖕᖔᑦ ᐊᑦᓯᓂᖅᐸᑦ ᓈᓴᐃᓂᐅᔪᑦ (Miller et al. 1977, Miller 1987, ᐅᑯᐊ ᐅᓂᒃ ᑳᑦ 2015−ᒧᑦ), ᖃᑯᖅᑕᐃᓪᓗ ᐃᑳᖕᖔᑦ ᐊᒥᓲᓂᖕᖏᓂᒃ ᓇᓚᐅᑦᓵᖅᑐᑦ 1+-ᐊᕐᕌᒍᓕᓐᓂᒃ ᑐᒃᑐᓂᒃ. (Gunn and Dragon 2002, Jenkins et al. 2011).

## Management Recommendations

Harvest is low and accessibility of Lougheed Island is difficult. There is currently no TAH on Peary caribou, and no changes to harvest management are recommended based on this survey. Monitoring changes in both the Bathurst Island Group and Lougheed Island caribou populations as if they are one population unit may provide better information in future to determine whether caribou are moving among the islands or primarily increasing and decreasing based on survival and recruitment on the Bathurst Island group and Findlay Group separately. The continued lack of muskoxen on the island also makes Lougheed an ideal area to examine caribou behavior and population dynamics independent of the influence of muskoxen.

## ᐊᐅᓚᑦᓯᓂᕐ ᒧᑦ ᐃᓱᒪᓕᐅᕈᑕᐅᔪᑦ

ᐊᖑᓇᓱᓐᓂᖅ ᐊᑦᓯᑦᑐᕚᓗᒃ Lougheed ᕿᑭᖅᑕᓕᐊᕐᓂᖅ ᐱᔭᕆᐊᑭᓐᖏᒪᑦ. ᒫᓐᓇ ᑲᑎᑦᓱᑎᒃ ᐊᖑᓇᓱᑦᑕᐅᔪᑦᓴᓂᒃ ᐱᑕᖃᖕᖏᑐᖅ ᐱᐅᓇ ᑐᒃᑐᓄᑦ, ᐊᓯᔾᔨᖅᑕᐅᓯᒪᒐᑎᓪᓗ ᐊᖑᓇᓱᓐᓂᕐ ᒧᑦ ᐊᐅᓚᑦᓯᓂᖅ ᐃᓱᒪᓕᐅᕈᑕᐅᓯᒪᔪᖅ ᑐᓐᖓᕕᐅᑦᓱᓂ ᐅᓇ ᖃᐅᔨᓴᕐᓂᐅᔪᖅ. ᖃᐅᔨᓴᕐᓂᖅ ᑕᒪᒃ ᐱᓐᓂ ᕿᖕᖓᒻᒥ ᑲᑎᒪᐅᖅᑐᓂᒃ ᐊᒻᒪᓗ Lougheed ᕿᑭᖅᑕᒥ ᑲᑎᒪᐅᖅᑐᓂᒃ ᓲᕐᓗ ᐊᑕᐅᓯᕐ ᑎᑐᑦ ᑐᓴᐅᒪᑦᓯᐊᑲᓐᓂᕈᑕᐅᓂᖅᓴᐅᕙᓪᓚᐃᔪᖅ ᓯᕗᓂᖅᑎᓐᓂ ᓇᓗᓇᐃᖅᓯᒍᑕᐅᓗᑎᒃ ᑐᒃᑐᐃᑦ ᓄᑦᑕᕐᒪᖔᑦ ᐊᑯᕐ ᖕᒋᓂ ᕿᑭᖅᑕᐃᑦ ᐅᕝᕙᓗ ᐊᒥᓱᓐᖑᖕᓕᕙᓪᓕᐊᒻᒪᖔᑦ ᐃᓄᐃᓴᓪᓕᕙᓪᓕᐊᒻᒪᖔᑦᓗᓐ ᓃᑦ ᑐᓐᖓᕕᐅᑦᓱᓂ ᐊᓐ ᓇᒍᓐ ᓇ14ᓂᖕᒋ ᓄᑦᑕᕐ ᓂᖕᖏᓗ ᕿᖕᖓᐅᑦ ᕿᑭᖅᑕᖕᓂ ᑲᑎᒪᐅᖅᑐᓂ ᐊᒻᒪᓗ Findlay Group ᐃᒻᒥᒃ ᑯᑦ. ᐅᒥᒻᒪᖃᑦᓯᐊᖕᖏᓂᖅᑕᐅᖅ Lougheed ᕿᑭᖅᑕᖕᓂ ᖃᐅᔨᓴᕐ ᕷᓴᑦᓯᐊᖑᔪᑦ ᑐᒃᑐᐃᑦ ᐱᐅᓯᖕᖏᓂᒃ ᐊᒥᓲᓂᖕᖏᓂᓪᓗ ᐃᒻᒥᒃ ᑰᖕᖔᓂᒃ ᐅᒥᒻᒪᐃᑦ.

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**Appendix 1. 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 patchy 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 caribou on Lougheed Island, July 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.

| **Y** | **Var(Y)** | **n** | **Z ($km^2$)** | **z ($km^2$)** | **N** | **y** | **Density (per $km^2$)** | **CV** |
|---|---|---|---|---|---|---|---|---|
| 140 | 1511.91 | 4 | 1359.58 | 252.13 | 24 | 26 | 0.1031 | 0.28 |

**DISTRIBUTION AND ABUNDANCE OF PEARY CARIBOU (*Rangifer tarandus pearyii*) AND MUSKOXEN (*Ovibos moschatus*) ON SOUTHERN ELLESMERE ISLAND, MARCH 2015**

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And

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7 August 2015

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**ᐊᕕᒃ ᑐᖅᓯᒪᓂᖏᓐ ᖃᓄᕐ ᓗ ᐅᓄᖅᑎᒋᓂᖏᓐ ᑐᒃ ᑐᐃᑦ**
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**Summary**

We flew a survey of southern Ellesmere, Graham, and Buckingham islands by Twin Otter in 50 hours between March 19 and 26, 2015, to update the population estimate for caribou and muskoxen in the study area. Previous survey attempts in April and August 2014 were cancelled due to weather. Severe winter weather in the early 2000s, resulted in poor condition and low muskox numbers during the previous survey in 2005, although the area supported relatively high densities of muskoxen in the past. This survey found that muskoxen had recovered from the previous population crash and caribou continued to persist at low densities, as seen in previous surveys.

Muskoxen were abundant north of the Sydkap Ice Cap along Baumann Fiord, north of Goose Fiord, west and north of Muskox Fiord, and on the coastal plains and river valleys east of Vendom Fiord, although they were also seen on Bjorne Peninsula and the south coast from Harbor Fiord to Jakeman Glacier. Short yearlings (10-month old) made up 22% of the population in March 2015. We observed 1146 muskoxen, and calculated a population estimate of 3200 ± SE 602. Although this is the highest estimate recorded for surveys of the area, most previous surveys covered only part of the area, included other areas, or provided only minimum counts. However, the muskox population does appear to have recovered from the low of 312-670 (95% CI) recorded in 2005.

We only saw 38 Peary caribou during the March survey. They were concentrated on the north tip of Bjorne Peninsula and Graham Island, although not as many as had been seen there in 2005. We saw another group east of Vendom Fiord and a group between Bird Fiord and Sor Fiord. That area is also where we saw 2 groups totaling 8 caribou in the August 2014 survey attempt (neither of the 2014 survey attempts covered most of the areas where caribou were expected to be, and none were seen in April 2014). The low number of observations and large variance, making it difficult to tell whether the population has declined from 2005, when 109-442 caribou (95% CI) were estimated to inhabit the same study area. We estimated 183 ± SE 128 caribou, so the population is likely stable at low density on southern Ellesmere Island.

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**ᓇᐃᓈᖅᓯᒪᓂᖓ**

ᖃᖓᑕᓪ ᓗᑕ ᖃᐅᔨᓴᓚᐅᖅᑐᒍᑦ ᐅᒥᖕᒪᑦ ᓄᓈᓐ ᓂ, ᒍᓅᕼᐊᒻ, ᐸᑭᖕ ᕼᐋᒻ ᓗ ᕿᑭᖅᑕᖕᖏᓂᒃ ᒪᕐ ᕈᓕᒃ ᑯᑦ 50 ᐃᑲᕐ ᕋᓄᑦ ᒫᔅ 19-ᒥᑦ 26-ᒧᑦ, 2015, ᓄᑖᙳᐊᕈᒪᓪ ᓗᒍᑦ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓂᖏᓂᒃ ᓇᓚᐅᑦ ᑖᕐ ᓂᖅ ᑐᒃ ᑐᒧᑦ ᐅᒥᖕᒪᖕ ᓄᓪ ᓗ ᖃᐅᔨᓴᕐ ᕕᐅᔪᒧᑦ. ᖃᐅᔨᓴᕋᓱᐊᓚᐅᖅᑑᓪ ᓗᐊᑦ ᐊᐃᕐ ᓇᓕᐊᒻ ᒪᓗ ᐋᒎᓯ 2014-ᒥᑦ ᑭᓯᐊᓂ ᓄᖅᑲᖅᑎᑕᐅᓚᐅᖅᑐᑦ ᓯᓚ ᐱᔾ ᔪᑎᒋᓪ ᓗᒍᑦ. ᐅᑭᐅᖅ ᓯᓚᕈᔫᑲᑦᑎᓪ ᓗᒍᑦ 2000-ᖑᓕᕙᖅ ᓘᓂ, ᖃᐅᔨᓴᕈᑕᐅᑦ ᑎᐊᓚᐅᙱᖅ ᐅᒥᖕᒪᐃᓪ ᓗ ᐅᓄᙲ ᓗᑎᒃ ᖃᐅᔨᓴᕐ ᓂᐅᓚᐅᖅᑐᒥᑦ 2005-ᖑᑎᓪ ᓗᒍᑦ, ᐊᒥᓲ ᕙᓚᐅᕋᓗᐊᖅ ᓗᑎᒃ ᐅᒥᖕᒪᐃᑦ ᑕᐃᑲ ᓂ. ᖃᐅᔨᓴᖅ ᑎᓪ ᓗᒋᑦ ᖃᐅᔨᓚᐅᖅᑐᑦ ᐅᒥᖕᒪᐃᑦ ᐅᓄᖅᓯᒃ ᑲᓐ ᓂᕐ ᓂᖏᓂᒃ ᐅᓄᕈᓐ ᓅᕐ ᓂᐅᓚᐅᖅᑐᒥᑦ ᑐᒃ ᑐᐃᓪ ᓗ ᐅᓄᖅᓯ ᓗᐊᙶᓇᖅ ᓗᑎᒃ, ᑕᐃᒫᒃ ᖃᐅᔨᔭᐅᓯᒪᔪᖅ ᖃᐅᔨᓴᖅᑕᐅᖃᑦ ᑕᕐ ᓂᑯᓂ.

ᐅᒥᖕᒪᑦ ᐊᒥᓱᓚᐅᖅᑐᑦ ᓯᕐ ᒥᕈᓗᒃ ᓱᕋᒃ ᑎᕐ ᓂᐅᑉ ᐅᐊᖕ ᓇᖕᓂ ᐸᐅᒥᓐ ᑲᖏᖅ ᓗᐊᓂ, ᑲᖑᔾ ᐅᐊᖕ ᓇᖕᓂ, ᐅᒥᖕᒪᐅᑉ ᑲᖏᖅ ᓗᐊᑕ ᐱᖑᖕ ᓇᖕᓂ ᐅᐊᖕ ᓇᖕᓂᓗ, ᖃᖏᖅ ᓗᐊᔫᓪ ᓗ ᐱᖕᖁᑦᑕ ᓯᒃ ᔭᖕᓂ ᖁᖕᓂᓗ, ᑕᑯᔭ ᐅᓚᐅᖃᓪ ᓗᑎᒡ ᓗ ᑰᓚᓇᔫᑉ ᐃᓚᖕᓂ Hᐅᐳ ᑲᖏᖅ ᔫᓪ ᓗ ᓂᒋᐊᑕ ᓯᒃ ᔭᖅ ᐸᓯᐊᓂᑦ ᓯᕐ ᒥᐊᓗᖕ ᒧᑦ. ᓄᕐ ᕋᐃᑦ (ᖁᓕᓂᒃ ᑕᖅᑭᓖᑦ) 22%-ᖑᓚᐅᖅᐳᑦ ᐅᓄᖅᑎᒋᓂᖏᓐ ᒫᔅ 2015-ᒥᑦ. ᑕᑯᓚᐅᖅᑐᑦ 1146 ᐅᒥᖕᒪᖕᓂᑦ, ᐅᓄᖅᑎᒋᓂᖏᓐ ᓂᓪ ᓗ ᓇᓚᐅᑦ ᑖᖅᓱᑕ 3200 ± SE 602. ᑖᓐ ᓇ ᐅᓄᕐ ᓂᖅᐹᖑᓪ ᓗᐊᖅᑎᓪ ᓗᓂ ᓇᓚᐅᑦ ᑖᖅᑕᐅᓯᒪᔪᒥᑦ ᖃᐅᔨᓴᕐ ᕕᐅᖃᑦ ᑕᖅᓯᒪᔪᒥᑦ, ᖃᐅᔨᓴᖅ ᑕᐅᓯᒪᔪᓕᒫᑲᓴᑦ ᑕᒪᑐᒪ ᓄᓇᐅᑉ ᐃᓚᐃᓐ ᓇᖕᓂᐅᕗᖅ, ᐱᖃᓯᐅᑎᓪ ᓗᓂ ᐊᓯᖏᑦ ᓄᓇᐃᑦ, ᐅᓄᙳᕐ ᓂᓪ ᓘᓐ ᓅᑦ ᓈᓴ ᐃᓯᒪᑐᐃᓐ ᓇᖅ ᓱᑎᒃ. ᑭᓯᐊᓂᓕ, ᐅᒥᖕᒪᑦ ᐅᓄᖅᑎᒋᓂᖏᑦ ᐅᓄᖅᓯᒋᐊᖅᐹᓪ ᓕᖅᓯᒪᔪᑦ ᐊᒥᓲᖏᑎᔪᒥᑦ 312-670 (95% CI) ᓇᐃᓴᖅ ᑕᐅᓂᑯᑦ 2005-ᒥᑦ.

38-ᖑᓇᕐ ᓂᒃ ᑐᒃ ᑐᓯ ᓚᐅᖅᑐᑦ ᒫᔾ ᔭᒥ ᖃᐅᔨᓴᖅᑎᓪ ᓗᑕ. ᑰᓚᓇᔫᑉ ᐃᒪᖓᑕ ᐅᐊᖕ ᓇᖕᓂ ᐊᒻ ᒪ ᒍᓅᕼᐊᒻ ᕿᑭᖅᑕᖕᓂ, ᑕᐃᒫᒃ ᓯᓕ ᐅᓄᖅᑎᒋᓚᐅᙲᑲ ᓗᐊᖅ ᓱᑎᒃ 2005-ᒥᑦ. ᑐᒃ ᑐᓂᑦ ᑕᑯᓚᐅᕐ ᒥᔪᑦ ᑲᖏᖅ ᓱᐊᓗᖕᒥ ᑕᑯᒃ ᑲᓐ ᓂᓚᓪ ᓗᑕ ᑎᖕᒥᐊᑦ ᑲᖏᖅ ᓱᐊᓂ ᐊᒻ ᒪ ᓯᐊ ᑲᖏᖅ ᓱᐊᓂ. ᑕᐃᑲ ᓂᑦ ᓴᐃᓐ ᓇᖅ ᑕᑯᓚᐅᕐ ᒥᔪᑦ ᒪᕐ ᕆᓪᓚᖕᓂᑦ ᑲᑎᖕ ᓱᒋᑦ 8 ᑐᒃ ᑐᐃᑦ ᐋᒎᓯ 2014-ᒥᑦ ᖃᐅᔨᓴᕕᐅᓇᓱᐊᓚᐅᖅᑐᒥᑦ (2014-ᒥᑦ ᖃᐅᔨᓴᕈᑕᐅᓇᓱᐊᓚᐅᖅᑐᑦ ᑕᒪ ᐅᓈᓗᐊᓚᐅᙱᑦ ᓄᓇᒃ ᑯᑦ ᑐᒃ ᑐᓄᑦ ᐃᓂᒋᓪ ᓗᐊᕋᓱᒋᔭᐅᔪ ᓄᑦ, ᑕᑯᓚᐅᕋᑎᒡ ᓗ ᐊᐃᕐ ᓇᓕ 2014-ᒥᑦ). ᐊᒥᓲᙱᓂᖏᓐ ᑕᑯᔭᐅᔪᑦ ᖃᓄᐃᑦ ᑐᑯ ᓘᔭ ᐅᓂᖏᓐ ᓂᓪ ᓗ, ᓇᓗᓇᕈᑕᐅᓚᐅᖅᐳᖅ ᐅᓄᕈᓐ ᓅᓇᐊᕐ ᒪᖔᖅ 2005-ᒥᑦ, 109-442 ᑐᒃ ᑐᐃᑦ (95% CI) ᓇᓚᐅᑦ ᑖᖅ ᑕᐅᓚᐅᖅᑎᓪ ᓗᒋᑦ ᑕᐃᑲ ᓂᑦ ᓴᐃᓐ ᓇᖅ ᖃᐅᔨᓴᕐ ᕕᐅᔪᒥᑦ. ᓇᓚᐅᑦ ᑖᓚᐅᖅᑐᑦ 183 ± SE 128 ᑐᒃ ᑐᖃᕋᓱᖕᓈᓪ ᓗᑕ, ᐅᓄᕈᓐ ᓅᖅᐸᓪ ᓕᐊᓗᐊᕌᓗᙱ ᑐᒃ ᓴᐅᔭᑦ ᐅᒥᖕᒪᑦ ᓄᓈᑦ ᑕᓂᒋᐊᓂ.

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## Introduction

Peary caribou (*Rangifer tarandus pearyi*) are a small, light-coloured subspecies of caribou/reindeer inhabiting the Canadian Arctic Archipelago in the Northwest Territories and Nunavut from the Boothia Peninsula in the south to Ellesmere Island in the north. They are sympatric with muskoxen (*Ovibos moschatus*) over much of their range although diet, habitat preferences, and potentially interspecific interactions separate the two species at a finer scale (Resolute Bay Hunters and Trappers Association [HTA] and Iviq HTA, pers. comm.). Arctic wolves (*Canis lupus*) occur at low densities throughout Peary caribou range, but the most significant cause of population-wide mortality appears to be irregular die-offs precipitated by severe winter weather and ground-fast ice that restricts access to forage (Miller et al 1975, Miller and Gunn 2003, Miller and Barry 2009).

Peary caribou have been surveyed infrequently and irregularly on Ellesmere Island since Tener's 1961 survey extrapolated 200 animals for the island (Tener 1963). Weather issues prevented a full systematic survey of the island however, and the reliability of this estimate is questionable. Riewe (1976) flew unsystematic surveys primarily north of the Sydkap Ice Cap, along Baumann and Vendom Fiords and on the Svendsen, Raanes, and Bjorne peninsulas in 1973, with minimum counts of 150 caribou. In 1989, surveys on southern Ellesmere estimated 89 ± SE 31 caribou, including the Svendsen Peninsula (Case and Ellsworth 1991). In 2005, the GN systematically surveyed southern Ellesmere and Graham islands, with an estimate of 219 caribou (95% CI=109-244). Central and northern Ellesmere Island were surveyed in 2006, with an estimate of 802 caribou (95%CI=531-1207). Residents of Grise Fiord have not noticed a marked increase or decline in caribou where they hunt, primarily on Graham Island, the Bjorne Peninsula, the head of Muskox Fiord, and Baumann Fiord from Okse Bay to Stenkul Fiord. They have noticed some changing distribution patterns, with caribou caught in 2014 and 2015 on northeast Devon Island (Iviq HTA and Wildlife Officer J. Neely, pers. comm.).

Muskoxen are generally surveyed at the same time as caribou. Ellesmere Island was estimated by Tener (1963) to have more muskoxen, about 4000, than the rest of the Queen Elizabeth Islands combined. Southern Ellesmere Island, being largely comprised of ice fields, mountains and fiords, has historically had a much smaller muskox population than the Fosheim Peninsula and Lake Hazen areas further north (Tener 1963, Jenkins et al. 2011). The coastal lowlands along Baumann Fiord support some of the highest densities of muskoxen south of the Svendsen Peninsula (Iviq HTA pers. comm., Case and Ellsworth 1991, Inuit Qaujimajatuqangit [IQ] in Taylor 2005). In ground surveys of the Jones Sound region in 1966-67, Freeman (1971) counted 470 muskoxen on southern Ellesmere Island. In July 1973, Riewe (1973) estimated 1060 muskoxen north of the Sydkap Ice Cap, and on the Bjorne Peninsula, Raanes Peninsula, Svendsen Peninsula, Graham Island, and Buckingham Island. Of these, 260 muskoxen were estimated on Bjorne Peninsula alone (Riewe 1973). Case and Ellsworth (1991) estimated 2020 ± SE 285 muskoxen (including calves) on southern Ellesmere Island, including the Svendsen Peninsula, in July 1989. In May 2005, the population was estimated at only 456 (95%CI 312-670) 1+ year-old muskoxen south of Baumann and Vendom Fiords, including Graham and Buckingham islands, and many muskoxen seen on the survey were in poor condition (Campbell and Hope 2006, Jenkins et al. 2011). Residents of Grise Fiord recall freezing rain and ground-fast ice in fall/winter 2005, causing many muskox to starve (Iviq HTA, pers. comm.).

The Peary caribou and muskoxen of northern Devon Island, southern Ellesmere Island, and Graham Island are vitally important to the community of Grise Fiord. Muskoxen have been hunted in the area since the government ban on muskox hunting was lifted in 1969, and tags are currently set aside for domestic/commercial use and sport hunts. Caribou have been regularly hunted in the region since Grise Fiord was established in 1953, with most harvest since 1964 focusing on the Bjorne Peninsula, south shore of Baumann Fiord, and Graham Island (Riewe 1973, IQ in Taylor 2005, Iviq HTA pers. comm.). Petroleum exploration in the 1970s is believed to have caused caribou to shift their ranges and movements, and there is concern that future industrial activity could be detrimental to the herds as well (Iviq HTA, pers. comm.) This survey was conducted to update the population estimates, demographic characteristics, and distribution of Peary caribou and muskoxen on southern Ellesmere Island and Graham Island.

**ᐱᒋᐊᕈᑎᖕᒐ**

ᑐᒃᑐᐃᑦ ᒥᕿᔫᑉ, ᑕᖅᓯᖃᓂᖅᓯᐅᓪᓗᑎᒃ ᑐᒃᑐᕆᔭᐅᔪᓂᑦ ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᖕᓂ ᓄᓇᑦᓯᐊᕐᒥ ᓄᓇᕗᑦ ᒥᓗ ᐊᓪᓚᕐ ᓈᕐᔪᖕᒥᑦ ᓂᒋᐊᓂᑦ ᐅᒥᖕᒪᑦ ᓄᓈᓐᓂ ᐊᐅᖕᓇᖕᒪᓂᑦ. ᓄᓇᖅᑎᖅᑲᑦ ᑕᖅᑐᑦ ᐅᒥᖕᒪᖕᓂᑦ ᐃᓂᒋᔭᒥᓂᑦ ᑭᓯᐊᓂᓕ ᓂᕆᐊᒃ ᑕᖕᕆ, ᐃᓂᒋᔭᒪᔭᖕᕆ, ᓂᕐᔭᑎᐅᖅᑎᖅᕐᓂᕐᓗ ᐊᕚᒃ ᓯᓯᒪᔭᑦ ᑕᒪᒃᑯᓂᖕᒐ ᒥᑭᓐᓂᖅᓯᒃᑯᑦ (ᖃᐅᓯᐃᑦ ᑑᑉ ᐊᖑᓇᓯᐊᒃ ᑐᓕᕆᔾᒃ ᑯᖕᕆ [ᐊᖑᓯᒃ ᑐᓕᕆᔾᑦ ᐊᒻᒪᓗ ᐊᐃᕚᒃ ᐊᖑᓇᓯᒃᑐᓕᕆᔨᒃᑯᑦ, pers. comm.). ᐊᒪᖅᑯᑦ ᐱᑕᖅᑲᑦ ᑕᖅᐸᑦ ᐊᒥᓲᖖᒋᓱᑎᒃ ᑐᒃᑐᑦ ᐃᓂᒋᔭᖕᒋᓂ, ᑭᓯᐊᓂ ᐅᖁᕈᖕ ᓅᖅᐹᓪ ᓕᕈᑕᐅᓂᐊᖅᐹᖑᔪᔭᖅ ᓯᓚᕿᔪᒃ ᐅᑭᐅᒃᑯᑦ ᓄᓇᓗ ᕿᕿᑎᖅᑕᕐ ᓂᖕᒥᑦ ᓂᕆᔭᒃᓴᖕᕆ ᐃᖁᓕᖅᓱᓂᐅᒃ (ᒥᓗ ᐃᑦ ᐅᐃᓪ 1975, ᒥᓗ ᐊᒻᒪ ᒐᓐ 2003, ᒥᓗ ᐊᒻᒪ ᐱᐅᕆ 2009).

ᑐᒃᑐᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᒐᔪᓗᐊᙱᑦ ᐅᒥᖕᒪᑦ ᓄᓈᓐᓂ ᑕᐃᒪᙵᑎᓄ 1961-ᒥᑦ ᖃᐅᔨᓴᓚᐅᕐᒥᑦ 200 ᓂᕐᔭᑎᓂᒃ ᕿᑭᖅᑕᒥ (ᑎᓄ 1963). ᓯᓚ ᐱᓪᓗᒍᑦ ᓈᒪᔪᒥ ᖃᐅᔨᓴᕈᓐᓇᓚᐅᙱᑦᑐᑦ ᕿᑭᖅᑕᒥ ᑭᓯᐊᓂᓕ, ᑕᑎᕆᔭᒃᓯᐅᓂᖕᓗ ᑕᒪᑐᒪ ᓇᓚᐅᑦ ᑖᖅᑕᐅᔫᑉ ᐊᐱᖅᑯᑎᒋᔭᒃᓴᐅᕗᖅ. ᕆᐅ (1976) ᖃᖓᓐ ᓄᓂ ᖃᐅᔨᓚᕿᖅᑦᑕᓚᐅᖅᑐᖅ ᓯᕐᒥᕈᓗᒃ ᓱᕋᒃᑎᕐᓂᐅᑉ ᐅᐊᖕᓇᖕᓂ, ᐸᐅᒥᓐ ᐊᒻᒪ ᑲᖏᖅᓱᐊᓗᖕᒥᓪᓗ ᐊᒻᒪ ᔅᕚᓐᓴᓐ, ᕍᓐᔅ, ᑯᓚᓇᔫᑉ ᐃᓚᖕᓂᓪᓗ 1973-ᒥᑦ, ᐅᓄᙳᖕᓂ ᓈᓴᐅᑉᓱᓂ 150 ᑐᒃᑐᓂᑦ. 1989-ᒥᑦ, ᖃᐅᔨᓴᖅᑎᓪᓗᒋᑦ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ ᓇᓚᐅᑦ ᑖᓚᐅᖅᑐᑦ 89 ± SE 31 ᑐᒃᑐᖅᑲᕋᓯᒋᓐᓈᓪᓗᑎᒃ, ᐱᖅᑲᓯᐅᑎᓪᓗᓂ ᔅᕚᓐᓴᓐ (ᑲᐃᔅ ᐊᒻᒪ ᐃᐅᓪᔅᕘᑦ 1991). 2005-ᒥᑦ, ᓄᓇᕗᑦ ᒐᕙᒪᖓᐊᑕᖕᒌᓗᑎᒃ ᖃᐅᔨᓴᓚᐅᖅᑐᑦ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ ᒍᓃᕼᐊᒻ ᕿᑭᖅᑕᖕᒋᓪᓗ, ᓇᓚᐅᑦ ᑖᖅᓱᑎᒃ 219-ᓂᒃ ᑐᒃᑐᖅᑲᕋᓯᒋᓐᓈᓪᓗᑎᒃ (95% CI=109-244). ᕿᑎᖅᐸᓯᐊ ᐅᐊᖕᓇᖕᒪ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ 2006-ᒥᑦ, ᓇᓚᐅᑦ ᑖᖅᓱᑎᒃ 802ᓂᒃ ᑐᒃᑐᖅᑲᕋᓯᒋᓐᓈᓪᓗᑎᒃ (95%CI=531-1207). ᐊᐅᓯᐃᑦ ᑐᕐᒥᐅᑦ ᐅᔾᕗᕈᓯᖖᒋᑐᖅ ᐅᓄᖅᓯᕆᐊᕐᒪᖕᒌ ᐅᓄᕈᓐᓃᓇᐊᕐᒪᖕᒌ ᑕᓗᓐᓃᑦ ᑐᒃᑐᐃᑦ ᑐᒃᑐᓐᓇᓯᒡ ᕚᑎᕝᑕᖕᒋᓂ, ᐱᓗᐊᙵᐊᖅᑐᒥᑦ ᒍᓂᕼᐊᒻ ᕿᑭᖅᑖᓂ, ᑯᓚᓇᔫᑉ ᐃᓚᖕᓂ, ᐅᒥᖕᒪᐅᑉ ᑲᖏᖅᓱᐊᑕ ᐃᓯᕆᐊᕐᕚᐊᓂ, ᐸᐅᒥᓐ ᑲᖏᖅᓱᐊᓂᓪᓗ ᐆᒃᓯᒥᑦ ᔅᑎᖕᑯᓪ ᑲᖏᖅᓱᖕᒧᑦ. ᐅᔾᕗᕈᓯᒃᓯᒪᓕᖅᑐᑦ ᐊᕚᒃ ᑐᖅᓯᒪᓂᖕᒋ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᓂᖕᒋᓂᒃ, ᑐᒃᑐᑕᐅᓯᒪᔭᑦ 2014 ᐊᒻᒪ 2015-ᒥᑦ ᑕᓪᓗᕈᑦ ᑲᓇᖕᓈᓂ (ᐊᐃᕚᖅ ᐊᖑᓇᓯᒃᑐᓕᕆᔨᒃᑯᑦ ᐊᒻᒪᓗ ᐆᒪᔪᓕᕆᔨᒃᑯᑦ J. ᓃᓕ, pers. comm.).

ᐅᒥᖕᒪᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᒐᔪᒃᐳᑦ ᐊᑕᐅᑦᑎᒃ ᑰᖅᑎᖅᑕᖅᓱᑎᒃ ᑐᒃᑐᓂᑦ. ᐅᒥᖕᒪᑦ ᓄᓈ ᓇᓚᐅᑦ ᑖᖅᑕᐅᓚᖅᑐᖅ ᑎᓅᑉ (1963) ᐅᒥᖕᒪᖅᑲᕐ ᓂᖅᓯᐅᓂᕋᖅᓱᓂᐅᒃ, 4000-ᓗᐊᑦ, ᐅᓄᕐᓂᖅᓯᑦ ᑲᑎᓖᖅᓱᕆᑦ ᑯᐃᓐ ᐃᓕᓯ ᐱᐅᑉ ᕿᑭᖅᑕᖕᓃᑦᑐᑦ. ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ, ᐱᕐᑯᖅᑲᐅᖅᓱᓂ, ᖃᖅᑲᖃᐅᖅᓱᓂ ᑲᖏᖅᓱᖃᐅᖅᓱᓂᓗ, ᑭᖑᓂᖕᓂᑦ ᐅᒥᖕᒪᑦ ᐅᓄᙳᓂᖅᓯᐅᕙᓚᐅᖅᑐᑦ ᕗᓯᐃᓪᒥᑦ ᕼᐋᓯᓐ ᑕᓯᖕᒌᑕ ᐅᐊᖕᓇᖕᓂ (ᑎᓄ 1963, ᔮᓐᑭᓐᔅ ᐃᑦ ᐃᐅᓪ. 2011). ᓯᑉᔭᖅᐸᓯᖕᒐ ᐸᐅᒥᑦ ᑲᖏᖅᓱᐊᓂ ᐅᒥᖕᒪᖕᒋ ᐅᓄᕐᓂᖅᐹᖑᔪᖅᑲᑕᐅᕗᑦ ᔅᕚᓐᓴᓐ ᓂᒋᐊᓂ (ᐊᐃᕚᖅ ᐊᖑᓇᓯᒃᑐᓕᕆᔨᒃᑯᑦ pers. comm., ᑲᐃᔅ ᐊᒻᒪ ᐃᐅᓪᔅᕘᑦ 1991, ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖕᒋ [IQ] ᑕᐃᓗᒥᑦ 2005). ᓄᓇᒃᑯᑦ ᖃᐅᔨᓴᖅᑎᓪᓗᒋᑦ ᔫᓐ ᓴᐅᓐᒥᑦ 1966-67-ᒥᑦ, ᕗᕇᒪᓐ (1971) ᓈᓴᐃᓚᐅᖅᑐᖅ 470 ᐅᒥᖕᒪᖕᓂᑦ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ. ᔭᓚᐃ 1973-ᒥᑦ, ᕆᐅ (1973) ᓇᓚᐅᑦ ᑖᓚᐅᖅᑐᖅ 1060-ᓂᒃ ᐅᒥᖕᒪᖅᑲᕋᓯᒋᓐᓈᓪᓗᓂ ᓯᕐᒥᕈᓗᒃ ᓱᕋᒃᑎᕐᓂᐅᑉ ᐅᐊᖕᓇᖕᓂ, ᑯᓚᓇᔫᓪᓗ ᐃᓚᖕᓂ, ᔅᕚᓐᓴᓐ, ᕍᓐᔅ, ᒍᓂᕼᐊᒻ ᕿᑭᖅᑕ, ᐊᒻᒪ ᐸᑭᖕᕼᐊᒻ ᕿᑭᖅᑕᖕᒋᓐᓂ. ᑕᒪᒃᑯᓂᖕᒐ 260-ᓂᒃ ᐅᒥᖕᒪᖅᑲᕋᓯᒋᓐᓈᓚᐅᖅᑐᑦ ᑯᓚᓇᔫᑉ ᐃᓚᖕᓂᑐᐊᖅ (ᕆᐅ 1973). ᑲᐃᔅ ᐊᒻᒪ ᐃᐅᓪᔅᕘᑦ (1991) ᓇᓚᐅᑦ ᑖᓚᐅᖅᑐᑦ 2020 ± SE 285 ᐅᒥᖕᒪᖅᑲᕋᓯᒋᓐᓈᓪᓗᑎᒃ (ᐱᖅᑲᓯᐅᑎᓪᓗᑎᒃ ᓄᕐᓴᑦ) ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ, ᐱᖅᑲᓯᐅᑎᓪᓗᓂ ᔅᕚᓐᓴᓐ, ᔭᓚᐃ 1989-ᒥᑦ. ᒪᐃ 2005-ᒥᑦ, ᐅᓄᖅᑎᒋᓂᖕᒌ 456-ᑐᐃᓐ ᓇᐅᓇᓯᒋᔭᐅᓚᐅᖅᑐᑦ (95%CI 312-670) 1+ ᓄᑲᑐᒐᐃᑦ ᐸᐅᒥᓐ ᓂᒋᐊᓂ ᑲᖏᖅᓱᐊᓗᖕᒥᓪᓗ, ᐱᖅᑲᓯᐅᑎᓪᓗᑎᒃ ᒍᓂᕼᐊᒻ ᐸᑭᖕᕼᐊᒻᓗ ᕿᑭᖅᑕᖕᒌ, ᐊᒥᓱᓪᓗ ᐅᒥᖕᒪᑦ ᑕᑯᔭᐅᔪᑦ ᖃᐅᔨᓴᖅᑎᓪᓗᒋᑦ ᑕᑯᒥ ᓇᓚᐅᙳᕿᕈᓂᒃ (ᑳᒻᐳᓪ ᐊᒻᒪ ᕼᐆᑉ 2006, ᔮᓐᑭᓐᔅ ᐃᑦ ᐃᐅᓪ. 2011). ᐊᐅᓯᐃᑦ ᑐᕐᒥᐅᑦ ᐅᔾᕗᕈᓯᒃᑐᑦ ᒪᕐᑯᖃᑦ ᑕᓚᐅᕐᓂᖕᓂᑦ ᓄᓇᓗ ᕿᕿᑎᓚᐅᕐᓂᖕᓂᑦ ᐅᑭᐊᒃᓵᖅ/ᐅᑭᐅᖅ 2005-ᒥᑦ, ᐊᒥᓯᑦ ᐅᒥᖕᒪᑦ ᐱᕐᓕᓕᖅᓱᑎᒃ (ᐊᐃᕚᖅ ᐊᖑᓇᓯᒃᑐᓕᕆᔨᒃᑯᑦ, pers. comm.).

ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᑕᓪᓗᕈᑦ ᐅᐊᖕᓇᖕᒋᓂ, ᐅᒥᖕᒪᑦ ᓄᓈᑦ ᑕᓂᕆ ᐊᓂ, ᐊᒻᒪ ᒍᓅᕼᐊᒻ ᖅᑭᑭᖅᑕᖕᒋᓂ ᐱᒻᒪᕆᐅᕗᑦ ᐊᐅᓯ ᐃᑦᑐᕐ ᒥᐅᓄᑦ. ᐅᒥᖕᒪᒐᓯᖃᑦᑕᖅᑐᑦ ᑕᐃᑲᓂ ᑕᐃᒪᖕᒐ ᒐᕙᒪᐅᑉ ᓄᖅᑲᖅᑎᑦᑎᓯᒪᔪᓐᓂᕋᒥᑦ ᐅᒥᖕᒪᒐᓯᔪᓐᓇᕐᓂᕐᒥᑦ 1969-ᒥᑦ, ᓂᕕᖔᕐᑯᑕᓅᖅᓗᑎᒡᒍ ᓄᓇᓕᖕᓂᕐᒥᐅᑦ/ᐲ ᓇᐅᔾᔭᒃᓴᓇᓯᐊᖅᑐᑦ ᐊᖑᓇᓱᒋᐊᖅᐸᒃ ᑐᓄᓪᓗ. ᑐᒃᑐᓐ ᓇᓯᖃᑦᑕᐃᓐ ᓇᖅᐸᑦ ᑕᐃᒪᖕᒐ ᐊᐅᓯ ᐃᑦᑐᖅ ᓄᓇᓕᖅᑎᑕᐅᓚᒥ 1953-ᒥᑦ, ᑐᒃᑐᓯᒪᓂᖅᐹᖑᓕᓄᑎᒃ 1964-ᒥᑦ ᑰᓚᓇᔫᑉ ᐃᓚᖕᒋᓂ, ᐸᐅᒥ ᑲᖏᖅᖑᖕᒋᓂ ᓂᕆᐊᑕ ᓯᓪᔭᖕᒋᓂ, ᒍᓅᕼᐊᒻ ᖅᑭᑭᖅᑕᖕᒋᓂᒡᓗ (ᓇᐅ 1973, ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᖅᑕᖏᑦ ᑕᐃᓗᒥᑦ 2005, ᐊᐃᕙᖅ ᐊᖑᓇᓱᒃ ᑐᓕᓇᔨᒃ ᑯᑦ pers. comm.). ᐅᖅᓱᐊᓗᖕᓂ ᖃᓂᖅᑐᖃᖅᑎᓪᓗᒍᑦ 1970-ᖏᓐ ᓂᑦ ᑐᒃᑐᓄᑦ ᐊᓯᔾᔨᔾᔪᑕᐅᓇᓱᒋᔭᐅᕗᖅ ᓇᓂᓐ ᓂᖏᓐ ᓂᒃ ᐃᖏᕐ ᕿᓂᖏᓐ ᓂᓪᓗ, ᐃᓱᒫᓗᑕᐅᓪᓗᓂᓗ ᓯᕗᓂᒃ ᓴᑦᑎᓐᓂ ᖃᓄᐃᓕᐅᕈᑕᐅᔪᑦ ᐱᐅᔪᓐᓅᕈᑕᐅᕝ ᓕᐊᓂᐊᕐ ᓂᖕᒋᓂ ᑐᒃᑐᓄᑦ (ᐊᐃᕙᖅ ᐊᖑᓇᓱᒃ ᑐᓕᓇᔨᒃ ᑯᑦ, pers. comm.) ᖃᐅᔨᓴᓚᐅᖅᑐᑦ ᓄᑖᙳᐊᖅᓯᔪᒪᓪᓗᑎᒃ ᖃᓄᖅ ᐅᓄᖅᑎᒋᓇᓱᒋᔭᐅᖕᒪᖔᑦ, ᓄᓇᒦᑉ ᕕᑎᔭᖏᑦ ᖃᓄᐃᓕᖑᖕᒪᖔᑦ, ᐊᕙᒃ ᑐᖅᓯᒪᓂᖏᓐᓗ ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐅᒥᖕᒪᑦ ᓄᓈᑦ ᑕᓂᕆ ᐊᓂ ᒍᓅᕼᐊᒻ ᖅᑭᑭᖅᑕᖕᒋᓂᒡᓗ.

**Study Area**

The March 2015 aerial survey was flown to cover the same study area as the previous 2005 survey (Jenkins et al. 2011), which included Ellesmere Island south of Vendom Fiord, excluding the Svendsen Peninsula, and also including Graham and Buckingham islands. The area south of Jakeman Glacier to King Edward Point was originally included in the survey area but could not be flown due to weather. North Kent Island was circled in a reconnaissance flight but not surveyed systematically. Neither area was included in the 2005 survey.

The survey area is predominantly polar desert and semi desert, with more rugged topography along the mountains and fiords of the south coast which rise from sea level to 1000 m, transitioning to rolling terrain in the north along Baumann Fiord and the Bjorne Peninsula. Mountains dominate the eastern edge of the study area along the ice sheets, which, along with the Sydkap Ice Cap at almost 1500 m AMSL, are the highest points in the study area. Cryptogam herb barrens, cushion forb barrens, unvegetated bedrock and talus, and icefields dominate south of the Sydkap Ice Cap, mostly with <5% vegetation cover and less than 100 g/m$^2$ vegetation biomass (Gould et al. 2003, Walker et al. 2005). Further north, along Baumann Fiord and Bjorne Peninsula, vegetation cover increases to 5-50% and biomass increases to 100-500 g/m$^2$ (Gould et al. 2003). Prostrate dwarf shrub and herb tundra dominates, extending north and west of the study area on Svendsen Peninsula (Walker et al. 2005). The north end of Bjorne Peninsula also includes sedge and grass wetlands and large areas of graminoid, dwarf prostrate shrub, and forb tundra (Walker et al. 2005), with 50-80% vegetation cover (Gould et al. 2003). Exposed carbonate and non-carbonate bedrock is common along the edges of ice sheets at the eastern edge of the study area. Graham and Buckingham islands are typified by flat to rolling terrain below 150 m AMSL and relatively lush graminoid, forb, and cryptogam tundra, with areas of sedge and grass wetland, particularly on southwest Buckingham Island (Walker et al. 2005). Prostrate dwarf shrub-lichen tundra, which is not found elsewhere is the study area, is found on Graham and Buckingham islands (Gould et al. 2003). Vegetation cover is 5-50% on the islands, with primary productivity 100-500 g/m$^2$ (Gould et al. 2003).

Mean July temperatures are 3-5°C on the west side of the study area and 5-7°C in the east (Gould et al. 2003 and references therein). In March 2015, the average daily low temperature was -33.4°C and the average daily high temperature was -25.4°C (Environment Canada weather data for Grise Fiord, available http://climate.weather.gc.ca/index_e.html). There was very little snow throughout the study area, with 0-5 cm snow recorded on the ground at Grise Fiord in March, and 22.9 mm of precipitation (Environment Canada weather data).

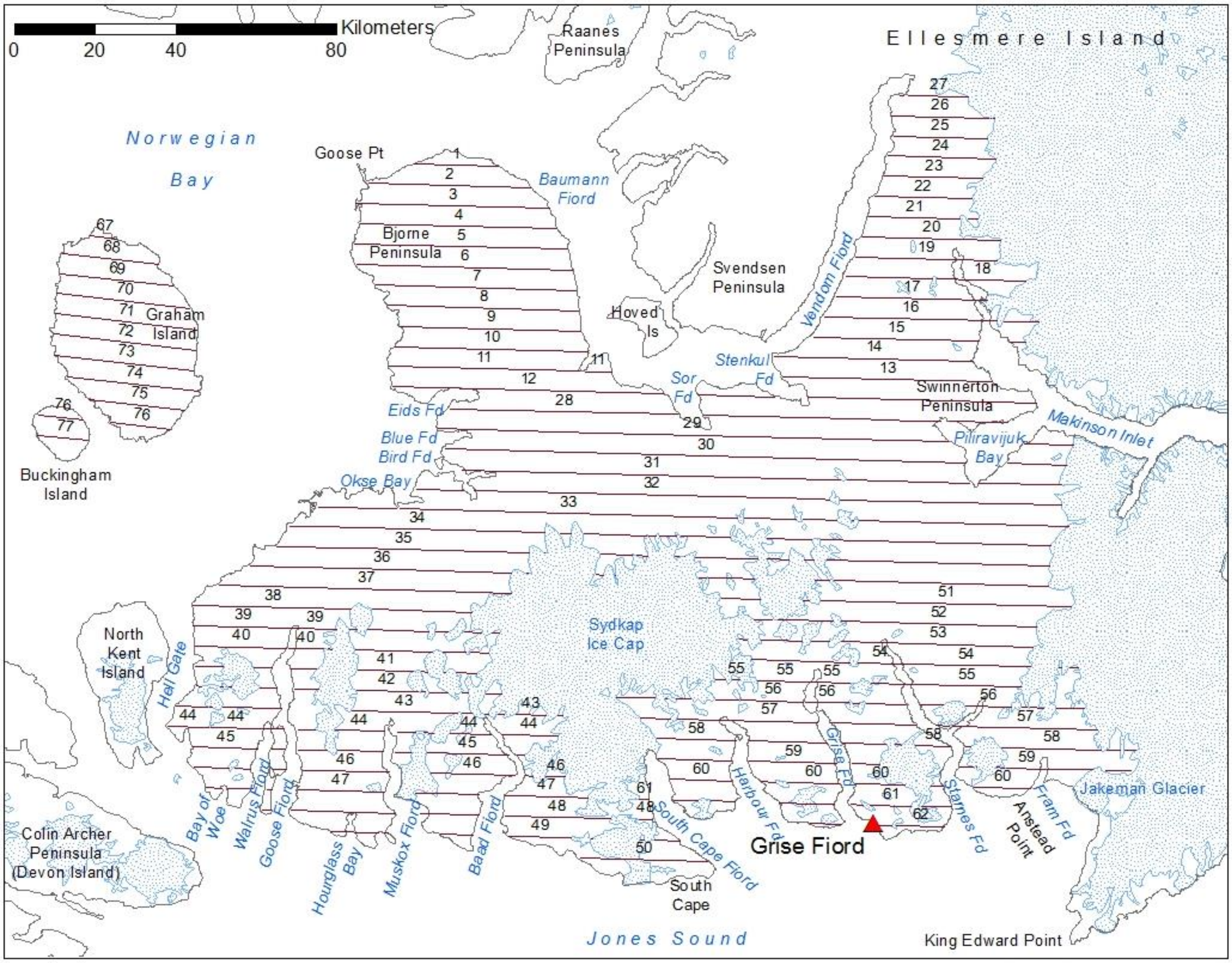


Figure 1. Transects over the study area, excluding ice caps (stippled blue), in dark red with numbers noted above the transects, running east-west, 5 km apart.

## Methods

### *Aerial Survey*

Although originally planned for April 2014, we were unable to complete the survey due to fog and wind. The survey was rescheduled in August, when caribou would be visible against the snow-free ground, but again weather prevented survey completion. Summaries of the April and August 2014 survey methodology and results are given in Appendix 1 and 2 but were not used in the analyses presented here. The survey was successfully flown March 19-26, 2015.

Survey transects (n=77, Appendix 3) followed the transects established for the 2005 distance sampling helicopter survey parallel to lines of latitude, with 5 km spacing and a 500 m strip on either side of the aircraft. Ice caps were excluded, and we did not detect any caribou, muskoxen, or their tracks on any ice caps during ferry flights. The area of southeastern Ellesmere Island from Jakeman Glacier to King Edward Point was originally included in the survey area, but persistent wind and fog in the area prevented flying the 4 short transects there. The area was not included in the 2005 survey. We flew reconnaissance around

North Kent Island since hunters had found caribou at the north end in previous years, but it was not systematically surveyed (nor was it surveyed in 2005), and we saw no caribou, muskoxen, or tracks. No caribou or muskoxen were present on North Kent Island when it was last surveyed in 2008.

To define the transect width for observers, 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 measured and marked on the ground to position wing strut marks (Figure 2).Multiple distance bins can be incorporated and marked on the wing strut, but for this survey we only used 1 mark representing 500 m. Fixed-wing strip transect sampling has been successfully used in the high arctic since 1961.

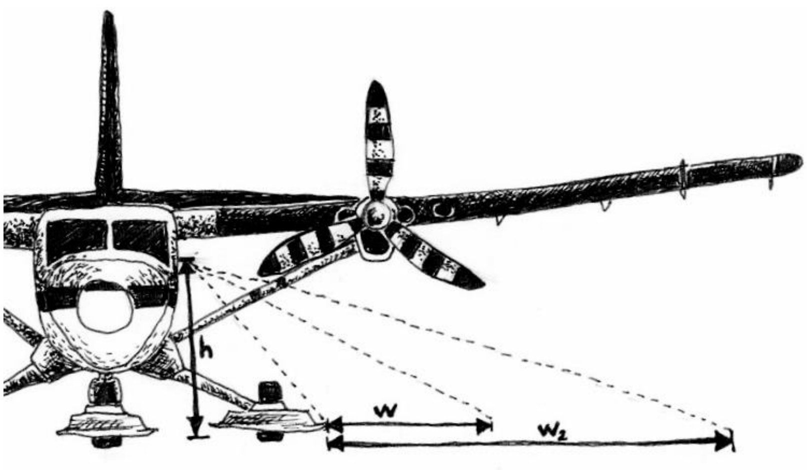


Figure 2. Derivation of wing strut marks for strip boundaries, where w and $w_2$ are calculated as described in the text, h is measured (2.2 m for Twin Otter on wheel-skis), and dotted lines indicate observer sightlines as modified from Norton-Griffiths (1978).

We did not stratify the study area because of changes to wildlife distributions and densities (confirmed by the April 2014 survey attempt) since the last survey 10 years ago and given the different habitat preferences for caribou and muskox,. We did, however, examine population estimates according to Case and Ellsworth's (1991) stratification for direct comparison of their July 1989 survey results (since no muskoxen were seen on transect on Graham/Buckingham islands, this part of the study area did not have to be added to the stratification).

Transects were flown at 150 km/hr (81 kts) with a DeHavilland Twin Otter. Surveys were only conducted on days with good visibility and high contrast to facilitate detection of animals, tracks, and feeding craters, as well as for operational reasons to ensure crew safety. Flight height was set at 500' (152 m), 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.

A Twin Otter with 4 passengers (2 front observers, 2 rear observers, one of whom was also data recorder) was used to follow a double-observer platform when possible (4 dedicated observers were not always available), which has been successful in the Kivalliq Region of Nunavut (see Campbell et al. 2012 for an overview of the methodology) and on Bathurst Island (Anderson 2014). In both the Bathurst Island survey and the South Ellesmere survey, front and rear observers were able to communicate and all observations by front and rear observers were lumped. Estimates of group size are a potentially large source of error in calculating population estimates, however Peary caribou are generally distributed in small groups where observer fatigue is likely to be a more important source of error (A. Gunn, pers. comm.). We found obvious benefits of using the platform where having the added observers not only increased the accuracy of age and sex classification, but also allowed for some crew members to classify with binoculars while others continued to scan for nearby groups and individuals.

All observations of wildlife and tracks were marked on a handheld Garmin GPSMAP 62STC global positioning system (GPS) unit, which also recorded the flight path every 30 seconds. Sex and age classification was limited, since the aircraft did not make multiple passes (to minimize disturbance), but adult/short yearling (calves from the previous spring, i.e. 10-11 months old) determination was often straightforward for muskox and aided by binoculars. Muskoxen were frequently spotted more than a kilometer off transect due to their large aggregations and dark colour in contrast to the snowy background. Depending on distance and topography, an accurate count could not always be determined for these groups. Newborn muskoxen were not present during the survey. GPS tracks and waypoints were downloaded through DNR Garmin and saved in Garmin GPS eXchange Format and as ESRI shapefiles. Data was entered and manipulated in Microsoft Excel and ArcMAP (ESRI, Redlands, CA).

*Analysis*

Flights linking consecutive transects were removed for population analysis, although survey speed and height were maintained and all observations recorded as if on survey. Similarly, sections of transect crossing inlets and ice fields were removed, as these areas were not included in the area used for density calculations. The study area was also stratified following Case and Ellsworth (1991) for direct comparison with their survey results (Figure 3). We considered stratifications by elevation and by treating the Bjorne Peninsula separately as well, to aid in future survey planning. Strata are summarized in Table 1.

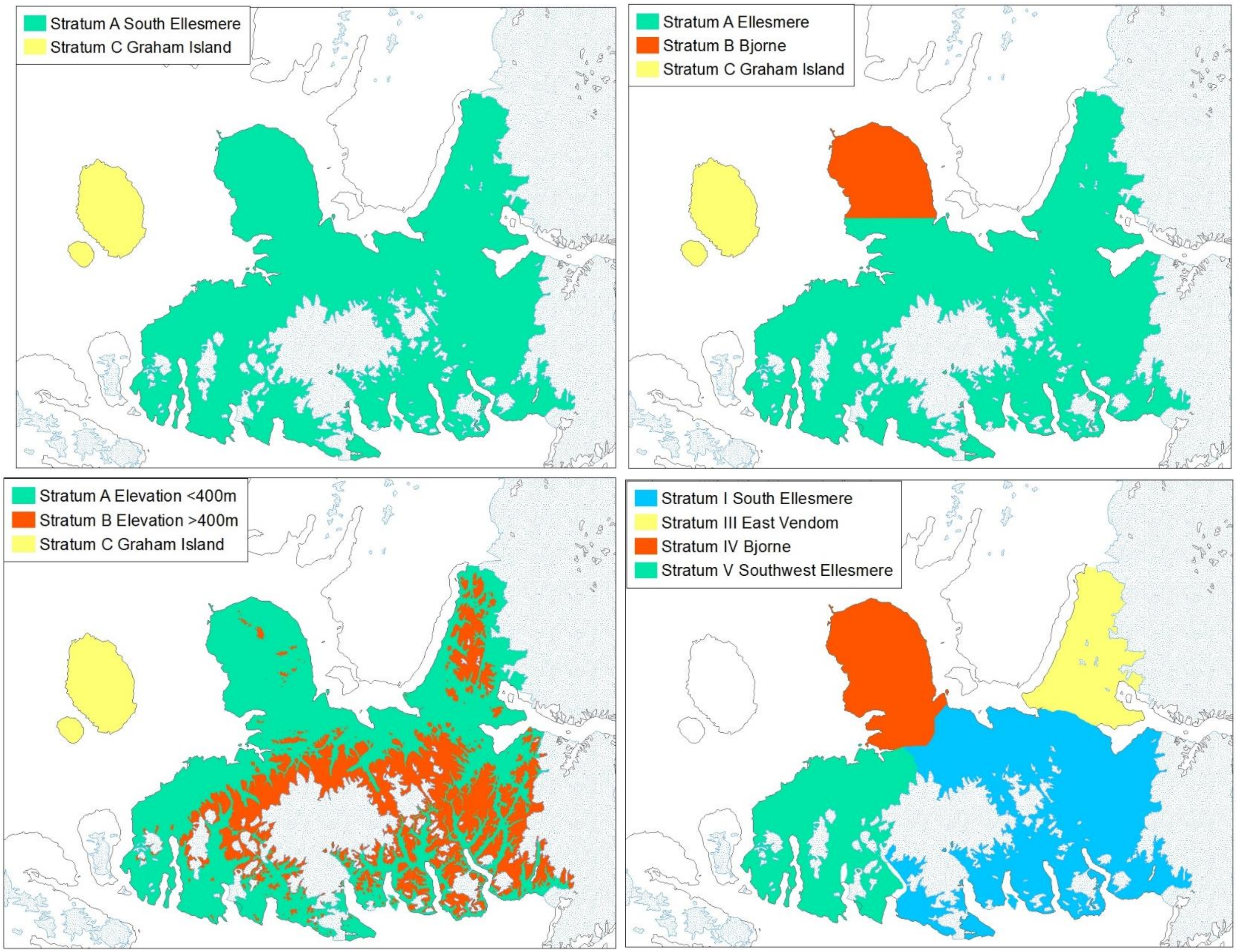


Figure 3. Several stratification regimes for the study area based on geography, elevation, and Case and Ellsworth's (1991) strata.

Table 1. Survey strata for southern Ellesmere Island, March 2015. Although 73 transects were flown, transects flown on the same latitude were combined as lines for further analysis (outlined in Appendix 3).

| Stratification | Block ID | Location | Strata Area, Z ($km^2$) | Transect Spacing (km) | Transects Surveyed | Lines Surveyed | Survey Area, z ($km^2$) | Sampling Fraction, f (%) |
|---|---|---|---|---|---|---|---|---|
| All | A | South Ellesmere | 21260 | 5 | 62 | 39 | 4896.0 | 0.199 |
| | C[1] | Graham, Buckingham | 1531 | 5 | 11 | 11 | 296.5 | 0.201 |
| Elevation | A | South Ellesmere Low Elevation (<400 m) | 13921 | 5 | 62 | 39 | 3322.5 | 0.195 |
| | B[2] | South Ellesmere High Elevation (>400 m) | 7339 | 5 | 54 | 38 | 1573.6 | 0.199 |
| | C[1] | Graham, Buckingham | 1531 | 5 | 11 | 11 | 296.5 | 0.198 |
| Bjorne | A | South Ellesmere | 18988 | 5 | 52 | 39 | 4439.1 | 0.201 |
| | B | Bjorne Peninsula | 2272 | 5 | 10 | 10 | 456.9 | 0.199 |
| | C[1] | Graham, Buckingham | 1531 | 5 | 11 | 11 | 296.5 | 0.265 |
| Case and Ellsworth | I | South Ellesmere | 10029 | 5 | 31 | 31 | 2657.9 | 0.201 |
| | III | East Vendom | 2865 | 5 | 17 | 17 | 576.0 | 0.202 |
| | IV | Bjorne | 3397 | 5 | 16 | 16 | 685.2 | 0.197 |
| | V | Southwest Ellesmere | 4969 | 5 | 18 | 18 | 977.0 | 0.230 |
| | C[1] | Graham, Buckingham | 1531 | 5 | 11 | 11 | 296.5 | 0.201 |

[1]For caribou estimates, Graham/Buckingham islands were both included and excluded, but no muskoxen were seen on transect there.

[2]No caribou were seen in the high elevation stratum.

Although Jolly's (1969) Method II is widely used for population estimates from surveys, it is designed for a simple random design, rather than for a systematic survey of a patchy population. For comparison, population calculations following Jolly's Method II are provided in Appendix 4, along with calculations following a systematic stratified survey design (Cochran 1977). The muskoxen and caribou detected in this survey were patchily distributed and serially correlated, not randomly distributed, and no stratification was applied based on population densities. 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).

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 $\varepsilon_i$ 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 (transects on the same latitude were combined for a total of 39 transects on Ellesmere Island and 10 transects on Graham and Buckingham islands). 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. The irregular study area boundaries mean that $f$ varies from the 20% sampling fraction indicated by the 1-km survey strip and 5-km transect spacing (see Appendix 4 for comparative calculations with a stratified sampling regime based on transect width and 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 several stratification regimes for the southern Ellesmere Island 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 unstratified (Ellesmere plus Graham and Buckingham islands) estimate and the nearest neighbor variance. All distance measurements used North Pole Azimuthal Equidistant projection and area-dependent work used North Pole Lambert Azimuthal Equal Area, with central meridian at 85°W and latitude of origin at 76°N (centered over the study area for high precision).

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 2005). The instantaneous rate of change is $r$, which is also represented as a constant ratio of population sizes, $\lambda$. When $r$ >0 or $\lambda$ >1, the population is increasing; when $r$ <0 or $\lambda$ <1 the population is decreasing. Values of $r$ ~0 or $\lambda$ ~1 suggest a stable population.

## Results

We flew surveys on March 19, 20, 21, 23, 24, 25, and 26, 2015 for a total of 49.5 hours (35.6 h and 4521 km on transect). Daily flight summaries are presented in Appendix 5 and incidental wildlife sightings are presented in Appendix 6. Visibility was excellent for all survey flights with clear skies (visual estimates of <10% cloud) and high contrast. Some patches of low cloud and blowing snow were encountered near Piliravijuk Bay, but visibility on transect was not impaired. Temperatures ranged from -33°C to -14°C during the survey. We saw 38 caribou and 1146 muskoxen in total, including 36 caribou on transect and 636 muskoxen on transect. Spatial data presented here represents waypoints, so 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 500 m, some muskox groups off transect were more than 2 km away.

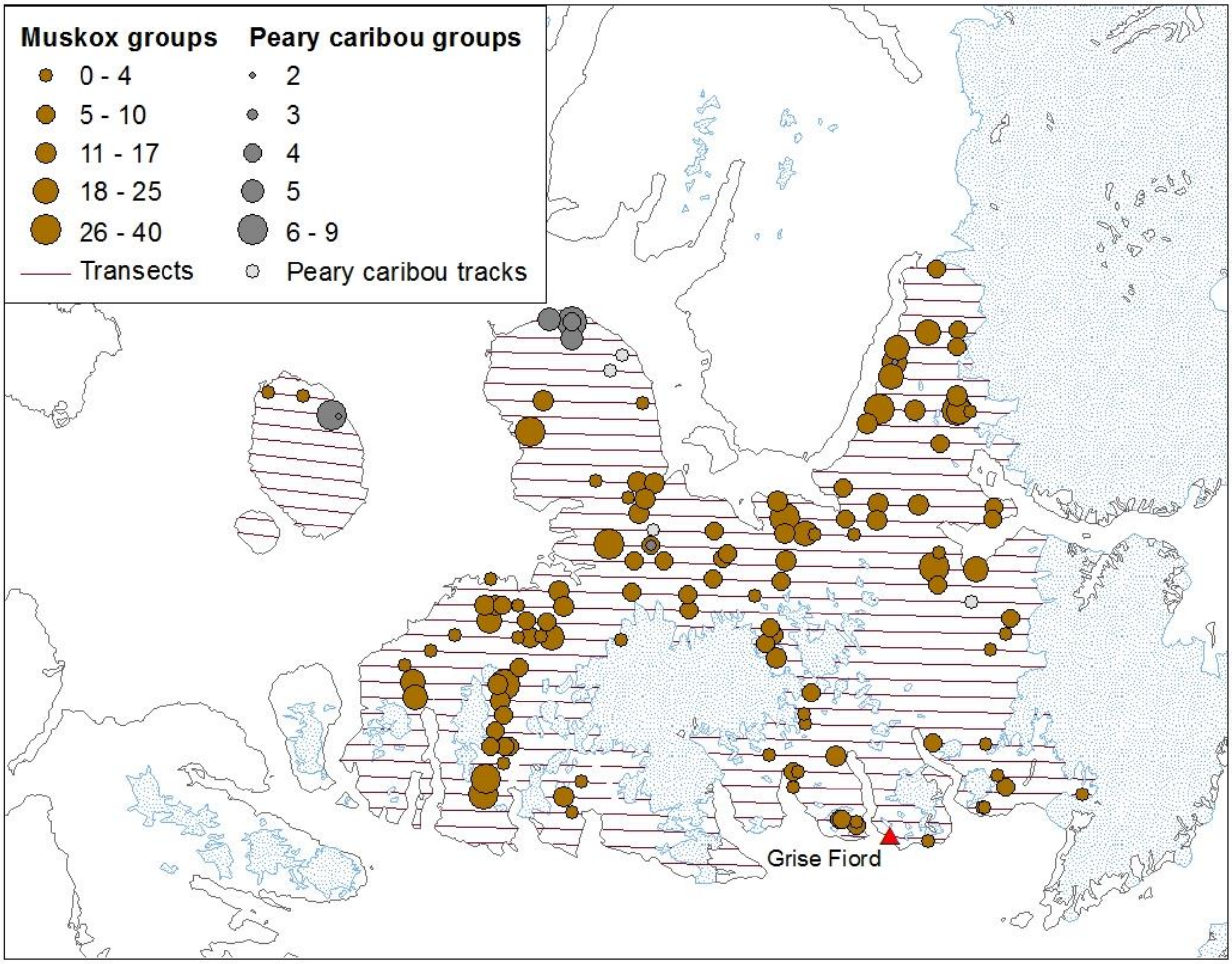


Figure 4. Observations of Peary caribou and muskoxen on southern Ellesmere, Graham, and Buckingham islands.

*Abundance Estimates*

Abundance estimates for muskoxen are given in Table 7 and population estimates for caribou are given in Table 8. The overall population estimates were 3200 ± SE 602 (CV=19%) and 183 ± SE 128 Peary caribou (CV=70%). The few observations used to calculate the caribou population estimate should be considered in interpreting the results.

Table 2. Calculations following Cochran (1977) for a systematic survey and ratio estimator for muskoxen on southern Ellesmere Island. Variance was calculated based on sample mean and based on nearest-neighbor to account for serial correlation in the data.

| Stratum | Stratum area Z (km$^2$) | Surveyed area z (km$^2$) | Count, y | Estimate, $\hat{Y}$ | Density, $\hat{R}$ | Nearest Neighbor | | | | Deviations from sample mean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV |
| All | 21260 | 4225 | 636 | **3200** | 0.151 | 164.804 | 362230 | 602 | 0.188 | 194.057 | 426528 | 653 | 0.204 |
| Low Elev | 13921 | 2792 | 571 | 2847 | 0.205 | 180.633 | 257061 | 507 | 0.178 | 202.559 | 288263 | 537 | 0.189 |
| High Elev | 7339 | 1433 | 65 | 333 | 0.045 | 14.438 | 11488 | 107 | 0.322 | 15.726 | 12513 | 112 | 0.336 |
| Total | 21260 | 4225 | 636 | **3180** | 0.150 | | 268549 | 518 | 0.163 | | 300776 | 548 | 0.172 |
| Main | 18988 | 3768 | 623 | 3140 | 0.165 | 247.205 | 486171 | 697 | 0.222 | 340.405 | 669465 | 818 | 0.291 |
| Bjorne | 2272 | 457 | 13 | 65 | 0.028 | 3.069 | 3076 | 55 | 0.858 | 2.768 | 2775 | 53 | 0.815 |
| Total | 21260 | 4225 | 636 | **3204** | 0.151 | | 489248 | 699 | 0.218 | | 672240 | 820 | 0.256 |
| I Southeast | 10029 | 2658 | 222 | 838 | 0.084 | 48.545 | 43637 | 209 | 0.249 | 91.216 | 81994 | 286 | 0.342 |
| III Vendom | 2865 | 576 | 212 | 1054 | 0.368 | 209.096 | 140033 | 374 | 0.355 | 255.597 | 171175 | 414 | 0.392 |
| IV Bjorne | 3397 | 685 | 30 | 149 | 0.044 | 8.269 | 6949 | 83 | 0.560 | 7.128 | 5990 | 77 | 0.520 |
| V Southwest | 4969 | 977 | 172 | 875 | 0.176 | 36.869 | 41588 | 204 | 0.233 | 34.958 | 39433 | 199 | 0.227 |
| Total | 21260 | 4896 | 636 | **2916** | 0.137 | | 232207 | 482 | 0.165 | | 298592 | 546 | 0.187 |

Table 3. Calculations following Cochran (1977) for a systematic survey and ratio estimator for Peary caribou on southern Ellesmere Island. Variance was calculated based on sample mean and based on nearest-neighbor to account for serial correlation in the data.

| Stratum | Stratum area Z ($km^2$) | Surveyed area z ($km^2$) | Count, y | Estimate, $\hat{Y}$ | Density, $\hat{R}$ | Nearest Neighbor | | | | Deviations from sample mean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV | Error Sum of Squares | Var ($\hat{Y}$) | SE | CV |
| All | 21260 | 4225 | 26 | 131 | 0.006 | 5.606 | 14405 | 120 | 0.618 | 7.247 | 18622 | 136 | 0.702 |
| Graham | 1531 | 296 | 10 | 52 | 0.034 | 3.513 | 2036 | 45 | 0.874 | 3.172 | 1838 | 43 | 0.830 |
| Total | 22791 | 4521 | 36 | **183** | 0.008 | | 16441 | 128 | 0.702 | | 20460 | 143 | 0.784 |
| Low Elev | 13921 | 2792 | 26 | 130 | 0.009 | 9.150 | 16458 | 128 | 1.103 | 9.193 | 16537 | 129 | 1.106 |
| Graham | 1531 | 296 | 10 | 52 | 0.034 | 3.513 | 2035 | 45 | 0.874 | 3.172 | 1838 | 43 | 0.830 |
| Total | 15452 | 3088 | 36 | **181** | 0.012 | | 18493 | 136 | 0.750 | | 18375 | 136 | 0.747 |
| Main | 18988 | 3768 | 3 | 15 | 0.001 | 0.072 | 168 | 13 | 0.793 | 0.067 | 156 | 12 | 0.845 |
| Bjorne | 2272 | 457 | 23 | 114 | 0.050 | 7.699 | 7717 | 88 | 0.768 | 14.800 | 14836 | 122 | 1.065 |
| Graham | 1531 | 296 | 10 | 52 | 0.034 | 3.513 | 2036 | 45 | 0.874 | 3.172 | 1838 | 42 | 0.830 |
| Total | 22791 | 4521 | 36 | **181** | 0.008 | | 9921 | 100 | 0.550 | | 16830 | 129 | 0.716 |
| IV Bjorne | 3397 | 685 | 26 | 129 | 0.038 | 8.027 | 6745 | 82 | 0.637 | 15.240 | 12806 | 113 | 0.878 |
| Graham | 1531 | 296 | 10 | 52 | 0.034 | 3.513 | 2036 | 45 | 0.874 | 3.172 | 1838 | 42 | 0.830 |
| Total | 4928 | 981 | 36 | **181** | 0.037 | | 8781 | 94 | 0.519 | | 14644 | 121 | 0.670 |

*Population Trends*

Muskoxen have clearly increased since the last survey in 2005. Based on a population estimate of 3200 in 2015 and 456 in 2005 (Jenkins et al, 2011), the instantaneous growth rate $r$ would be 0.202, or a lambda of 1.224. The few caribou sightings and large variance in the 2015 estimate of 183 caribou make determination of a trend since the 2005 estimate of 219 difficult, and the growth rate *r* of -0.018 or lambda of 0.982 should be interpreted with that in mind. More sophisticated analyses incorporating uncertainty in the estimates have not been undertaken, but the large uncertainty in both estimates would likely still make trend determination tenuous.

*Calf Recruitment*

In April 2014, 33 muskox groups were classified, with 42 short yearlings to 311 adults, or 15.6% short yearlings. In August, the spring 2014 calves were easily identified in 20 groups of 23 calves and 88 adults, making the new calves 23.9% of the population. In March 2015, we classified 101 groups, with 64 short yearlings and 289 adults. Short yearlings made up 22.1% of the population in March, suggesting high overwinter survival if the August calf counts are reflective of the entire study area.

Only 4 caribou groups were classified, totaling 1 short yearling to 8 adults. The low sample size prevents drawing any conclusions on calf recruitment.

*Group Size*

Muskox group size was about the same in March 2015, averaging 8.9-12.1 muskoxen (95% CI, n=106, median=8; Figure 5), as in April 2014, averaging 6.8-12.0 muskoxen (95% CI, n=33, median=6). The spring groups were larger than the August 2014 groups, which averaged 2.6-6.2 muskoxen (95% CI, n=20, median=3).

Caribou groups were much smaller, 2.6-6.9 caribou (95% CI, n=8; Figure 6). No caribou were seen in April 2014, and only 2 groups, of 1 caribou and 8 caribou, were seen in August 2014.

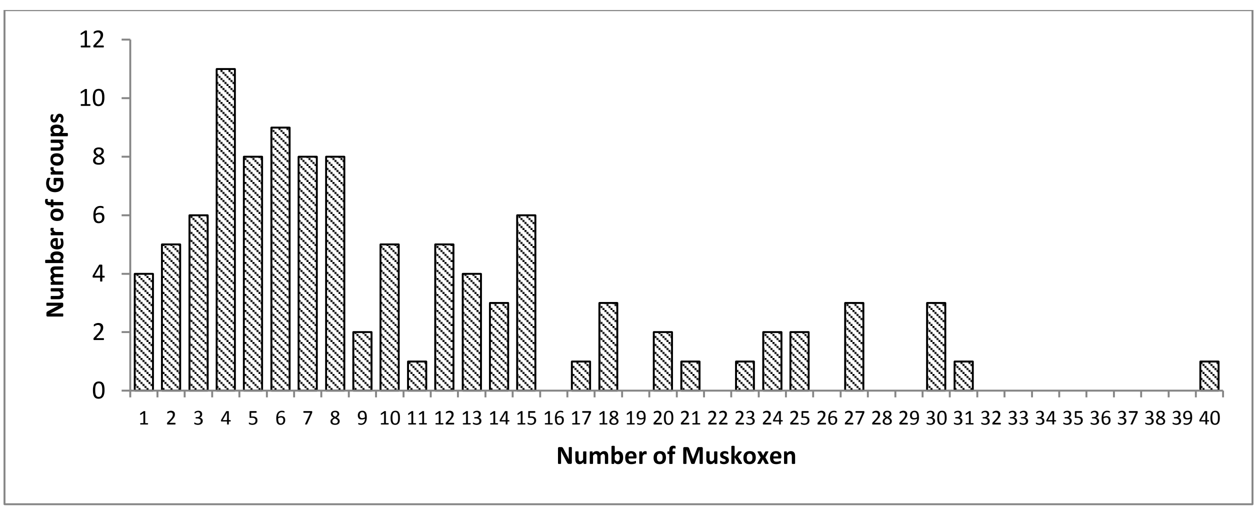


Figure 5. Histogram of group size for 106 muskox group size encountered March 19-26, 2015 on southern Ellesmere Island.

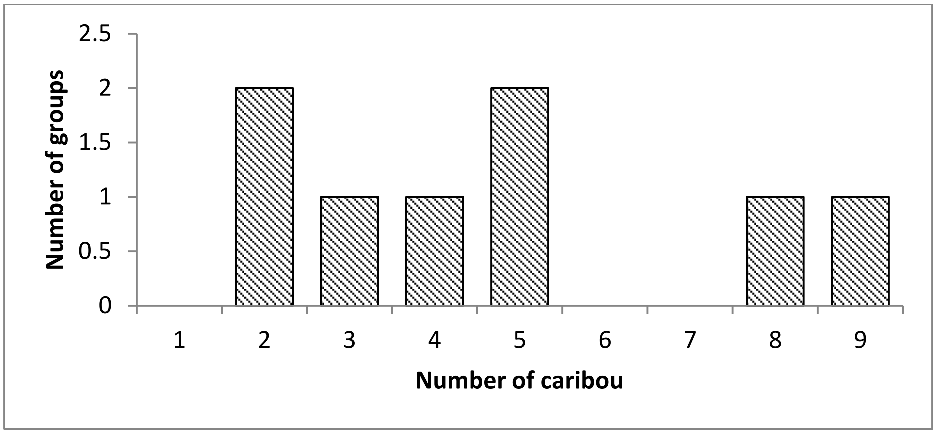


Figure 6. Histogram of group size for 8 Peary caribou groups encountered March 19-26, 2015 on southern Ellesmere Island.

## Discussion

*Population Trends*

Previous surveys of southern Ellesmere Island have used different survey platforms (Piper Super Cub, Tener 1963; Bell 206, Case and Ellsworth 1991, Jenkins et al. 2011 and April 2014 survey attempt; Twin Otter, Riewe 1973, this survey; ground surveys, Freeman 1971), different methodologies (distance sampling, Jenkins et al. 2011 and April 2014 survey attempt; strip transect, this survey, Tener 1963, Case and Ellsworth 1991; unstratified random block sampling, Case and Ellsworth 1991; unsystematic, Freeman 1971, Riewe 1973), and different survey areas. Population estimates and minimum counts are presented in Figure 7, although perhaps the most useful interpretation of the figure is the substantial data gaps it presents. Drawing conclusions on population trends using the disparate data available is difficult.

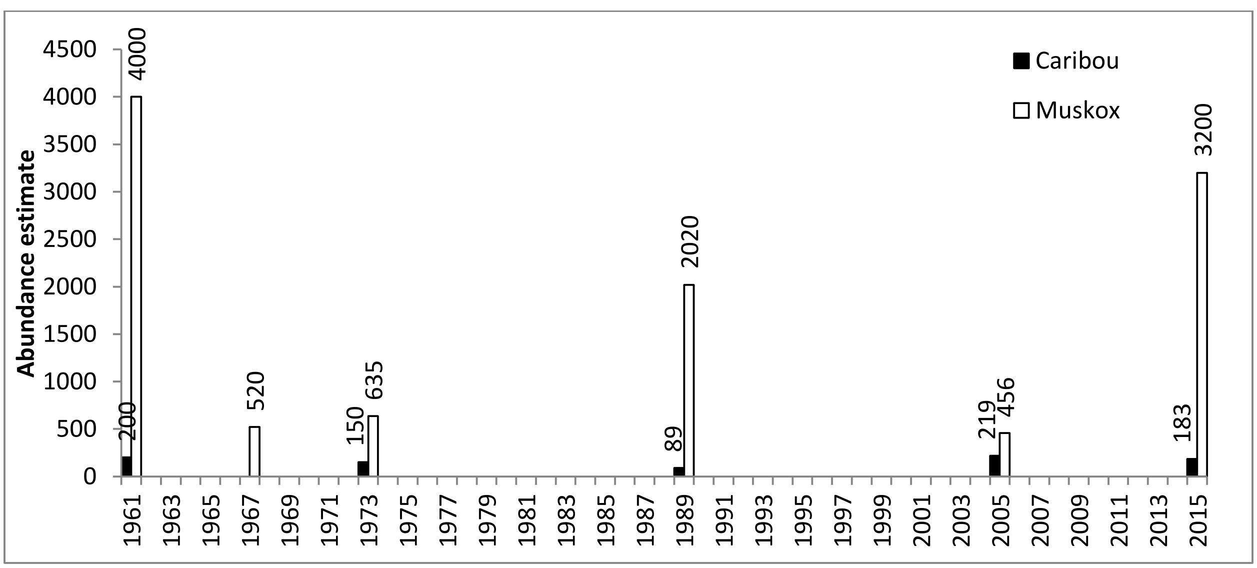


Figure 7. Summary of population estimates for muskoxen and Peary caribou on southern Ellesmere Island and Graham Island. The 1961 estimate is a guess for all of Ellesmere Island (Tener 1963), the 1989 estimate does not include Graham Island (Case and Ellsworth 1991), and 1967 and 1973 are based on minimum counts from unsystematic surveys (Freeman 1971, Riewe 1973). The 2005

and 2015 surveys covered the same study area as in 1989, but included Graham Island and excluded Hoved Island (Jenkins et al. 2011, this report).

In 1961, Tener (1963) observed 1165 muskoxen on Ellesmere Island, except parts of the south and east coasts and northwestern coasts that were inaccessible due to weather. He estimated about 4000 muskoxen on the island, and suggested about a quarter of the population was likely on the Fosheim Peninsula and Lake Hazen-Alert plateau, north of the southern Ellesmere study area (Tener 1963). Concentration areas on southern Ellesmere Island were identified at the head of Baumann Fiord and east of Vendom Fiord. Although he did not survey Vendom Fiord, Freeman (1971) counted 470 muskoxen on southern Ellesmere Island and 50 muskoxen on Graham Island during ground surveys in 1966 and 1967. In early May 1973, Riewe flew the Bjorne Penisula and saw 148 muskoxen, and an additional 60 between Sor and Stenkul Fiords – however, the transect spacing was 8 km and the flight height was 760 m AGL, too high to get more than a reconnaissance survey for muskox and too high to detect caribou at all (Riewe 1973). Later in May, they flew east of Vendom Fiord at 500 m AGL, and the July 1973 surveys were redesigned to be lower (152 m) and slower (176 kph) with more observers to more accurately survey wildlife. Overall, Riewe estimated 625 muskoxen on southern Ellesmere and another 10 on Graham Island (Riewe 1973). Case and Ellsworth (1991) estimated 2020 ± SE 285 muskoxen in July 1989 over approximately the same study area we flew in 2015 (minus Graham Island and including Hoved Island). They estimated a 56% increase in the muskox population from 1973 (Case and Ellsworth 1991). Approximating Case and Ellsworth's (1991) stratification for the 2015 survey, we calculated an average muskox density of 0.137 muskox/km$^2$, somewhat higher than the 1989 density estimate of 0.081 muskox/km$^2$ (Case and Ellsworth 1991).

In 2005, southern Ellesmere Island from Vendom Fiord south, the same area in this survey, was flown with an adaptive sampling technique, with east-west transects spaced 5 km apart, tightened to 2.5 km where caribou or caribou sign was detected (Jenkins et al. 2011). A ground survey was also conducted from Grise Fiord, primarily on the Bjorne Peninsula and north of the Sydkap Ice Cap – most other areas are not accessible by snowmobile. Ground crews observed 23 groups of 56 muskoxen and 6 dead muskoxen over 1662 km of survey (Jenkins et al. 2011). The aerial survey, May 4-30 2005, recorded 99 groups of muskoxen, totaling 277 1+ year-old animals and 2 newborns, on transect, and an additional 19 groups and 43 muskoxen off transect (Jenkins et al 2011, Government of Nunavut data unpubl.). In addition to the very low proportion of calves in the population (2%), observers reported 40 muskox carcasses during the survey and 2 adult muskoxen near death (Campbell and Hope 2006, Jenkins et al. 2011). Residents of Grise Fiord suggested freezing rain in winter 2002 (Taylor 2005), which may have reduced muskox condition, survival, and reproduction, and also recall ground-fast ice in winter 2005 (Iviq HTA, pers. comm.). The muskox population appears to have recovered from these climatic events, with rapid growth over the last 10 years.

It appears as though caribou have not been abundant on southern Ellesmere Island in recent times, which corroborates local knowledge of caribou distribution and abundance. The first survey of Ellesmere Island, in 1961, recorded 74 caribou (10.8% calves) and suggested 200 caribou present on the entire island (Tener 1963). Tener (1963) noted the low coverage and 'best guess' nature of this estimate, however. Of the observed caribou, most were seen north of the 2015 study area, and only 11 were seen at the head of Baumann Fiord (Tener 1963). The south coast from Grise Fiord to Simmons Peninsula was not surveyed due to weather (Tener 1963). In unsystematic surveys in May and July 1973, Riewe estimated 80 caribou on Bjorne Peninsula, along Sor and Stenkul Fiords, and along Vendom Fiord, and another 15 on Graham and Buckingham islands (Riewe

1973). Case and Ellsworth (1991) estimated 89 ± SE 31 caribou on southern Ellesmere Island, or an average density of 0.0036 caribou/km$^2$. If we include the entire 1989 study area, the caribou density would be slightly higher in 2015, at 0.006 caribou/km$^2$. The error around the estimate of 183 caribou for the 2015 survey is too broad to determine definitively whether the caribou population has increased, decreased, or remained stable since the 2005 survey, which estimated 109-442 caribou (95% CI). However, the pattern over several decades seems to suggest a persistent low density, so it is likely that the population is fairly stable at present.

*Changes in Distribution*

Muskox concentrations have been recorded along Baumann Fiord, Sor and Stenkul Fiords, the flat plain along Vendom Fiord, north of Muskox Fiord and along Norwegian Bay, and at Fram Fiord (Iviq HTA, pers. comm., Tener 1963, Riewe 1973, Case and Ellsworth 1991, Jenkins et al. 2011). Muskoxen were seen in all these areas during the 2015 survey, as well as the two survey attempts in April and August 2014, if the areas were flown.

Riewe (1973) noted some caribou on Graham Island, between Sor and Stenkul fiords, and on the Bjorne Peninsula. Case and Ellsworth (1991) described caribou observations as scattered across the study area, but in 2005 there were some clear concentration areas on Graham and Buckingham islands, northern Bjorne Peninsula, and southeast of Okse Bay. In 2014 and 2015, we saw caribou in the same areas, as well as a group on northern Vendom Fiord. We did not detect any caribou along the south coast, although they were formerly found in the area of Craig Harbor, Fram Fiord, and King Edward Point in the 1950s and 1960s, and occasionally seen there into the 1990s (IQ in Taylor 2005). We only saw one set of tracks south of Piliravijuk Bay, although caribou have been found there previously (IQ in Taylor 2005, Iviq HTA pers. comm.). Grise Fiord residents were also surprised that we did not see caribou at the head of Goose Fiord or Muskox Fiord, since they can usually be found there.

The most notable change in distribution compared to the 2005 survey is the relative lack of caribou and muskoxen on Graham and Buckingham Islands. During the 2005 survey, 50 caribou in 18 groups and 12 muskoxen in 3 groups were seen on Graham and Buckingham Islands. In 2015, we saw 10 caribou in 2 groups and 3 muskoxen in 2 groups. Part of this discrepancy is explained by the adaptive sampling protocol used in 2005; transects were flown 2.5 km apart in 2005 and 5 km apart in 2015. At the time of the 2015 survey, lack of snow had prevented hunters from Grise Fiord from accessing Graham Island, with the exception of one trip to retrieve a broken snowmobile during the survey, so additional information from hunters was not available for Graham Island. Caribou are known to move between islands in regular seasonal movements and when conditions force them (Miller 2002, Miller et al. 2005, IQ in Taylor 2005), and they do move between Graham Island and Bjorne Peninsula (IQ in Taylor 2005, Iviq HTA pers. comm.).

*Calf Recruitment*

The proportion of muskox calves in summer 2014 (24%) was higher than previous summer reports for the area. In 1961 Tener estimated 8% calves for the Bjorne Peninsula, not including solitary muskoxen (Tener 1963). Freeman (1971) suggested 12.5% calves for southern Ellesmere, Graham, and northern Devon islands based on 1965 and 1967 aerial surveys. Freeman (1970) developed a preliminary population model that suggested 10.5% calf production would be required to balance natural mortality for the region. Hubert (1972) surveyed northeast Devon Island in May 1972 and reported 16% calves. Riewe (1973) noted calf crops of 16% in July 1973 on the Bjorne Peninsula and surrounding area. In July 1989, Case and Ellsworth (1991) reported 17.3% calves, but only 7.3% yearlings. Only 2 newborn calves were seen on the 2005 survey (Campbell et al.

2006, Jenkins et al. 2011). The adult:calf ratios for August 2014 (24% calves) and March 2015 (22% calves) suggest high recruitment and good overwinter survival, and 16% short yearlings in April 2014 suggests good recruitment of the previous calf crop, in line with previously recorded recruitment rates for the area.

Lack of observations prevents any conclusions on calf recruitment for Peary caribou. In 1961, Tener (1963) observed 10.8% calves in the area. In July 1973, Riewe (1973) reported 5.5% calves. In July 1989, Case and Ellsworth (1991) reported 22.2% calves of 45 caribou observed, but no yearlings were present. The low yearling crop observed for muskoxen during the same survey suggests there may have been a severe winter that limited calf production and recruitment for both species in 1988. Observations by Grise Fiord hunters of caribou moving from Goose Point to Sherwood Head on Axel Heiberg and 2 dead muskoxen and 1 dead caribou on sea ice west of Bjorne Peninsula (IQ in Taylor 2005), also suggest there may have been an extreme weather event around this time. In 2005, there were no short yearlings seen and only 7% of the classified caribou were yearlings, following unusually snowy winters with icing events (Iviq HTA, pers. comm., Jenkins et al. 2011). Restricted forage access is expected to decrease calf production, since Peary caribou show a direct relationship between late winter fat and fertility (Thomas 1982). At least identifying one short yearling in the few groups we observed in 2015 is an improvement over 2005.

*Group Sizes*

Although there were fewer muskox groups encountered in August, the pattern of smaller group sizes reflects group sizes recorded by other researchers for summer. Muskox groups are largest early in the spring and smaller as summer progresses (Freeman 1971, Gray 1973), with winter (including April and May) groups about 1.7 times larger than summer groups (Heard 1992). Although Heard (1992) noted that group size is not generally related to muskox density, the group size in May 2005, 2.7 muskoxen on average (2.4-3.0 95% CI), was much smaller than the group sizes encountered in April 2014, August 2014, or March 2015. It is possible that the severe starvation conditions had fragmented groups and normal group structure was not observed during the 2005 survey. Group sizes encountered in March 2015 (8.9-12.1 muskoxen/group, 95%CI) were similar to the 10.0 muskoxen/group reported in 1966-1967 (Freeman 1971).

Ferguson (1991) suggested that caribou groups are largest in August and smaller in late winter. Fischer and Duncan (1976) noted that groups across the Arctic islands averaged 4.0 caribou in late winter, 2.8 caribou in early summer, and 8.8 caribou in mid-summer. The lack of observations during any of the 3 survey attempts means we are unable to evaluate any seasonal effect of group size for Peary caribou, but our average group size of 2.6-6.9 caribou (95% CI) is similar to the late winter group sizes encountered by Fischer and Duncan (1976).

The survey conducted by Case and Ellsworth (1991) in July 1989 was in response to observations by Grise Fiord residents of declining caribou populations and increasing muskox populations. It is interesting to note that after a crash in muskox populations in the early 2000s, a similar dynamic may be manifesting on southern Ellesmere again, with relatively few caribou and a muskox population that has increased rapidly over the last decade. The inverse relationship between caribou and muskox abundance has been noted by many communities where Peary caribou and muskoxen are sympatric, but the mechanism explaining this pattern remains unknown (Iviq HTA and Resolute Bay HTA, pers. comm., IQ in Taylor 2005). Furthermore, there appear to be some areas or conditions that permit both species to remain at high densities, as appears to currently be the case on Bathurst and Melville islands (Davison and Williams 2012, Anderson 2014).

**Management Recommendations**

Peary caribou and muskoxen on southern Ellesmere and Graham islands are an important source of country food and cultural persistence for the Inuit of Grise Fiord. Consistent with the Nunavut Land Claim Agreement, and the Management Plan for High Arctic Muskoxen of the Qikiqtaaluk Region, 2012-2017 (DOE 2014), these management recommendations emphasize the importance of maintaining healthy populations of caribou and muskox that support sustainable harvest. The current abundance and good calf recruitment suggests that the muskox population is healthy, and although relatively few caribou were seen, this appears to be fairly normal for the area.

Under the Management Plan (DOE 2014), Ellesmere Island is considered a single management unit, MX-01, with no quota. It is highly recommended that a harvest reporting system be maintained even without a quota in place. This allows biologists, community members, and decision makers to track harvest patterns and changes in wildlife populations over time and to determine whether changes to management zones or harvest restrictions have the desired effect.

Harvest trends for muskoxen over the last decade suggest that Grise Fiord harvests fewer muskoxen than in the 1990s, averaging fewer than 10 tags per year from 2005-2014 (Government of Nunavut Harvest Database, unpubl. data). An unusually high harvest in 2012-13 due to several problem muskoxen in town resulted in the use of 13 tags in what is now MX-01 - less than 0.5% harvest if the population was similar in 2013 to the current 2015 population and if only southern Ellesmere Island and Graham Island are considered (which does not take into account the high muskox populations elsewhere in MX-01, notably the Fosheim Peninsula and Lake Hazen). Hunters can also access the Svendsen and Raanes peninsulas, north of the study area, which are also included in MX-01, and were not surveyed in 2015. 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.

Although we saw only 38 caribou during the survey, the results of previous surveys over the same areas suggest that caribou have persisted at relatively low densities on southern Ellesmere Island for at least as long as they have been regularly hunted from Grise Fiord. There may or may not have been a decline from the 2005 survey, the variation around the estimates is too wide to tell. It is unlikely that harvest restrictions on Peary caribou will result in any marked increase in the population, as harvest is restricted to a small human population with limited access to the caribou range. Increased monitoring of sightings and reporting caribou harvest would provide a more complete picture of where caribou are on the landscape, and could inform population metrics like calf recruitment.

This survey also contributes additional data to the pattern observed by community members, of the inverse relationship between muskox and caribou densities. Although there is general consensus that when some muskox populations are high, sympatric caribou populations are low, the mechanism remains a subject of some debate – the strong smell of the muskoxen is repulsive to caribou, or the muskoxen trample foraging areas and compact the snow, or wolves that hunt the muskoxen have a disproportionate effect on the caribou, or some other factors. Additional research by biologists and IQ holders into this mechanism would be beneficial for informing caribou and muskox management in the High Arctic.

## ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᓕᖁᔭᐅᔪᑦ

ᑐᒃᑐᐃᑦ ᐅᒥᖕᒪᐃᓪᓗ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ ᒍᓈᕼᐊᒻ ᕿᑭᖅᑕᖕᓂ ᐱᓪᓕᕆᐅᕗᑦ ᓂᕿᒃᓴᕆᔭᐅᕙᒃᓱᑎᒃ ᐃᓕᖅᑯᓯᕐᒧᓗ ᐸᐸᑦᑎᔾᔪᑕᐅᓗᓂ ᐃᓄᖕᓄ ᐊᐅᓯᐃᑦᑐᒥ. ᒪᓕᒃᓱᒍᑦ ᓄᓇᕗᒻᒥ ᓄᓇᑖᕐᓂᕐᒧᑦ ᐊᖏᕈᑎ, ᐊᐅᓚᑦᑎᓂᕐᒧᓗ ᐸᕐᓇᐅᑎ ᐅᑭᐅᖅᑕᖅᑑᑉ ᐅᒥᖕᒪᖕᓄ ᕿᑭᖅᑖᓗᖕᒥ, 2012-2017 (ᐊᕙᑎᓕᕆᔨᒃᑯᑦ 2014), ᑕᒪᒃᑯᐊ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᓕᖁᔭᐅᔪᑦ ᓴᖅᑭᔮᖅᑎᑦᑎᕗᑦ ᐱᓪᓕᕆᐅᓂᖓᓂ ᐊᒥᓲᑎᑦᑏᓐᓇᕋᓯᐊᕐᓂᖅ ᑐᒃᑐᓂᑦ ᐅᒥᖕᒪᖕᓂᓗ ᐊᖑᓇᓱᒃᑕᐅᖃᑦᑕᐃᓐᓇᑯᓐᓇᖁᓕᕐᓗᒋᑦ. ᒫᓐᓇᐅᔪᖅ ᐊᒥᓲᑎᒋᓂᖕᒥ ᓄᕐᕋᖃᐅᑦᑎᐊᕐᓂᖕᒋᓗ ᓇᓗᓇᐃᖅᐳᖅ ᐅᒥᖕᒪᑦ ᐅᓄᖅᑎᒋᓂᖕᒥᒃ ᖃᓄᐃᖕᒋᑎᐊᕐᓂᖕᓕᓂ, ᑭᓯᐊᓂᑦ ᑕᐅᖅ ᐊᒥᓲᖕᒋᑐᓂᒃ ᑐᒃᑐᓂᑦ ᑕᑯᓚᐅᕋᓗᐊᖅᑎᓪᓗᒋᑦ, ᑕᒪᓐᓇ ᖃᐅᔨᓴᕐᕕᐅᔪᖅ ᑕᐃᒪ ᐃᒐᔪᒃᑐᖅ.

ᐊᐅᓚᑦᑎᓂᕐᒥᑦ ᐸᕐᓇᐅᑎᑎᒍᑦ (ᐊᕙᑎᓕᕆᔨᒃᑯᑦ 2014), ᐅᒥᖕᒪᑦ ᓄᓈ ᑕᐅᑐᒃ ᑕᐅᕗᖅ ᐊᑕᐅᓯᖅᑐᑦ ᐊᐅᓚᑕᐅᔭᓇᐊᓕᒃᑐᑦ, MX-01, ᓂᕕᖕᖔᑯᑕᒃ ᑰᖕᒋᑐᖅ. ᐊᑐᖁᔮᓪᒪᓇᒃᐳᑦ ᐊᖑᓇᓱᒃᑕᐅᕙᒃᑐᓄᑦ ᐅᓂᒃᑳᕈᑎᒥᒃ ᓂᕕᖕᖔᑯᑕᒃ ᑰᖕᒋᑲᓗᐊᖅᑎᓪᓗᒋᑦ. ᑕᐃᒪ ᐃᑎᓪᓗᒍᑦ ᓂᕐᔪᑎᓂᒃ ᖃᐅᔨᓴᖅᑏᑦ, ᓄᓇᓕᖕᓂᕐᒥᐅᑦ, ᐃᓯᒪᓕᐅᑎᔩᓪᓗ ᓇᐅᑦᑎᖅᓯᕈᓇᕐᓂᐊᖅᑐᑦ ᐊᖑᓇᓯᑉᕕᐅᕙᒃᑐᓂᑦ ᐊᓯᔾᔨᖅᐸᓕᓕᐊᔪᓂᓪᓗ ᐊᒥᓲᑎᒋᖕᓂ ᖃᑯᒧᙵᐸᓕᓕᐊᑎᓪᓗᒍᑦ ᓇᓗᓇᐃᕐᓗᑎᓪᓗ ᐊᓯᔾᔨᖅᑐᑦ ᐊᐅᓚᑦᑎᔾᔪᑕᐅᔪᓄᑦ ᐊᖑᓇᓯᒃᑕᐅᕙᒃᑐᓂᓪᓘᓐᓃᑦ ᑭᓪᓕᖅᑯᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᐊᑑᑎᓂᖃᕐᒪᖔᑦ.

ᐊᖑᓇᓱᖕᓂᐅᕙᒃᑐᑦ ᐅᒥᖕᒪᖕᓂᑦ ᐊᕐᖁᒧᑦ ᖁᓕᐅᕌᖅᑐᓄᑦ ᓇᓗᓇᐃᖅᐳᖅ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᐅᒥᖕᒪᒃ ᐸᖕᖔᓂᐊᖅᓴᓕᕐᓂᖕᒋᓂᒃ ᑕᐃᒪᙵ 1990-ᖕᒋᓂᑦ, ᖁᓕᑦ ᑐᖕᓖᓂ ᓂᕕᖕᖔᑯᑕᓂᒃ ᐊᑐᖅᑐᖅᑲᖅᐸᒃᓱᓂ 2005-ᒥᑦ 2014-ᒧᑦ (ᓄᓇᕗᑦ ᒐᕙᒪᒃᑯᑦ ᐊᖑᓇᓱᒃᑕᐅᕙᒃᑐᓄᑦ ᑎᑎᖅᑲᖁᑎᖏᑦ, ᓴᖅᑭᑕᐅᓯᒪᖕᒋᑐᑦ ᑎᑎᖅᑲᑦ). ᐅᓄᕐᔩᒥᓪᓗᑎᒃ ᐊᖑᓇᓱᒃᑕᐅᔪᑦ 2012-13-ᒥᑦ ᐱᓪᓗᒋᑦ ᐊᒥᓱᑦ ᐊᑲᐅᙱᐅᕈᑏᑦ ᐅᒥᖕᒪᑦ ᓄᓇᓕᖕᓄᐊᖅᑕᕐᓂᖕᒋᓄᑦ ᐊᑐᕈᑕᐅᓕᓚᐅᖅᐳᖅ 13-ᓂᒃ ᓂᕕᖕᖔᑯᑕᓂᑦ ᑕᐃᔭᐅᓕᖅᑐᒥᑦ MX-01 - 0.5% ᑐᖕᓖᓂ ᐊᖑᔭᐅᓇᔭᖅᑐᑦ ᐅᓄᖅᑎᒋᓂᖕᒥᒃ ᐊᔾᔨᖃᓚᐅᕈᑎᒃ 2013-ᒥᑦ ᒫᓐᓇᐅᔪᖅ 2015-ᒥᑦ ᐅᓄᖅᑎᒋᓂᖕᒥᒃ ᐊᒻᒪᓗ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂᕐᒥᐅᑦ ᒍᓈᕼᐊᒻᓗ ᕿᑭᖅᑕᖕᓂ ᐃᓯᒪᒋᔭᐅᒍᑎᒃ (ᐃᓚᓕᐅᔾᔨᓯᒪᖕᒋᑐᖅ ᐅᒥᖕᒪᑲᓪᓚᖕᓂᑦ MX-01-ᒥᕈᔪᒃ, ᐱᓗᐊᖕᖑᐊᖅᑐᒥᑦ ᖃᔅᓴ ᐃᓪᒥ ᕼᐋᓯᓐᓗ ᑕᓯᐊᓂ). ᐊᖑᓇᓱᒃᑏᑦ ᑉᕕᓐᓴᓐᑰᕈᓐᓇᕐᒥᔪᑦ ᕋᓐᑯᓪᓗ, ᖃᐅᔨᓴᕐᕕᔫᑉ ᐅᐊᖕᓇᖕᓂ, ᐱᖅᑯᓯᐅᑉᔭᐅᓯᒪᔪᑦ MX-01-ᒥᑦ, ᖃᐅᔨᓴᖅᑕᐅᓚᐅᕋᑎᓪᓗ 2015-ᒥᑦ. ᓄᓇᓕᖕᓂ ᖃᐅᔨᒪᔭᐅᔪᑦ ᐊᒻᒪ ᑭᖑᓂᑦᑎᓐᓂ ᖃᐅᔨᓴᖅᑕᐅᓂᑯᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᓯᒪᕗᑦ, ᐅᓄᖅᑎᒋᓂᖕᒥᒃ ᐊᓯᔾᔨᑳᓚᒍᓐᓇᖅᑐᑦ ᓂᕆᐅᓇᖕᖏᑐᒃᑯᓪᓗ ᓯᓚᕈᔪᒃ ᖃᓂᒋᔭᖕᓕᓂ ᓇᓂᑯ ᓄᔭᕐᓘᓐᓃᑦ ᐱᕐᓕᓕᕈᑕᐅᔪᓐᓇᖅᑐᖅ ᓅᒃᑕᐅᔪᓐᓇᖅᑐᕐᓘᓐᓃᑦ, ᑕᐃᒪᐃᓪᒪᑦ ᓇᐅᑦᑎᖅᓯᐃᓐᓇᕐᓂᖅ ᐊᓯᔾᔩᖅᑎᑦᑐᓂᕐᓗ ᐊᐅᓚᑦᑎᔾᔪᑎᓂᒃ ᐱᓪᓕᕆᐅᕗᑦ.

38-ᖕᒋᓇᕐᓂᑦ ᑕᑯᓚᐅᕋᓗᐊᖅᑎᓪᓗᑕ ᑐᒃᑐᓂᒃ ᖃᐅᔨᓴᖅᑎᓪᓗᑕ, ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᑭᖑᓂᑦᑎᓐᓂᒃ ᖃᐅᔨᓴᕈᑕᐅᓯᒪᔪᓂᒃ ᑕᐃᑲᓂᑦ ᓴᐃᓐᓇᖅ ᓇᓗᓇᐃᖅᐳᖅ ᑐᒃᑐᐃᑦ ᐊᒥᓲᖅᑕᖕᒋᓂᒃ ᐅᒥᖕᒪᑦ ᓄᓈᑦᑕ ᓂᒋᐊᓂ ᑕᐃᒪᙵᐊᖑᓇᓱᒃᑕᐅᖃᑦᑕᕐᒪᑕ ᐊᐅᓯᐃᑦᑐᕐᒥ. ᐅᓄᕈᓐᓃᓕᑐᐃᓐᓇᓇᓄᐊᖅᓚᓕᐅᖅᑐᑦ 2005-ᒥᑦ ᖃᐅᔨᓴᕐᓂᐅᔪᒥᑦ, ᐊᔾᔨᒌᖕᒋᓂᖕᒋ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᒥᑦ ᐊᔾᔨᒌᙳᐊᖅᐳᑦ ᓇᓗᓇᐃᑎᐊᒃᓴᓴᖅ. ᐊᖑᓇᓱᖕᓂᕐᒧᑦ ᑭᓪᓕᖅᑯᖅᑎᑦᑎᓂᖅ ᑐᒃᑐᓂᑦ ᐅᓄᖅᓯᕗᓕᖅᑎᑦᑎᓇᔭᖅᑰᖕᒋᑲᓗᐊᖅᓱᓂ, ᐊᖑᓇᓱᖕᓂᖅ ᑭᓪᓕᖅᑎᑕᐅᕋᓂᒃ ᑲᒥᑦ ᐃᓄᑭᓐᓂᐅᔪᒧᑦ ᐱᕕᑭᔅᓱᑎᒃ ᑐᒃᑐᓕᖕᓄ. ᓇᐅᑦᑎᖅᓯᔩᒥᓕᕐᓂᖅ ᑕᑯᔭᐅᕙᒃᑐᓂᑦ ᐅᓂᒃᑲᐅᓯᖃᖃᑦᑕᕐᓂᕐᓗ ᑐᒃᑐᑕᐅᕙᒃᑐᓂᑦ ᓇᓗᓇᐃᑭᑕᐅᒃ ᐄᒥᓇᔭᖅᐳᖅ ᑐᒃᑐᑦ ᓇᓃᓪᒪᖕᒋ ᓄᓇᒥᑦ, ᑐᑭᓯᓇᕈᑕᐅᔪᖅ ᓇᓇᓕᓪᑐᓂ ᓯᕐᓗᖃᓄᖅ ᓄᕐᕋᖃᖅᑎᒥᒪᓕᕐ.

ᑖᓐᓇ ᖃᐅᔨᓴᕐᓂᖅ ᐃᓚᓕᐅᔾᔭᐅᑎᑦᑎᓯᒪᕗᖅ ᑎᑎᖅᑲᓂᒃ ᖃᓄᐃᑉᐸᓪᓕᐊᓂᓇᔭᐅᕙᒃᑐᓂᒃ ᑕᐅᑐᒃᑕᐅᕙᒃᑐᑦ ᓄᓇᓕᖕᓂᕐᒥᐅᓂ, ᖃᓄᐃᖅᑲᑎᑮᑉᐸᖕᒪᖕᒋ ᐅᒥᖕᒪᑦ ᑐᒃᑐᐃᓪᓗ. ᑐᑭᓯᓇᕐᓂᖕᒪ ᐊᖕᖏᑕᐅᓯᒪᒐᓗᐊᖅᓲᓂ ᐅᒥᖕᒪᒃ ᑕᐅᖅᑲᐅᕌᖕᒋ, ᑐᒃᑐᐃᑦ ᐊᒥᓲᕙᖕᖑᓂᖕᒋᓂ, ᐊᐅᓚᓂᓇᔭᖕᒐᓱᓕ ᐅᖅᑲᐅᓯᐅᖅᑲᑦᑕᖅᐳᖅ – ᐅᒥᖕᒪᒃ ᓴᓐᓂᓗᐊᕐᓂᖅ ᒪᒪᓇᔭᐅᙵᖅ ᑐᒃᑐᓂᑦ, ᐅᒥᖕᒪᐃᑦ ᑐᖕᒪᖅᑕᖕᒋ ᓂᕿᖃᖅᕕᐅᕙᒃᑐᓂᑦ ᑎᓯᒃᓴᐅᑕᐅᓂᖕᒋᐊᐳᒻᒥ, ᐊᒪᖅᑯᓪᓘᓐᓃᑦ ᐅᒥᖕᒪᒐᓱᑉᐸᒃᑐᑦ ᐊᔅᓴᕿᖕᒋᑐᓂᒃ ᐊᒃᑑᑎᕗᑦ ᑐᒃᑐᓄᑦ, ᐊᓯᖕᒋᑑᓐᓅᑦ ᖃᓄᐃᒃᔪᑕᐅᔪᑦ. ᖃᐅᔨᓴᕈᑕᐅᒃᑲᓐᓂᖅᑐᑦ ᐆᒪᔭᓂᒃ

ᖃᐅᔨᓴᖅᑎᓂᑦ ᐊᒻᒪ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂ ᐱᖃᖅᑎᐅᖃᑕᐅᔪᓂᑦ ᑕᒪᑐᒧᖓ ᐊᐅᓚᓂᕆᔭᖕᓄ ᐊᑑᑎᓇᔭᖅᑐᖅ ᑐᑭᓯᑦᓯᐊᕈᑕᐅᓗᑎᒃ ᑐᒃ ᑐᓂᑦ ᐅᒥᖕᒪᖕᓂᓪᓗ ᐊᐅᓚᑦᑎᔅ ᔪᑎᒃ ᓴᓂᑦ ᖁᑦᑎᒃ ᑐᖅ ᐅᑭ ᐅᖅᑕᖅᑐᒥᑦ.

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## Appendix 1. Summary of partial survey conducted by helicopter in April 2014.

### Methods – April Helicopter Survey

Survey transects approximately followed transects established for the 2005 distance sampling helicopter survey parallel to lines of latitude at 5-km spacing. The April survey was designed to follow the same methodology as the 2005 survey (helicopter distance-sampling, Buckland et al. 2001, Jenkins et al. 2011). Transects were flown at 150 km/hr (81 kts) with a Bell 206 helicopter. Surveys were only conducted on days with good visibility and high contrast to facilitate detection of animals, tracks, and feeding craters, as well as for operational reasons to ensure crew safety. Flight height was set at 400' (122 m). The April survey was flown with one pilot, 1 front observer/navigator, and 2 rear observers.

All observations of wildlife and fresh tracks were marked on a handheld Garmin Montana 650 GPS unit, which also recorded the flight path with positions taken every 30 seconds. During the helicopter survey, we circled groups and marked their exact locations, but the Twin Otter did not approach groups. Sex and age classification was limited to adult/short yearling/newborn calf. Only one newborn muskox was seen in April, on April 24. In April, because the survey was prior to caribou calving, smaller body size and shorter faces on caribou were the primary distinguishing features of young of the year (10-month-old calves/short yearlings). In August, calves were obvious by small body size and we did not attempt to distinguish yearlings. GPS tracks and waypoints were downloaded through DNR Garmin and saved in Garmin GPS eXchange Format, Google Keyhole Markup Language, and as ESRI shapefiles. Data was entered and manipulated in Microsoft Excel spreadsheets.

Small ferry flights (flights linking consecutive transects) were removed for population analysis, although survey speed and height were maintained and all observations recorded as if on survey. Similarly, sections of transect crossing inlets and between islands were removed since density calculations are based on land area only.

Since the survey was not completed, nor did it cover a reasonable unit for which a population estimate could be calculated, no population estimate was derived. The survey was structured to have data analyzed in Distance 6.0 (Thomas et al. 2009, available from http://distancesampling.org/), with distance to transects calculated for each observation using the Euclidean Distance function in ArcMap 10 (ESRI, Redlands, CA). Conventional distance sampling for line transect data would have been used, with detection function curves, following Buckland et al. (2001). The detection function $\hat{g}(x)$ is the probability of detecting a cluster of animals given its perpendicular distance from the transect line, and $\hat{P}_\alpha$ is the probability that a cluster is detected:

$$\hat{P}_\alpha = \frac{\int_0^w \hat{g}(x)dx}{w}$$

The effective strip width (ESW) is the distance at which as many clusters are detected beyond it as are missed within it (Buckland et al. 2001). The ESW can be substituted for $w\hat{P}_\alpha$ to calculate density, where *n* is the number of clusters observed and *L* is the transect length:

$$\hat{D} = \frac{n}{(2wL\hat{P}_\alpha)}$$

Since each cluster represents one or several animals, $\widehat{D}$ is multiplied by the average cluster size to obtain the density, *D*. The cluster size likely influenced detection function as well – where size bias was present, it can be incorporated into the regression; where size bias was not present, the average cluster size can be used.

### Results – April Helicopter Survey

We attempted the survey from April 1-25, but the helicopter was delayed in Pond Inlet until April 9. We flew transects by helicopter on April 12, 13, 16, 20, and 24, 2014 for a total of 3,340 km (1,899 km on transect). Visibility was excellent for all survey flights with clear skies (visual estimates of <10% cloud) and high contrast. We observed 311 muskoxen in 33 groups (Figure 8), including 42 short yearlings (11 months old), making up 15.6% of the population. The only newborn calf was observed on April 24, 2014. Of the 33 groups seen, group size averaged 9.4 including short yearlings (6.8-12.0 95% CI), or 8.2 adults (5.8-10.5 95% CI) (Figure 9).

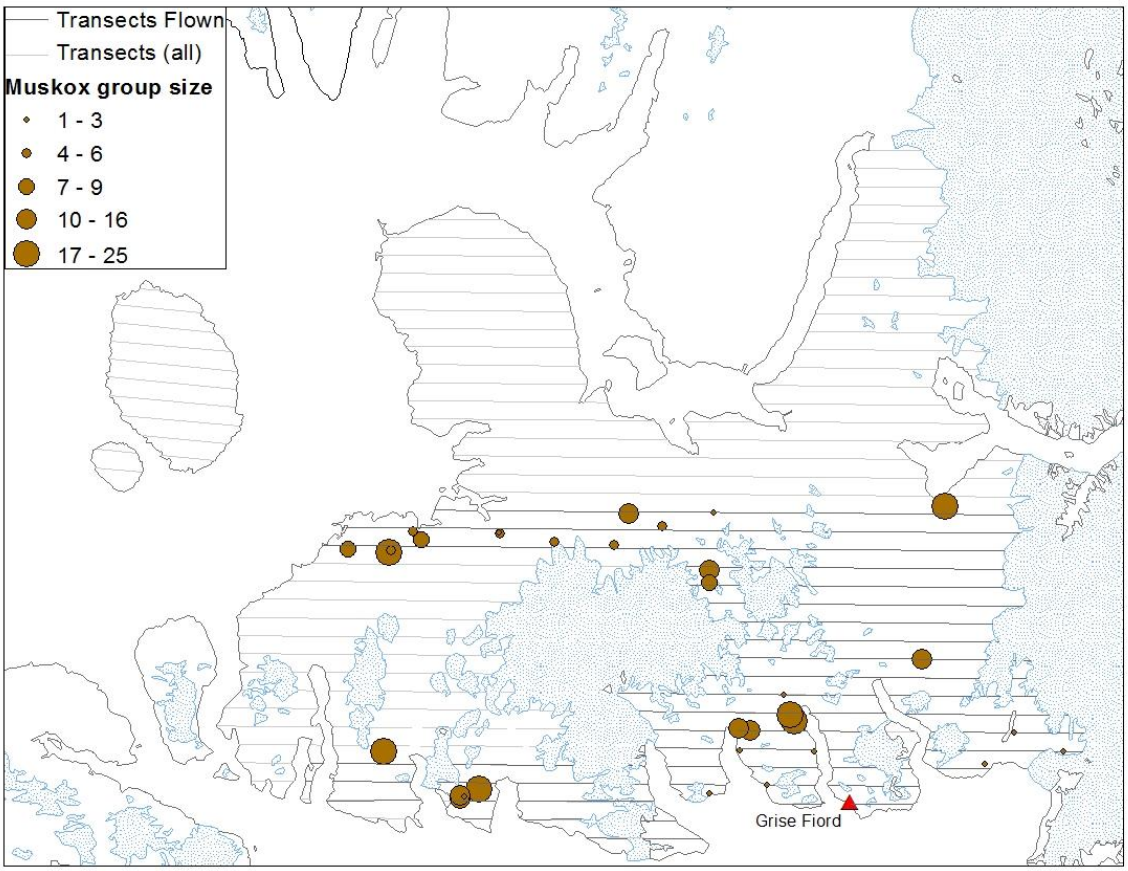


Figure 8. Observations of muskox April 12-24, 2014, totaling 311 muskoxen in 33 groups, on helicopter distance-sampling survey of southern Ellesmere Island. No caribou were observed.

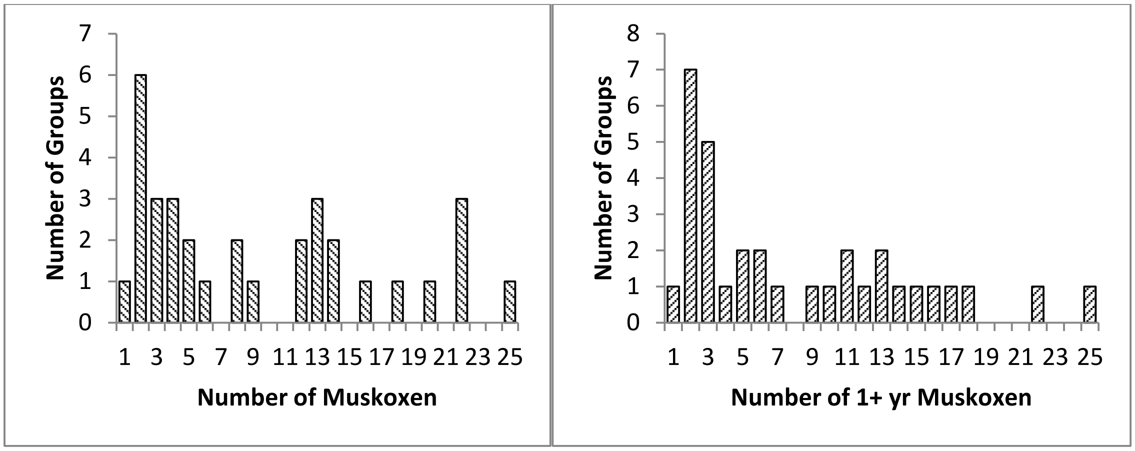

Figure 9. Histograms showing group size including short yearlings and including 1+ year-old animals only for 33 muskoxen groups observed on southern Ellesmere Island in April 2014.

**Daily Flight Summaries**

**12 APRIL 2014**
Grise Fiord, South Ellesmere
Transects 48, 49, 50, 57 (part), 58, 59, 60, 61
Track file: 12Apr2014.shp/kml/gpx
Waypoint file: SEllemsere_12Apr2014.shp/kml/gpx

Aircraft: Bell 206LR F-PHO
Pilot: Darryl Hefler
Navigator/Recorder: Morgan Anderson
Observers: Adrian Kakkee, Eepa Ootoovak

Weather mostly calm and clear with light breeze (strong at ground level off the ice cap). Saw 1 polar bear, 75 muskox – several large groups. 1 set of wolf tracks up a valley. Fog west towards Hell Gate and wind off ice caps in the east.

Flight times: 09:20-11:42; 12:00-14:28; 15:15-16:36. Refuel in Grise Fiord.

**13 APRIL 2014**
Sydkap Ice Cap, South Ellesmere
Transects 51, 52, 53, 54, 55, 56, 57 (part); 35, 36, 51 between ice caps
Track file: 13Apr2014.shp/kml/gpx
Waypoint file: SEllemsere_13Apr2014.shp/kml/gpx

Aircraft: Bell 206LR F-PHO
Pilot: Darryl Hefler
Navigator/Recorder: Morgan Anderson
Observers: Adrian Kakkee, Eepa Ootoovak

Weather mostly calm and clear with ice crystals over the fiords. Polar bear track in valley up onto ridge, 1 set of caribou tracks seen. 35 muskox seen.

Flight times: 13:27-16:02; 16:18-18:39. Refuel at Sydkap cache.

**16 APRIL 2014**
Sydkap Ice Cap, South Ellesmere
Transects East part of 51, 36, 35, 34
Track file: 16Apr2014.shp/kml/gpx
Waypoint file: SEllemsere_16Apr2014.shp/kml/gpx

Aircraft: Bell 206LR F-PHO
Pilot: Darryl Hefler
Navigator/Recorder: Morgan Anderson
Observers: Josh Kilabuk, Jaypetee Akeeagok

Morning cloudy clearing in afternoon, still hazy to north and west. Turned back early due to wind. Saw no wildlife.

Flight times: 15:04-16:34; 16:55-18:16. Refuel at Sydkap cache.

**20 APRIL 2014**
North of Sydkap Ice Cap, South Ellesmere
Transects 34, 33, part 32
Track file: 20Apr2014.shp/kml/gpx
Waypoint file: SEllemsere_20Apr2014.shp/kml/gpx

Aircraft: Bell 206LR F-PHO
Pilot: Darryl Hefler
Navigator/Recorder: Morgan Anderson
Observers: Morgan Anderson, Garland Pope

Weather clear and calm, -15°C. Saw 82 muskox.
Flight times: 15:55-18:20; 18:35-19:31; 19:47-20:11. Refuel at Sydkap cache.

**24 APRIL 2014**
Okse Bay, South Ellesmere
Transects 32, 46, 47
Track file: 24Apr2014.shp/kml/gpx
Waypoint file: SEllemsere_24Apr2014.shp/kml/gpx

Aircraft: Bell 206LR F-PHO
Pilot: Darryl Hefler
Navigator/Recorder: Morgan Anderson
Observers: Josh Kilabuk, Jaypetee Akeeagok, Mark Akeeagok

Wind 2 kts, -13°C, clear. Fuel pump issues at Okse Bay cache so returned to refuel in Grise Fiord. Engineer couldn't find anything wrong with fuel pump when checking drums at the airport – must have been vapor lock. Swapped observers and did a short trip along Jones Sound before wind picked up (some muskox groups seen previously from other survey lines).

Flight times: 11:10-12:28; 12:52-13:58; 14:50-16:51 Opened 1 drum at Okse cache but unable to pump it.

**Appendix 2. Summary of partial survey conducted August 2014.**

**Methods – August Fixed-wing Survey**

Survey methodology for the August fixed-wing survey was the same as that described for the March 2015 fixed-wing survey. However, we stratified the survey area to fly every second transect in the area north of Grise Fiord and east of the Sydkap Ice Cap (10-km transect spacing) since no caribou and few muskoxen had been observed there in April. We may have reflown that area if there was a marked seasonal distribution of muskoxen - unfortunately the limited seasons in which residents of Grise Fiord can access many of their hunting areas also meant local knowledge was not always available.

**Results – August Fixed-wing Survey**

We attempted to fly the survey area August 2-9, but were delayed due to weather and flew August 11-21. However, fog and wind continued to be an issue, and besides a brief flight on August 13 (593 km, 73 km on transect), we only flew 1 full day, August 15 (1865 km, 1259 km on transect). We saw 88 muskoxen in 20 groups, including 23 calves – 23.9% of the population (Figure 10). Group size was also significantly smaller than in April (t-test for unequal variances based on adult muskoxen only, p=0.001, df=48), with an average of the 20 groups observed being 4.4 muskoxen (2.6-6.2 95% CI) or 3.6 adult muskoxen (2.2-4.9 95% CI) (Figure 11).

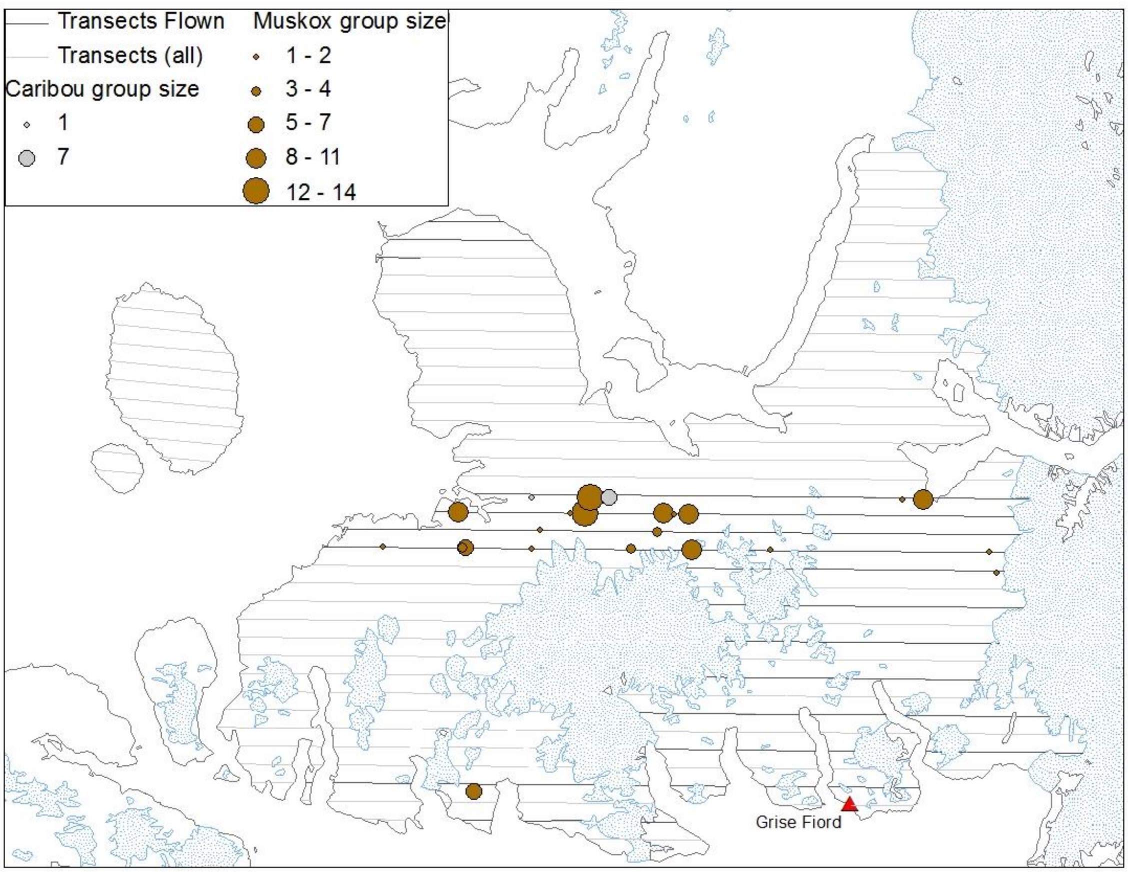


Figure 10. Observations of muskox August 15, 2014, totaling 88 muskoxen in 20 groups and 8 caribou in 2 groups, on Twin Otter fixed-width strip survey of southern Ellesmere Island.

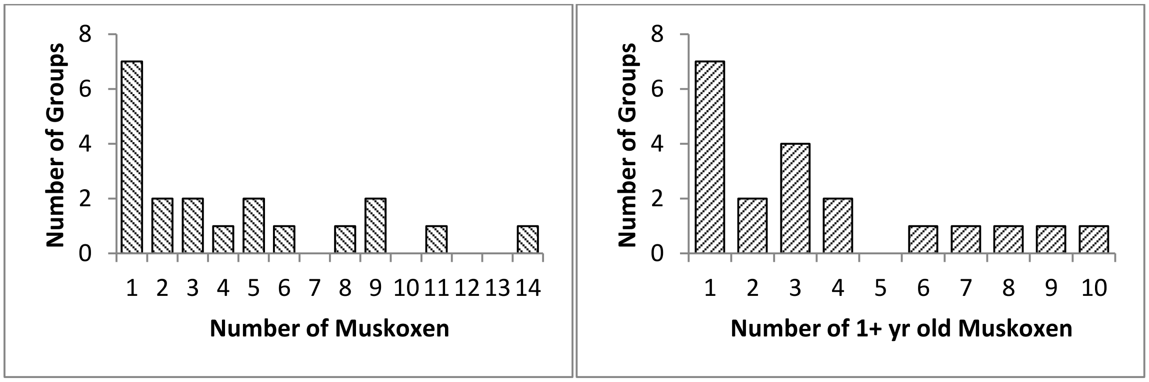

Figure 11. Histograms showing group size including short yearlings and including 1+ year-old animals only for 20 muskoxen groups observed on southern Ellesmere Island in August 2014.

### Daily Flight Summaries

**13 AUGUST 2014**
Graham Island, Bjorne Peninsula
Transects 1, 2, 3
Track file: track_13aug14.shp/kml/gpx
Waypoint file: wpts_13aug14.shp/kml/gpx

Aircraft: Twin Otter F-KBG
Pilots: Terry Welch, Sebastien Trudel
Navigator/Recorder: Morgan Anderson
Observers: Etuangat Akeeagok, Eepa Ootoovak

Overcast at Grise Fiord with light wind from south. Ceiling dropping as day went on from 500' at Okse Bay down to 200' at Bjorne Peninsula until we were flying at 20' and had to turn back. 1 polar bear on Graham Island and a herd of 263 arctic hares on Bjorne Peninsula.
Flight times: 13:25-16:00.

**15 AUGUST 2014**
Grise Fiord, South Ellesmere
Transects 49, 47, 61, 59, 57, 55, 53, 51, 35, 34, 33, 32, 31
Track file: track_15aug14.shp/kml/gpx
Waypoint file: wpts_15aug14.shp/kml/gpx

Aircraft: Twin Otter F-KBG
Pilots: Terry Welch, Sebastien Trudel
Navigator/Recorder: Morgan Anderson
Observers: Etuangat Akeeagok, Tim Hall

Sunny and clear with some cloud in the east moving in, ceiling about 4000'. Saw 88 muskoxen, 8 caribou.
Flight times: 09:07-13:25; 14:00-19:50; 20:30-21:00. Refuel and pack out drums from Makinson Inlet cache.

**Appendix 3. South Ellesmere Island survey transects, 2014-2015.**

Table 4. Transect end points and general locations on southern Ellesmere Island, Graham Island, Buckingham Island, and North Kent Island for a Peary caribou and muskox survey in April 2014, August 2014, and March 2015.

| Transect | Location | Longitude West End | Latitude West End | Longitude East End | Latitude East End | Flown Apr? | Flown Aug? | Flown Mar? |
|---|---|---|---|---|---|---|---|---|
| 1 | Bjorne Peninsula | -87.63447 | 77.86272 | -86.73525 | 77.86813 | | Y | Y |
| 2 | Bjorne Peninsula | -88.10144 | 77.81358 | -86.38718 | 77.82430 | | Y | Y |
| 3 | Bjorne Peninsula | -88.21828 | 77.76728 | -86.17769 | 77.77975 | | Y | Y |
| 4 | Bjorne Peninsula | -88.15352 | 77.72272 | -86.09019 | 77.73481 | | | Y |
| 5 | Bjorne Peninsula | -88.20685 | 77.67702 | -85.97389 | 77.68989 | | | Y |
| 6 | Bjorne Peninsula | -88.16799 | 77.63222 | -85.91615 | 77.64484 | | | Y |
| 7 | Bjorne Peninsula | -87.95133 | 77.58906 | -85.87106 | 77.59977 | | | Y |
| 8 | Bjorne Peninsula | -87.81693 | 77.54505 | -85.83368 | 77.55468 | | | Y |
| 9 | Bjorne Peninsula | -87.67639 | 77.50104 | -85.80916 | 77.50957 | | | Y |
| 10 | Bjorne Peninsula | -87.71097 | 77.45559 | -85.72368 | 77.46451 | | | Y |
| 11 | Bjorne Peninsula | -87.76401 | 77.40998 | -85.47639 | 77.41946 | | | Y |
| 12 | Sor Fiord | -87.70839 | 77.36527 | -81.15694 | 77.33925 | | | Y |
| 13 | Vendom Fiord | -83.73859 | 77.41373 | -81.58975 | 77.39114 | | | Y |
| 14 | Vendom Fiord | -83.82041 | 77.45940 | -81.78288 | 77.43910 | | | Y |
| 15 | Vendom Fiord | -83.42168 | 77.50181 | -81.23609 | 77.47629 | | | Y |
| 16 | Vendom Fiord | -83.30973 | 77.54610 | -81.08733 | 77.51917 | | | Y |
| 17 | Vendom Fiord | -83.18055 | 77.59020 | -81.61272 | 77.57242 | | | Y |
| 18 | Vendom Fiord | -83.08156 | 77.63453 | -81.19908 | 77.61148 | | | Y |
| 19 | Vendom Fiord | -82.97330 | 77.67873 | -81.49649 | 77.66122 | | | Y |
| 20 | Vendom Fiord | -82.89174 | 77.72315 | -81.44469 | 77.70571 | | | Y |
| 21 | Vendom Fiord | -82.82779 | 77.76773 | -81.67575 | 77.75424 | | | Y |
| 22 | Vendom Fiord | -82.75438 | 77.81220 | -81.72205 | 77.80010 | | | Y |
| 23 | Vendom Fiord | -82.64875 | 77.85633 | -81.60740 | 77.84376 | | | Y |
| 24 | Vendom Fiord | -82.61015 | 77.90112 | -81.46311 | 77.88695 | | | Y |
| 25 | Vendom Fiord | -82.54402 | 77.94563 | -81.54255 | 77.93333 | | | Y |
| 26 | Vendom Fiord | -82.55925 | 77.99098 | -81.47106 | 77.97755 | | | Y |
| 27 | Vendom Fiord | -82.41491 | 78.03464 | -81.72545 | 78.02630 | | | Y |
| 28 | Sor Fiord | -87.10957 | 77.32436 | -81.45119 | 77.29861 | | | Y |
| 29 | Sor Fiord | -87.22732 | 77.27847 | -80.80488 | 77.24276 | | | Y |
| 30 | Okse Bay | -87.14461 | 77.23384 | -80.88482 | 77.19888 | | | Y |
| 31 | Okse Bay | -86.95900 | 77.18976 | -80.91725 | 77.15417 | | Y | Y |
| 32 | Okse Bay | -87.41053 | 77.14174 | -80.95440 | 77.10954 | Y | Y | Y |
| 33 | Okse Bay | -88.41144 | 77.08742 | -80.88911 | 77.06313 | Y | Y | Y |
| 34 | Okse Bay | -88.64246 | 77.03956 | -81.07619 | 77.02108 | Y | Y | Y |
| 35 | Okse Bay | -88.76076 | 76.99291 | -81.09787 | 76.97618 | Y | Y | Y |

| Transect | Location | Longitude West End | Latitude West End | Longitude East End | Latitude East End | Flown Apr? | Flown Aug? | Flown Mar? |
|---|---|---|---|---|---|---|---|---|
| 36 | Okse Bay | -88.99815 | 76.94463 | -81.12122 | 76.93131 | Y | | Y |
| 37 | Okse Bay | -89.28209 | 76.89543 | -86.41150 | 76.92134 | | | Y |
| 38 | Hell Gate | -89.52179 | 76.84659 | -86.78557 | 76.87461 | | | Y |
| 39 | Hell Gate | -89.50189 | 76.80165 | -86.50905 | 76.83068 | | | Y |
| 40 | Hell Gate | -89.46363 | 76.75700 | -86.60392 | 76.78515 | | | Y |
| 41 | Hell Gate | -89.44504 | 76.71205 | -86.70739 | 76.73954 | | | Y |
| 42 | Hell Gate | -89.41607 | 76.66726 | -86.46522 | 76.69541 | | | Y |
| 43 | Hell Gate | -89.58928 | 76.61929 | -85.86393 | 76.65183 | | | Y |
| 44 | Hell Gate | -89.65093 | 76.57305 | -85.89644 | 76.60664 | | | Y |
| 45 | Hell Gate | -89.39647 | 76.53185 | -86.22186 | 76.56078 | | | Y |
| 46 | Hell Gate | -89.37060 | 76.48701 | -85.82347 | 76.51646 | Y | | Y |
| 47 | Hell Gate | -89.23670 | 76.44380 | -85.59824 | 76.47151 | Y | | Y |
| 48 | South Cape | -88.69421 | 76.40607 | -84.97882 | 76.42585 | Y | | Y |
| 49 | South Cape | -88.03612 | 76.36841 | -84.72207 | 76.38004 | Y | Y | Y |
| 50 | South Cape | -85.66961 | 76.33605 | -84.45351 | 76.33392 | Y | | Y |
| 51 | Sydkap Ice Cap East | -84.35379 | 76.92041 | -80.91082 | 76.88241 | Y | Y | Y |
| 52 | Sydkap Ice Cap East | -84.03205 | 76.87364 | -81.25458 | 76.84301 | Y | | Y |
| 53 | Sydkap Ice Cap East | -84.16772 | 76.82922 | -81.29792 | 76.79847 | Y | Y | Y |
| 54 | Sydkap Ice Cap East | -84.05603 | 76.76347 | -81.33347 | 76.75379 | Y | | Y |
| 55 | Sydkap Ice Cap East | -84.40423 | 76.74004 | -81.44148 | 76.71028 | Y | Y | Y |
| 56 | Sydkap Ice Cap East | -85.35577 | 76.69719 | -80.83927 | 76.65471 | Y | | Y |
| 57 | Sydkap Ice Cap East | -85.12552 | 76.65182 | -80.71679 | 76.60719 | Y | Y | Y |
| 58 | Sydkap Ice Cap East | -84.96454 | 76.60639 | -80.36300 | 76.55497 | Y | | Y |
| 59 | Grise Fiord | -84.94742 | 76.56121 | -80.38464 | 76.51010 | Y | Y | Y |
| 60 | Grise Fiord | -84.82892 | 76.51578 | -81.38498 | 76.48313 | Y | | Y |
| 61 | Grise Fiord | -84.79307 | 76.47054 | -82.14173 | 76.44914 | Y | Y | Y |
| 62 | Grise Fiord | -83.64674 | 76.41956 | -82.21794 | 76.40494 | Y | | Y |
| 63 | King Edward Point | -80.32850 | 76.28240 | -80.08014 | 76.27710 | | | |
| 64 | King Edward Point | -80.70348 | 76.24464 | -80.10151 | 76.23224 | | | |
| 65 | King Edward Point | -81.08990 | 76.20656 | -80.44681 | 76.19423 | | | |
| 66 | King Edward Point | -81.06136 | 76.16078 | -80.90309 | 76.15787 | | | |

| Transect | Location | Longitude West End | Latitude West End | Longitude East End | Latitude East End | Flown Apr? | Flown Aug? | Flown Mar? |
|---|---|---|---|---|---|---|---|---|
| 67 | Graham Island | -90.94404 | 77.63906 | -90.65056 | 77.63938 | | | Y |
| 68 | Graham Island | -91.20496 | 77.59320 | -90.19494 | 77.59394 | | | Y |
| 69 | Graham Island | -91.20271 | 77.54789 | -90.01941 | 77.54837 | | | Y |
| 70 | Graham Island | -91.21067 | 77.50254 | -89.81838 | 77.50261 | | | Y |
| 71 | Graham Island | -91.20102 | 77.45724 | -89.72927 | 77.45705 | | | Y |
| 72 | Graham Island | -91.18842 | 77.41196 | -89.72520 | 77.41172 | | | Y |
| 73 | Graham Island | -91.15933 | 77.36670 | -89.72157 | 77.36638 | | | Y |
| 74 | Graham Island | -90.99896 | 77.32173 | -89.65881 | 77.32087 | | | Y |
| 75 | Graham Island | -90.75374 | 77.27676 | -89.76529 | 77.27587 | | | Y |
| 76 | Graham Island | -91.23614 | 77.23054 | -89.89893 | 77.23087 | | | Y |
| 77 | Buckingham Island | -91.22981 | 77.18523 | -90.70254 | 77.18616 | | | Y |
| 78 | North Kent Island | -90.51898 | 76.78474 | -89.82273 | 76.79647 | | | |
| 79 | North Kent Island | -90.59282 | 76.73708 | -89.72872 | 76.75239 | | | |
| 80 | North Kent Island | -90.52884 | 76.69304 | -89.71216 | 76.70780 | | | |
| 81 | North Kent Island | -90.44490 | 76.64939 | -90.14237 | 76.65386 | | | |
| 82 | North Kent Island | -90.24349 | 76.56265 | -89.84342 | 76.57127 | | | |
| 83 | North Kent Island | -90.18308 | 76.51749 | -89.74876 | 76.52355 | | | |

Table 5. Transects matched up by latitude from north to south to make lines for analysis.

| Transect(s) | Length ( below 400 m), km | Length (above 400m), km | Total Length, km |
|---|---|---|---|
| 27 | 16.41 | | 16.41 |
| 26 | 16.85 | 7.84 | 24.69 |
| 25 | 17.57 | 5.84 | 23.41 |
| 24 | 20.11 | 6.81 | 26.92 |
| 23-01 | 34.91 | 10.73 | 45.64 |
| 22-02 | 55.20 | 9.61 | 64.81 |
| 21-03 | 55.83 | 18.21 | 74.04 |
| 20-04 | 68.60 | 14.85 | 83.44 |
| 19-05 | 76.34 | 12.16 | 88.49 |
| 18-06 | 78.34 | 19.66 | 98.00 |
| 17-07 | 69.88 | 17.75 | 87.64 |
| 16-08 | 81.20 | 18.62 | 99.82 |
| 15-09 | 84.52 | 6.19 | 90.70 |
| 14-10 | 90.48 | 7.22 | 97.70 |
| 13-11 | 106.85 | 0.04 | 106.89 |
| 12 | 140.97 | 2.80 | 143.77 |
| 28 | 127.76 | 2.75 | 130.51 |
| 29 | 130.09 | 9.40 | 139.49 |
| 30 | 107.16 | 37.68 | 144.84 |
| 31 | 92.73 | 52.71 | 145.45 |
| 32 | 77.24 | 78.52 | 155.76 |
| 33 | 79.65 | 99.91 | 179.57 |
| 34 | 68.04 | 102.41 | 170.45 |
| 35 | 58.64 | 97.44 | 156.08 |
| 36 | 52.77 | 86.78 | 139.55 |
| 37-51 | 50.80 | 96.00 | 146.80 |
| 38-52 | 55.98 | 76.14 | 132.12 |
| 39-53 | 54.89 | 72.83 | 127.73 |
| 40-54 | 64.19 | 69.54 | 133.73 |
| 41-55 | 49.61 | 55.67 | 105.27 |
| 42-56 | 53.12 | 75.92 | 129.04 |
| 43-57 | 90.89 | 78.03 | 168.92 |
| 44-58 | 106.59 | 65.52 | 172.12 |
| 45-59 | 104.67 | 43.03 | 147.70 |
| 46-60 | 98.19 | 30.73 | 128.92 |
| 47-61 | 95.77 | 26.04 | 121.82 |
| 48-62 | 86.83 | 11.98 | 98.81 |
| 49 | 41.85 | 4.00 | 45.85 |
| 50 | 30.00 | 2.08 | 32.08 |

**Appendix 4. 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.

To determine possible stratification regimes for future surveys on southern Ellesmere, we broke the study area into several strata (Table 6) and used Jolly's Method II to calculate population estimates (Table 7, Table 8).

Table 6. Survey strata for southern Ellesmere Island, March 2015.

| Stratification | Block ID | Location | Strata Area ($km^2$) | Base-line[1] (km) | Transect Spacing (km) | Transects Surveyed | Survey Area ($km^2$) | Percent Covered |
|---|---|---|---|---|---|---|---|---|
| Islands | A | South Ellesmere | 21260 | 257 | 5 | 62 | 4896.0 | 19.9 |
| | C | Graham, Buckingham | 1531 | 59 | 5 | 11 | 296.5 | 19.3 |
| Elevation | A | South Ellesmere Low (<400 m) | 13921 | 257 | 5 | 62 | 3322.5 | 20.1 |
| | B | South Ellesmere High (>400 m) | 7339 | 217 | 5 | 54 | 1573.6 | 19.5 |
| | C | Graham, Buckingham | 1531 | 59 | 5 | 11 | 296.5 | 19.3 |
| Bjorne | A | South Ellesmere | 18988 | 257 | 5 | 52 | 4439.1 | 19.8 |
| | B | Bjorne Peninsula | 2272 | 51 | 5 | 10 | 456.9 | 20.1 |
| | C | Graham, Buckingham | 1531 | 59 | 5 | 11 | 296.5 | 19.3 |
| Case and Ellsworth | I | South Ellesmere | 10029 | 124 | 5 | 31 | 2657.9 | 26.5 |
| | III | East Vendom | 2865 | 88 | 5 | 17 | 576.0 | 20.1 |
| | IV | Bjorne | 3397 | 82 | 5 | 16 | 685.2 | 20.2 |
| | V | Southwest Ellesmere | 4969 | 94 | 5 | 18 | 977.0 | 19.7 |
| | C[2] | Graham, Buckingham | 1531 | 59 | 5 | 11 | 296.5 | 19.3 |

[1] Baseline was the number of possible transects at 1-km wide and parallel to lines of longitude, to cover the entire strata.

[2] For caribou estimates, Graham/Buckingham islands were both included and excluded, but no muskoxen were seen on transect there.

Table 7. Abundance estimates (Jolly 1969 Method II) for muskoxen on southern Ellesmere Island, March 2015, based on several stratification regimes. 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 caribou/muskoxen, Y is the estimated caribou/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 $km^2$) |
|---|---|---|---|---|---|---|---|---|---|
| Islands CV=0.255 | A | 2604 | 441085 | 62 | 21260 | 5192.5 | 257 | 636 | 0.122 |
| | C | 0 | 0 | 11 | 1531 | 296.5 | 59 | 0 | 0 |
| | Total | 2604 | 441085 | 73 | 22791 | | 316 | 636 | 0.122 |
| Elevation CV=0.171 | A | 2392 | 219697 | 62 | 13921 | 3322.5 | 257 | 571 | 0.172 |
| | B | 303 | 8174 | 54 | 7339 | 1573.5 | 217 | 65 | 0.041 |
| | C | 0 | 0 | 11 | 1531 | 296.5 | 59 | 0 | 0 |
| | Total | 2696 | 227871 | 127 | 22791 | 5192.5 | 533 | 636 | 0.122 |
| Bjorne CV=0.337 | A | 2665 | 594526 | 52 | 18988 | 4439.1 | 257 | 623 | 0.140 |
| | B | 19 | 3498 | 10 | 22712 | 1573.5 | 51 | 13 | 0.008 |
| | C | 0 | 0 | 11 | 1531 | 296.5 | 59 | 0 | 0 |
| | Total | 2684 | 598025 | 73 | 22791 | 6309.1 | 367 | 636 | 0.101 |
| Case and Ellsworth CV=0.229 | I | 838 | 99075 | 31 | 10029 | 2657.9 | 124 | 222 | 0.084 |
| | III | 1055 | 241963 | 17 | 2865 | 576.0 | 88 | 212 | 0.368 |
| | IV | 149 | 8523 | 16 | 3397 | 685.2 | 82 | 30 | 0.044 |
| | V | 875 | 51843 | 18 | 4969 | 977.0 | 94 | 172 | 0.176 |
| | Total | 2916 | 401403 | 82 | 21260 | 4896.0 | 388 | 636 | 0.130 |

Table 8. Peary caribou population estimates for caribou on southern Ellesmere Island, March 2015, based on several stratification regimes. 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 caribou/muskoxen, Y is the estimated caribou/muskoxen with variance Var(Y). The coefficient of variation (CV) is also provided.

| | Stratum | Y | Var(Y) | n | Z ($km^2$) | z ($km^2$) | N | y | Density (per $km^2$) |
|---|---|---|---|---|---|---|---|---|---|
| Islands CV=0.536 | A | 113 | 4822 | 62 | 21260 | 4896.0 | 257 | 26 | 0.005 |
| | C | 52 | 2343 | 11 | 1531 | 296.5 | 59 | 10 | 0.034 |
| | Total | 165 | 7164 | 73 | 22791 | 5192.5 | 316 | 36 | 0.007 |
| Elevation CV=0.505 | A | 109 | 4681 | 62 | 13921 | 3322.5 | 257 | 26 | 0.008 |
| | B | 0 | 0 | 54 | 7339 | 1573.5 | 217 | 0 | 0 |
| | C | 57 | 2327 | 11 | 1531 | 296.5 | 59 | 10 | 0.037 |
| | Total | 166 | 7009 | 127 | 22791 | 5192.5 | 533 | 36 | 0.007 |
| Bjorne CV=0.659 | A | 13 | 173 | 52 | 18988 | 4439.1 | 257 | 23 | 0.001 |
| | B | 33 | 7170 | 10 | 22712 | 1573.5 | 51 | 3 | 0.015 |
| | C | 57 | 0 | 11 | 1531 | 296.5 | 59 | 10 | 0.037 |
| | Total | 103 | 7343 | 73 | 22791 | 6309.1 | 367 | 36 | 0.006 |
| Case and Ellsworth CV=0.786 | I | 0 | 0 | 31 | 10029 | 2657.9 | 124 | 0 | 0 |
| | III | 0 | 0 | 17 | 2865 | 576.0 | 88 | 0 | 0 |
| | IV | 129 | 7883 | 16 | 3397 | 685.2 | 82 | 26 | 0.038 |
| | V | 0 | 0 | 18 | 4969 | 977.0 | 94 | 0 | 0 |
| | Total | 129 | 7883 | 82 | 21260 | 4896.0 | 388 | 26 | 0.005 |
| Case and Ellsworth (+Graham) CV=0.640 | I | 0 | 0 | 31 | 10029 | 2657.9 | 124 | 0 | 0 |
| | III | 0 | 0 | 17 | 2865 | 576.0 | 88 | 0 | 0 |
| | IV | 129 | 7883 | 16 | 3397 | 685.2 | 82 | 26 | 0.038 |
| | V | 0 | 0 | 18 | 4969 | 977.0 | 94 | 0 | 0 |
| | C | 52 | 2343 | 11 | 1531 | 296.5 | 59 | 10 | 0.034 |
| | Total | 181 | 10225 | 93 | 22791 | 5192.5 | 447 | 36 | 0.007 |

*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 from 3180 muskoxen and 180 caribou 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 9. Abundance estimates for a stratified systematic survey (Cochran 1977) of muskoxen on southern Ellesmere Island, March 2015. *I* is the number of transects sampled.

| | Strata | Estimated Abundance Y | Var(Y) | I | Transect Spacing S (km) | Transect Width w (km) | Observed Individuals y | Density (per km$^2$) |
|---|---|---|---|---|---|---|---|---|
| All CV=0.223 | | 3180 | 331785 | 73 | 5 | 1 | 636 | 0.150 |
| Elevation CV=0.172 | A | 2855 | 282070 | 62 | 5 | 1 | 571 | 0.205 |
| | B | 325 | 17321 | 54 | 5 | 1 | 65 | 0.044 |
| | Total | 3180 | 299390 | 136 | | | 636 | 0.150 |
| Bjorne CV=0.181 | A | 3115 | 327264 | 52 | 5 | 1 | 623 | 0.164 |
| | B | 65 | 3756 | 10 | 5 | 1 | 13 | 0.029 |
| | Total | 3180 | 331019 | 62 | | | 636 | 0.150 |
| Case and Ellsworth CV=0.184 | I | 1110 | 83886 | 31 | 5 | 1 | 222 | 0.111 |
| | III | 1060 | 199166 | 17 | 5 | 1 | 212 | 0.370 |
| | IV | 150 | 9771 | 16 | 5 | 1 | 30 | 0.044 |
| | V | 860 | 50781 | 18 | 5 | 1 | 172 | 0.173 |
| | Total | 3180 | 343603 | 82 | | | 636 | 0.150 |

Table 10. Abundance estimates for a stratified systematic survey (Cochran 1977) for Peary caribou on southern Ellesmere Island, March 2015. *I* is the number of transects sampled.

| | Strata | Estimated Abundance Y | Var(Y) | I | Transect Spacing S (km) | Transect Width w (km) | Observed Individuals y | Density (per km$^2$) |
|---|---|---|---|---|---|---|---|---|
| All CV=0.359 | | 180 | 4177 | 73 | 5 | 1 | 36 | 0.008 |
| Elevation CV=0.367 | A | 130 | 2155 | 62 | 5 | 1 | 26 | 0.009 |
| | B | 0 | 0 | 54 | 5 | 1 | 0 | 0 |
| | C | 50 | 2200 | 11 | 5 | 1 | 10 | 0.033 |
| | Total | 180 | 4355 | | | | 36 | 0.008 |
| Bjorne CV=0.374 | A | 15 | 184 | 52 | 5 | 1 | 3 | 0.001 |
| | B | 115 | 2156 | 10 | 5 | 1 | 23 | 0.051 |
| | C | 50 | 2200 | 11 | 5 | 1 | 10 | 0.033 |
| | Total | 180 | 4539 | 73 | | | 36 | 0.008 |
| Case and Ellsworth CV=0.366 | I | 0 | 0 | 31 | 5 | 1 | 0 | 0 |
| | III | 0 | 0 | 17 | 5 | 1 | 0 | 0 |
| | IV | 130 | 2261 | 16 | 5 | 1 | 26 | 0.038 |
| | V | 0 | 0 | 18 | 5 | 1 | 0 | 0 |
| | Total | 130 | 2261 | 82 | | | 26 | 0.006 |
| Case and Ellsworth (+Graham) CV=0.371 | I | 0 | 0 | 31 | 5 | 1 | 0 | 0 |
| | III | 0 | 0 | 17 | 5 | 1 | 0 | 0 |
| | IV | 130 | 2261 | 16 | 5 | 1 | 26 | 0.038 |
| | V | 0 | 0 | 18 | 5 | 1 | 0 | 0 |
| | C | 50 | 2200 | 11 | 5 | 1 | 10 | 0.033 |
| | Total | 180 | 4461 | 93 | | | 36 | 0.008 |

**Appendix 5. Daily flight summaries for south Ellesmere survey flown by Twin Otter, March 2015.**

Table 11. 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 | Flying Time | Transect Time | Area | Comment |
|---|---|---|---|---|---|---|---|---|
| 18-Mar-15 | 12:30 | 14:20 | | | 1.83 | 0 | Bjorne Peninsula | -27°C, clear, some wind to east around Vendom Fd, otherwise calm |
| 19-Mar-15 | 9:20 | 14:35 | 15:10 | 19:34 | 9.65 | 6.13 | Graham and Buckingham Islands | -20°C, clear, almost no wind |
| 20-Mar-15 | 12:10 | 16:30 | | | 4.33 | 3.78 | Hell Gate and Grise Fiord | -28°C, some wind by Hell Gate and east, 15 kph +catabatics at ice sheets |
| 21-Mar-15 | 11:30 | 15:40 | | | 4.17 | 3.63 | Hell Gate to Skaare Fiord | -28°C, clouds around Hell Gate, wind about 15 kph |
| 22-Mar-15 | | | | | 0 | 0 | Grounded | Low cloud prevented flying |
| 23-Mar-15 | 9:50 | 15:32 | 16:12 | 20:00 | 9.5 | 8.28 | West of Sydkap Ice Cap and north of Grise Fiord | -25°C, 50% cloud around Grise Fiord to 100% cloud in east and fog over Hell Gate, fairly calm with more wind from east later in the day at east/west ends of study area |
| 24-Mar-15 | 9:40 | 15:05 | 15:40 | 20:30 | 10.25 | 8.15 | Sydkap ice cap north to Sor Fiord | -29°C, clear, some wind on east side of study area |
| 25-Mar-15 | 9:18 | 13:15 | | | 3.95 | 2.58 | Vendom Fiord | -28°C, sunny clear with scattered low cloud/fog around Makinson Inlet and along east coast (also wind/mechanical turbulence) |
| 26-Mar-15 | 9:38 | 13:00 | 15:08 | 17:38 | 5.87 | 3.05 | Sor Fiord to Makinson Inlet; Hell Gate | -30°C, clear with scattered cloud wind up to 15 kph but mostly calm, some fog around Hell Gate |

Pilots - Rob Bergeron, John Sidwell; Navigator - Morgan Anderson

Observers:
Mar 19 – Morgan Anderson, Eepa Ootoovak, Scott Darroch
Mar 20 – Morgan Anderson, Aksakjuk Ningiuk
Mar 21 – Morgan Anderson, Olaf Killiktee, Imooshie Nutuqajuk, Mark Akeeagok
Mar 23 – Morgan Anderson, Simon Singoorie, Olaf Killiktee, Frankie Noah
Mar 24 – Morgan Anderson, Aksakjuk Ningiuk, Eepa Ootoovak, Simon Singoorie, Olaf Killiktee
Mar 25 – Morgan Anderson, Frankie Noah, Jon Neely, Frank Holland
Mar 26 – Morgan Anderson, Jopee Kiguktak, Scott Darroch

**Appendix 6. Incidental wildlife observations.**

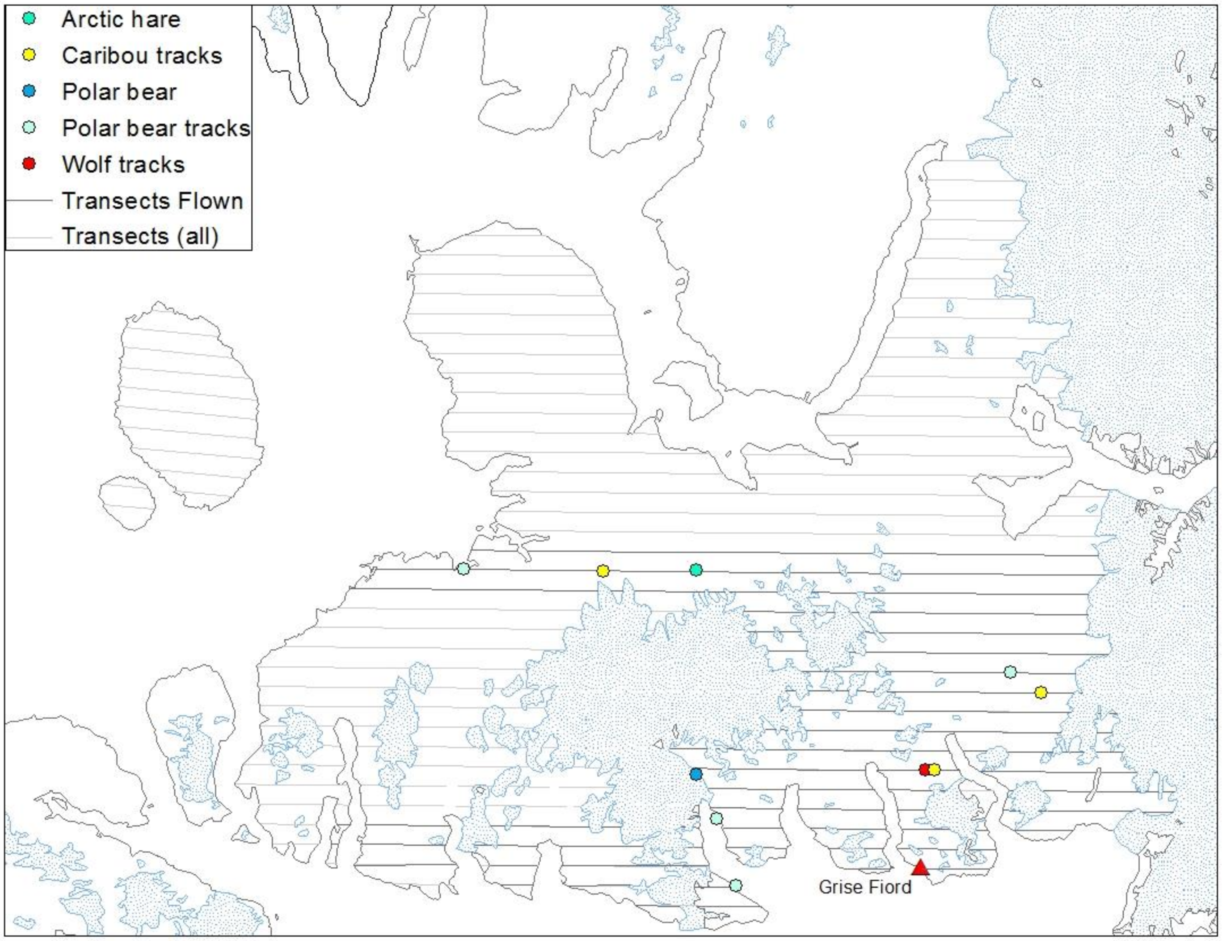


Figure 12. Incidental observations April 12-24, 2014 during a caribou/muskox survey of southern Ellesmere Island by Twin Otter.

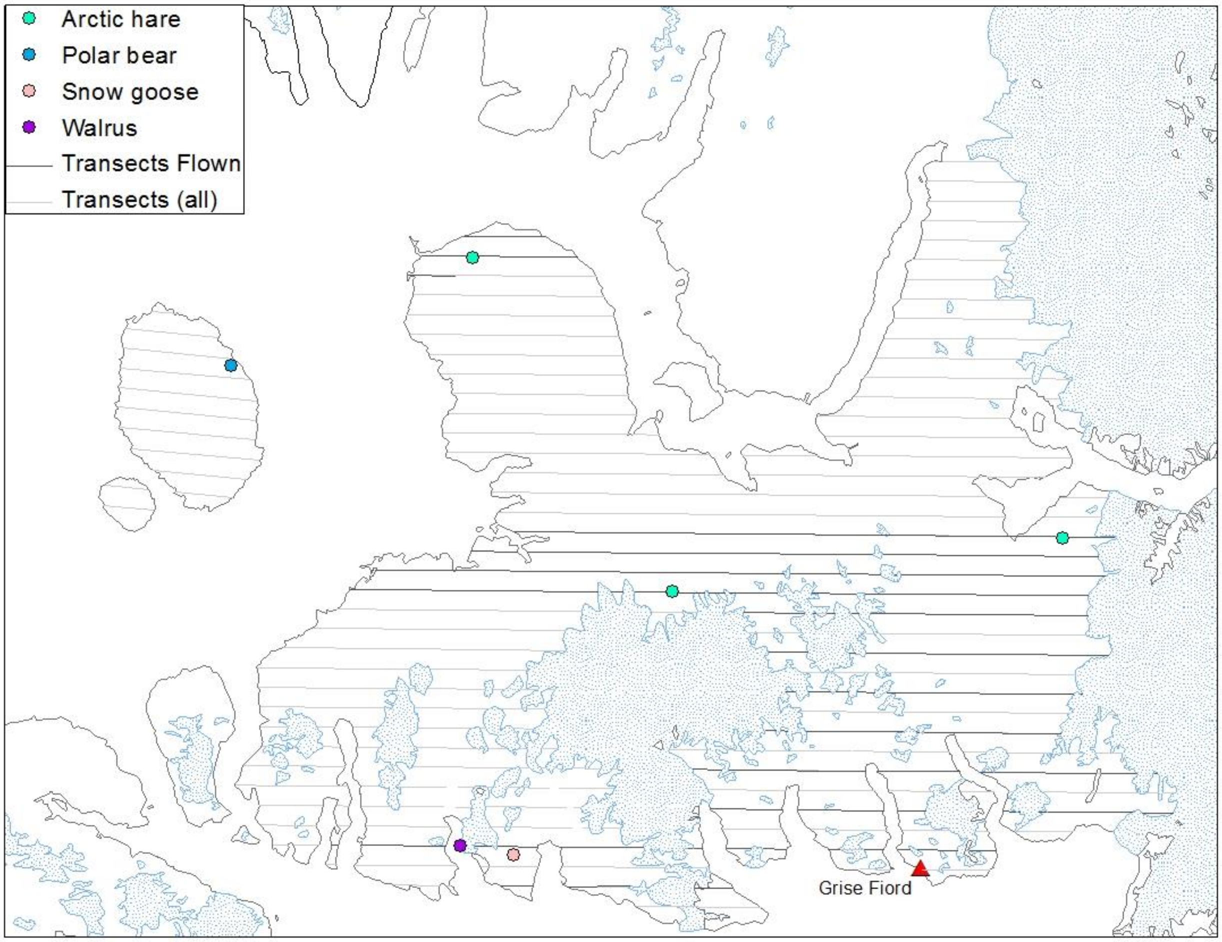


Figure 13. Incidental observations August 13 and 15, 2014 during a caribou/muskox survey of southern Ellesmere Island by Twin Otter.

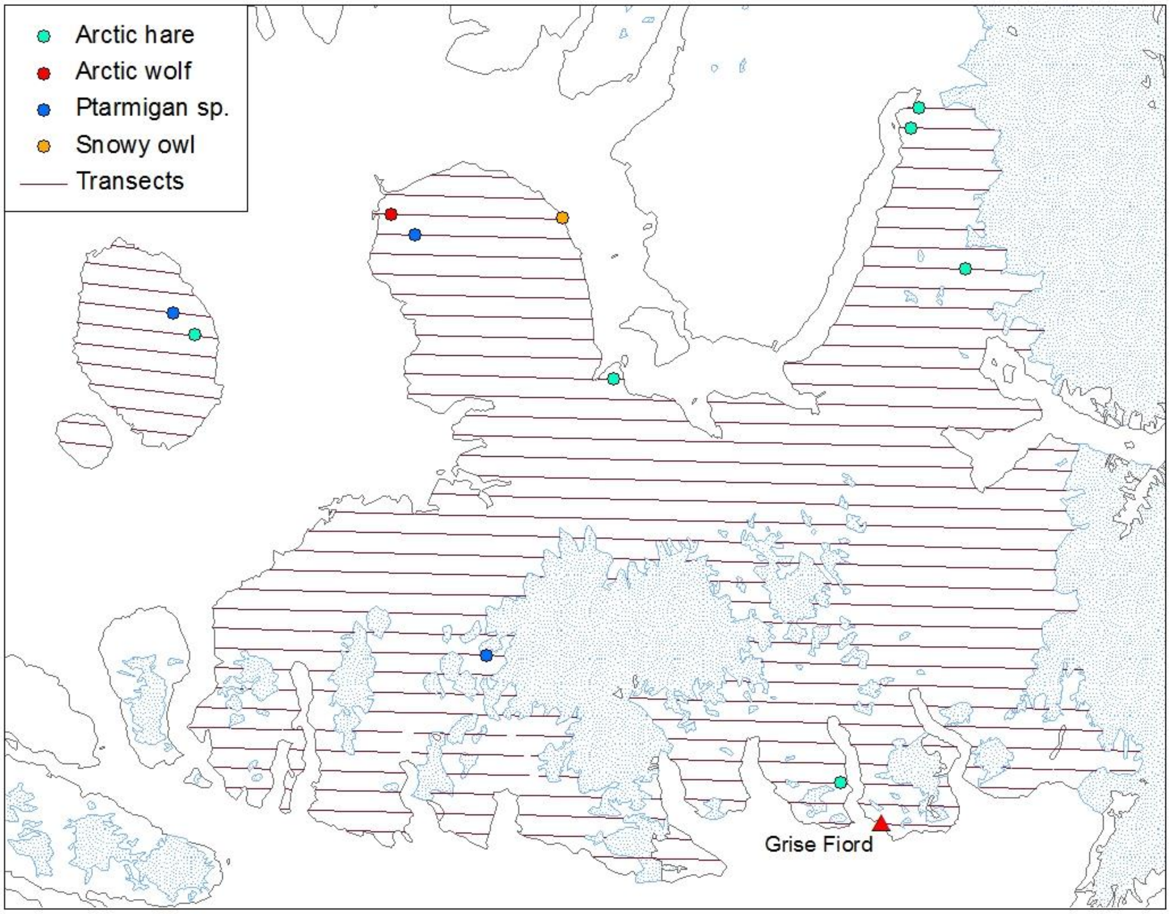


Figure 14. Incidental observations March 19-26, 2015 during a caribou/muskox survey of southern Ellesmere Island by Twin Otter. The hare observations at Baumann Fiord and north of Makinson Inlet were large herds. Two adult wolves were seen on Bjorne Peninsula.

# Recent trends in abundance of Peary Caribou (*Rangifer tarandus pearyi*) and Muskoxen (*Ovibos moschatus*) in the Canadian Arctic Archipelago, Nunavut

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2011

Wildlife Report, No.1, Version 2

Jenkins et al. 2011. Recent trends in abundance of Peary Caribou (*Rangifer tarandus pearyi*) and Muskoxen (*Ovibos moschatus*) in the Canadian Arctic Archipelago, Nunavut. Department of Environment, Government of Nunavut, Wildlife Report No. 1, Pond Inlet, Nunavut. 184 pp.

## Recommendations to Government

## ABSTRACT

Updated information on the distribution and abundance for Peary caribou on Nunavut’s High Arctic Islands estimates an across-island total of about 4,000 (aged 10 months or older) with variable trends in abundance between islands. The total abundance of muskoxen is estimated at 17,500 (aged one year or older). The estimates are from a multi-year survey program designed to address information gaps as previous information was up to 50 years old. Information from this study supports the development of Inuit Qaujimajatuqangit (IQ)- and scientifically-based management and monitoring plans. It also contributes to recovery planning as required under the 2011 addition of Peary caribou to Schedule 1 of the federal Species At Risk Act based on the 2004 national assessment as Endangered.

The population estimates are mostly based on line transect distance sampling methods designed to increase survey accuracy. The survey estimates were for caribou (10 months or older) as the surveys were almost all pre-calving (April-May). We surveyed the islands as island groups between 2001 and 2008. We estimated 187 caribou (95% CI 104–330 caribou) on Bathurst Island Complex in May, 2001 which is an increase since a die-off in the mid-1990s. Sightings during 2010 suggest the increase of Peary caribou on Bathurst Island has continued. We observed only a single, adult female caribou during the aerial survey of Cornwallis Island and Little Cornwallis Island in May, 2002 and on Devon Island in April/May 2008, we counted 17 caribou after flying 7985 km.

In May 2004, we did not see Peary caribou on Prince of Wales and Somerset islands which indicates no recovery from the severe decline between 1980 and 1995. The observation of possibly only one Peary caribou on Boothia Peninsula during a muskoxen survey in 2006 (M. Dumond, personal communication) gives emphasis to a caribou study on the Peninsula.

The total estimated abundance of caribou on Ellesmere Island (including Graham Island) is 1,021 caribou based on surveys of southern Ellesmere (219 caribou 95% CI 109-442) in May, 2005, and northern Ellesmere (802 caribou 95% CI 531 -1207) in May 2006. On Axel Heiberg Island in April 2007, we estimated 2,291 (95% CI 1,636 – 3,208). Due to the low occurrence of caribou on Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, and Meighen Islands, we estimated the total abundance of Peary caribou as 282 (95% CI 157 – 505 ) for these islands. For Lougheed Island, 32 clusters of caribou were observed providing a density estimate of 262 caribou/1000 $km^2$.

For muskoxen, survey estimates were for animals one year or older, as the surveys coincided with calving (April-May). A total of 12,683 muskoxen were counted across the study area, including 1,492 new born calves. In May, 2001 we observed 7 clusters of muskoxen on Bathurst Island Complex for a minimum count of 82 muskoxen. We report a minimum count of 18 muskoxen during the aerial survey of Cornwallis and Little Cornwallis Island in May, 2002 and estimate 513 (95% CI 302 – 864) on Devon Island in April/May 2008.

For May 2004, we estimated 2,086 muskoxen (95% CI 1,582 – 2,746) on Prince of Wales Island and another 1,910 (95% CI 962 – 3,792) on Somerset Island. We estimated 456 (95% CI 312 – 670) on Southern Ellesmere in 2005, and observed 40

emaciated muskox carcasses during the survey. The estimated abundance of muskoxen on Northern Ellesmere was 8,115 (95% CI 6,632 – 9,930) for May 2006, and we noted high concentration of muskoxen with newborn calves on the Fosheim Peninsula. On Axel Heiberg Island in April 2007, we estimated 4,237 (95% CI 3,371 – 5,325) muskoxen and noted high concentrations east of the Princess Margaret Range. In contrast, due to the low occurrence of muskoxen on Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, Meighen, and Lougheed islands we report a combined minimum count of 21 muskoxen for those islands.

***Key Words*:** Peary caribou, Muskoxen, Aerial Survey, Ground Survey, Nunavut, Distance Sampling, *Rangifer tarandus pearyi, Ovibos moschatus*

## ᖃᓄᐃᓐᓇᓱᒋᔭᐅᓂᖓ

ᓄᓪᓗᙳᖅᑎᓯᒪᙵᓕᕐᑐᑎᕕᐊᖅᑎᑦᓴᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ ᓇᓅᓐᓂᖏᑦ ᐅᓄᕐᓂᖏᓪᓗ ᓄᓇᕗᒻᒥᑦ ᖁᓪᓯᒃᑐᕐᒥᑦ ᕿᑭᖅᑕᖏᓐᓂᑦ ᓇᓚᐅᑦᓵᖅᓯᒪᔪᑦ ᕿᑭᖅᑕᐅᔪᓂᑦ ᑲᑎᓪᓗᒋᑦ ᐃᒪᖓᒎ 4,000 (10-ᓂᒃ ᑕᕐᕿᕐᑲᖅᑐᑦ ᐅᖓᑖᓂᓘᓐᓅᑦ) ᐊᔾᔨᙳᙱᓂᕐᑲᖅᑲᑎᒃ ᐅᓄᕐᓂᖏᑦ ᕿᑭᑦᑕᓂᒃ ᐊᔾᔨᙳᙱᑐᓂᒃ. ᑲᑎᓪᓗᒋᑦ ᐅᓄᕐᓂᖏᑦ ᐅᒥᖓᐃᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᖅ 17,500 (ᐅᑭᐅᕐᑲᖅᑐᑦ 1 ᐅᖓᑖᓂᓘᓐᓅᑦ). ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐊᑐᖅᑐᑦ ᐊᑕᐅᓯᐅᙱᑦᑐᕐᒥᒃ ᐅᑭᐅᓂᒃ ᖃᐅᔨᓴᕐᓂᐅᓯᒪᔪᓂᒃ ᐋᕐᕿᒃᓱᖅᑕᐅᓯᒪᔪᑦ ᑲᒪᒋᔭᕐᑲᕐᓂᐊᕐᓗᑎᒃ ᑐᑭᓯᐊᕈᑎᒃᓴᖃᙱᓂᐅᔪᓂᒃ ᑕᐃᒃᑯᐊ ᑭᖑᓪᓕᑦ ᑐᑭᓯᐊᕈᑎᒃᓴᐅᓚᐅᖅᑐᑦ ᓄᑕᐅᙱᑎᑎᓚᐅᕐᒪᑖ 50 ᐅᑭᐅᓄᑦ ᑎᑭᓪᓗᒍ. ᑐᑭᓯᐊᕈᑎᒃᓴᑦ ᑖᒡᕙᙵᑦ ᖃᐅᔨᓴᕐᓂᐅᔪᒥᒃ ᐃᑲᔪᖅᑐᐃᔪᖅ ᐱᕗᓪᓕᐊᓂᖏᓐᓂᒃ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᕐᑲᖏᓐᓂᒃ – ᐊᒻᒪ ᖃᐅᔨᓴᕐᓂᓕᕆᓂᕐᒨᓕᖓᔪᓂᒃ ᐊᐅᓚᓯᔪᓂᕐᒧᒃ ᖃᐅᔨᓴᕐᓂᕐᒧᓪᓗ ᐸᕐᓇᐅᑎᓂᒃ. ᐃᑲᔪᖅᑐᐃᖏᔪᖅ ᐅᑎᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᐸᕐᓇᖕᓂᕐᒧᑦ ᐱᔭᕆᐊᕐᑲᖅᑑᒐᒥ ᑖᒡᕙᓂ 2011-ᒥᑦ ᐃᓚᒋᐊᕐᓂᐅᔪᒥᒃ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᓂᒃ ᐃᑖᒃᑯᑦ 1-ᒧᑦ ᒐᕙᒪᑐᕐᑲᒃᑯᑦ ᐆᒪᔪᐃᑦ ᐅᓗᕆᐊᓇᖅᑐᕐᑦᑐᑦ ᒪᓕᒐᕐᔪᐊᕐᒥᑦ ᒪᓕᒃᓱᑎᒃ 2004-ᒥᑦ ᑲᓇᑕᓕᒫᒧᑦ ᖃᐅᔨᓴᕈᑕᐅᓚᐅᖅᑐᕐᒥᒃ ᐅᓗᕆᐊᓇᖅᑑᓱᒋᔭᐅᓪᓗᑎᒃ.

ᐅᓄᕐᓂᖏᓐᓂᒃ ᓇᓚᐅᑦᓵᕐᓂᐅᔪᑦ ᒪᓕᓗᐊᖅᑐᑦ ᐊᖌᒃᑐᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᓄᓇᑦ ᐅᖓᓯᖕᓂᖏᑎᒍᑦ ᖃᐅᔨᓴᕈᑎᕐᑲᖅᑲᑎᒃ ᐋᕐᕿᒃᑕᐅᓯᒪᔪᑦ ᑕᒪᖏᓐᓂᖅᓴᐅᓂᕐᒥᒃ ᓈᓴᕐᓂᐅᔪᕐᒥᒃ. ᓈᓴᕐᓂᐅᔫᒃᑯᑦ ᓇᓚᐅᑦᓵᖅᑕᐅᓯᒪᔪᑦ ᐃᓚᕐᑲᓚᐅᖅᑐᑦ ᑐᒃᑐᓂᒃ (10-ᓂᒃ ᑕᕐᕿᕐᑲᖅᑐᑦ ᐅᖓᑖᓕᓘᓐᓅᑦ) ᓈᓴᕐᓂᐅᓚᐅᖅᑐᑦ ᑕᒪᐃᓐᓂᑲᓴᒃ ᑲᔪᓯᓚᐅᕐᒪᑕ ᓄᕐᓇᐊᓚᐅᖅᑎᓐᓇᒋᑦ (ᐃᐳᕈ-ᒪᐃ). ᓈᓴᓚᐅᖅᑐᒍᑦ ᕿᑭᖅᑕᕐᓂᑦ ᑲᑎᓯᒪᓂᐅᓪᓗᑎᒃ ᕿᑭᖅᑕᐅᔪᑦ ᐊᑯᓐᓂᖓᓐᓂᑦ 2001 ᐊᒻᒪ 2008. ᓇᓚᐅᑦᓵᖅᑐᒍᑦ 187 ᑐᒃᑐᑦ (95% *CI* 104-300 ᑐᒃᑐᕐ) ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᒪᐃ, 2001-ᒥᑦ ᐊᒥᓲᙳᕐᓂᐅᓪᓗᓂ ᑕᒪᙳᑦ ᑐᕐᑯᒐᕐᓂᐅᓚᐅᖅᓯᒪᔪᒥᒃ 1990-ᖏᓐᓂᕐ. ᑕᑯᔭᐅᑦᑕᕐᓂᐅᔪᑦ 2010-ᒥᑦ ᐃᓱᒪᒋᔭᐅᓕᖅᑐᖅ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᑲᔪᓯᖕᒪᕐ. ᑕᑯᓚᐅᖅᑐᑦ ᐊᑕᐅᓯᑐᐊᕐᒥᒃ ᐊᕐᓇᓪᓗᕐᒥᒃ ᑐᒃᑐᒥᒃ ᖃᖓᑕᓲᒃᑯᑦ ᓈᓴᕐᓂᖃᖅᑎᓪᓗᒋᑦ ᒪᕐᕉᓕᕐᑭᒥᑦ (*Cornwallis Island* ᐊᒻᒪ *Little Cornwallis Island*) ᒪᐃ, 2002-ᒥᑦ ᐊᒻᒪᓗ ᑕᓪᓗᕈᑎᒥᑦ ᐃᐳᕈ/ᒪᐃ 2008-ᒥᑦ, ᓈᓴᓚᐅᖅᑐᒍᑦ 17-ᓂᒃ ᑐᒃᑐᓂᒃ ᖃᖓᑕᓚᐅᖅᖢᑕ 7,985 ᑭᓛᒥᑕᓂᒃ.

ᒪᐃ 2004-ᒥᑦ, ᑕᑯᓐᓂᓚᐅᖅᑐᒍᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᓂᒃ ᑭᙵᐃᓚᕐᒥᑦ ᐊᒻᒪ ᑰᖓᓇᔫᑉ ᓄᓇᖓᓂᑦ ᑐᑭᓯᔾᔪᑕᐅᓪᓗᓂ ᑕᒪᓇ ᐅᑎᖅᐸᓪᓕᐊᙳᓂᖏᓐᓂᒃ ᑕᐃᒪᙵᑦ ᐅᓄᕈᓐᓇᐃᓪᒪᕆᖕᓂᐅᓚᐅᖅᑐᕐᒥᒃ ᐊᑯᓐᓂᖓᓐᓂᑦ 1980 ᐊᒻᒪ 1995. ᑕᑯᓂᐅᓚᐅᖅᑐᖅ ᐃᒻᒪᖄ ᐊᑕᐅᓯᕐᑐᐊᕐᒥᒃ ᖃᑯᖅᑕᑯᓗᒃ ᑐᒃᑐᒥᒃ ᐆᑎᐊᒥᑦ (*Boothia Peninsula*) ᐅᒥᖕᒪᖕᓂᒃ ᓈᓴᕐᓂᖅᑲᖅᑎᓪᓗᓂ 2006-ᒥᑦ (*M. Dumond*, ᓇᖕᒥᓂᖅ ᑐᓴᖅᑎᓐᓂᕆᓚᐅᖅᑕᖓ) ᐱᒻᒪᕆᐅᓕᖅᑎᑦᓯᔪᖅ ᑐᒃᑐᓂᒃ ᖃᐅᔨᓴᕆᐊᖃᕐᓂᐅᔪᓐᖓᒃ ᑕᐃᑲᓂ.

ᑲᑎᓪᓗᒋᑦ ᓇᓚᐅᑦᓵᕐᓂᐅᔪᑦ ᑐᒃᑐᑦ ᐅᓄᕐᓂᖕᒋᓐᓂᒃ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖓᓂᒃ (ᐃᓕᑦᓗᒍ ᒍᕋᒻ ᕿᑭᖅᑕᖅ *Graham Island*) 1,021 ᑐᒃᑐᑦ ᒪᓕᒃᑲᒋᑦ ᓈᓴᕐᓂᐅᓯᒪᔪᑦ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖓᓂ ᓂᒋᖓᓂᒃ (219 ᑐᒃᑐᑦ 95% *CI* 109-442 ᑐᒃᑐᑦ) ᒪᐃ, 2005-ᒥᑦ, ᐊᒻᒪ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖓᓂ ᐅᐊᖕᓇᖓᓂ (802 ᑐᒃᑐᑦ 95% *CI* 531 -1207 ᑐᒃᑐᑦ) ᒪᐃ, 2006-ᒥᑦ. ᐅᒥᖕᒪᑦ ᓄᓈᓂᑦ (*Axel Heiberg Island*) ᐄᐳᕈ 2007-ᒥᑦ, ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 2,291 (95% *CI* 1,636 – 3,208). ᑐᒃᑐᖃᕐᔪᙱᓗᐊᕐᓂᖕᒋᓐᓂᒃ ᑖᒃᑯᐊ ᕿᑭᖅᑕᐅᔪᓂᒃ *Amund Ringnes, Ellef Ringnes, King Christen, Cornwall,* ᐊᒻᒪ *Meighen*, ᓇᓚᐅᑦᓵᖅᓯᒪᔪᒍᑦ ᑲᑎᓪᓗᒋᑦ ᐅᓄᕐᓂᖏᑦ ᖃᑯᖅᑕᑯᓗᐃᑦ ᑐᒃᑐᑦ 282-ᖑᔪᑦ (95% *CI* 157 – 505) ᑖᒃᑯᓇᓂ ᕿᑭᖅᑕᓂᑦ. ᓛᕼᐃᑦ ᕿᑭᖅᑕᕐᒥᑦ (*Lougheed Island*) 32 ᑲᑎᓯᒪᓂᐅᔪᑦ ᑐᒃᑐᑦ ᑕᑯᔾᔮᓚᐅᖅᑐᑦ ᓇᓚᐅᑦᓵᕈᑕᐅᓕᖅᑲᑎᒃ ᐃᒻᒪᖄ 262 ᑐᒃᑐᑦ/1,000 ᑭᓛᒥᑕᑦ ᐃᖅᑐᐊᖅᑐᑦ.

ᐅᒥᖕᒪᐃᑦᓕ, ᓈᓴᕐᓂᐅᓯᒪᔫᒃᑯᑦ ᓇᓚᐅᑦᓵᕐᓂᐅᓚᐅᖅᑐᑦ ᐅᑭᐅᖃᖅᑐᓂᒃ 1 ᐅᖓᑖᓂᓘᓐᓃᑦ, ᓈᓴᕐᓂᖃᓚᐅᕐᒪᑦ ᐊᑕᐅᑦᓯᒃᑯᑦ ᓄᕐᕆᐊᕐᓂᖅᑲᖅᑎᓪᓗᒋᑦ (ᐄᐳᕈ-ᒪᐃ). ᑲᑎᓪᓗᒋᑦ 12,683 ᐅᒥᖕᒪᐃᑦ ᓈᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᓈᓴᕐᕕᓕᒫᒥᑦ, ᐃᓚᒋᓪᓗᒋᑦ 1,492 ᐃᓅᓕᕆᑦ ᓄᕐᖁᐃᑦ. ᒪᐃ, 2001-ᒥᑦ ᑕᑯᓚᐅᖅᑐᒍᑦ 7-ᓂᒃ ᑲᑎᓯᒪᓂᐅᔪᓂᒃ ᐅᒥᖕᒪᖕᓂᒃ ᑐᒃᑐᓯᐅᕐᕕᖕᒥᑦ ᐊᓪᓕᖅᐹᒥᒃ ᓈᓴᕐᓂᖅᑲᖅᓗᓂ 82 ᐅᒥᖕᒪᐃᑦ. ᐅᓂᒃᑳᖅᓯᒪᔪᒍᑦ ᐊᓪᓕᖅᐹᒥᒃ 18 ᐅᒥᖕᒪᐃᑦ ᖃᖓᑕᔮᒃᑯᑦ ᓈᓴᕐᓂᖅᑲᖅᑎᓪᓗᑕ *Cornwallis* ᐊᒻᒪ *Little Cornwallis Island*-ᒥᑦ ᒪᐃ, 2002-ᒥᑦ ᐊᒻᒪ ᓇᓚᐅᑦᓵᖅᑲᖅᑕ 513-ᓂᒃ (95% *CI* 302 – 864) ᑕᓪᓗᕈᑎᒥᑦ ᐄᐳᕈ/ᒪᐃ 2008-ᒥᑦ.

ᒪᐃ 2004-ᒧᑦ, ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 2,086 ᐅᒥᖕᒪᕐᑲᖅᑲᖅᓗᓂ (95% *CI* 1,582 – 2,746) ᑭᙵᐃᓚᕐᒥᑦ ᐊᒻᒪᓗᒃᑲᓐᓂᖅ 1,910 (95% *CI* 962 – 3,792) ᑰᖓᓇᔫᑉ ᓄᓇᖓᓂ. ᓇᓚᐅᑦᓵᓚᐅᖅᑐᒍᑦ 456-ᓂᒃ (95% *CI* 312 – 670) ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖓᓂ ᓂᒋᖓᓂ 2005-ᒥᑦ, ᐊᒻᒪ ᑕᑯᓪᓗᑕ 40-ᓂᒃ ᑐᖃᖓᔪᓂᒃ ᐅᒥᖕᒪᕐᓂᒃ

ᓈᓴᕐᓂᖅᑲᖅᑎᓪᓗᑕ. ᓇᓚᐅᑦᕿᖅᑕᐅᓯᒪᔪᑦ ᐅᒥᖕᒪᐃᑦ ᐅᓄᕐᓂᖏᑦ ᐊᐅᓯᐃᑦᑐᕐᒥᐅᑦ ᕿᑭᖅᑕᖕᒐᓂ ᐅᐊᖕᓇᖕᒐᓂ 8,115-ᖑᓚᐅᖅᑐᑦ (95% *CI* 6,632 – 9,930) ᒪᐃ 2006-ᒧᑦ, ᐅᔾᔨᕆᔭᕐᖃᖅᐹᓪᓗ ᐅᓄᕐᓂᖏᑦᑕ ᑲᑎᓯᒪᔪᑦ ᐅᒥᖕᒪᐃᑦ ᓄᕐᕋᕐᖃᖅᑐᑦ ᕗᓴᐃᒻᒥᑦ (*Fosheim Peninsula*). ᐅᒥᖕᒪᑦ ᓄᓈᑦᓂ ᐄᐳᕈ 2007-ᒥᑦ, ᓇᓚᐅᑦᕿᓚᐅᖅᑐᒍᑦ 4,237-ᓂᒃ (95% *CI* 3,371 – 5,325) ᐅᒥᖕᒪᖕᓂᒃ ᐅᔾᔨᕆᔭᕐᖃᖅᐹᓪᓗ ᐅᓄᖅᑐᓂᒃ ᑲᑎᓯᒪᔪᓂᒃ ᐳᕆᓐᓯᐊᓯ ᒫᑯᐃ ᐃᓂᕐᑲᕐᕖᖕᒥᑦ (*Princess Margaret*). ᐅᒥᖕᒪᒃᑕᕐᑲᓗᐊᙱᓂᖕᒋᓐᓂᒃ ᕿᑭᖅᑕᓂᒃ *Amund Ringnes, Ellef Ringnes, King Christen, Cornwall, Meighen,* ᐊᒻᒪ *Lougheed* ᐅᓂᒃᑳᓚᐅᖅᑐᒍᑦ ᑲᑎᑦᓗᒋᑦ ᐊᑦᓕᖅᐸᓖᒥᒃ ᓈᓴᖅᑕᐅᓂᖕᒋᓐᓂᒃ 21 ᐅᒥᖕᒪᐃᑦ ᑕᐃᒃᑯᓄᖕᒐ ᕿᑭᖅᑕᓄᑦ.

***ᓇᓗᓇᐃᕈᑎᑦ ᑕᐃᔫᓯᑦ:*** ᕿᑭᖅᑕᓗᐃᑦ ᑐᒃᑐᑦ, ᐅᒥᖕᒪᑦ, ᖃᖕᒐᑕᓲᒃᑯᑦ ᓈᓴᕐᓂᖅ, ᓄᓇᒃᑯᑦ ᓈᓴᕐᓂᖅ, ᓄᓇᕘᑦ, ᐅᖕᒐᓯᖕᓂᒃᑯᑦ ᐆᒃᑐᕋᕈᑎᕐᑲᕐᓂᖅ, *Rangifer tarandus pearyi, Ovibos moschatus*

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**PREFACE:**

Section 5 and 6 of this report do not necessary represent the views of co-author G. Hope.

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# 1.0 INTRODUCTION

Peary caribou (*Rangifer tarandus pearyi*) are a distinct caribou subspecies that occurs almost entirely on islands within the Canadian Arctic Archipelago. These ungulates live the farthest north of all *Rangifer* in North America, and are the smallest in stature and in population size (Banfield, 1961). In February 2011, Peary caribou were listed as Endangered under the federal Species at Risk Act, due to declines in abundance and expected changes in long-term weather patterns (Canada Gazette Part II, Vol 145, No4, 2011-02-16). This action has trigged recovery planning and current information on population abundance and trends is required. However, because of their remote location, widespread distribution, and the general inaccessibility of their range, research has been limited and foundation information on the distribution and abundance of Peary caribou is lacking for some portions of their range. Through this report we hope to address some information deficiencies and assist in the planning effort.

Endemic to Canada, the terrestrial range of Peary caribou is roughly 540,000 km$^2$ and extends across the Queen Elizabeth Islands in the north, and east from Banks Island to Somerset and the Boothia Peninsula in the south (Figure 1). Ice surrounds the islands for most of the year and caribou on some islands use the sea ice during seasonal migrations (Miller 1990b; Miller *et al*., 2005a). Although the range is vast, the area is characterized by extreme weather (Maxwell, 1981), long periods of darkness and large expanses of bare ground, ice and rock (Gould *et. al.,* 2002). The landscape is treeless and environmental conditions, which include a short growing season, approach the physiological tolerance limits of plants (Edlund and Alt, 1989; Edlund *et al*., 1990; Gould *et al.,* 2002). Except for a few northerly islands, muskoxen (O*vibos moschatus*) occur in sympatry with Peary caribou (Figure 2) and in the last 50 years have expanded their range and recolonized areas previously unoccupied (Gunn and Dragon, 1998; Taylor 2005).

In contrast, muskoxen were extirpated from much of their southern range by the early 1900s causing the Canadian Government to implement controls on muskox hunting and trading in 1917 (Urquhart, 1982). In remote areas, muskoxen continued to be used for subsistence (Urquhart, 1982) and since 1969 Inuit of northern Canada have been permitted to hunt muskoxen under a quota system. In general, this species has been recovering and in the Northwest Territories muskoxen have been listed as Secure (Working Group of General Status of NWT Species, 2006). Internationally, muskoxen have been assessed as Low Risk Least Concern by the IUCN (IUCN 2010). On some Arctic islands however, muskoxen, like Peary caribou, have experienced significant declines due to severe weather events (Miller *et al*., 1977a; Miller 1998; Gunn and Dragon 2002).

In 1961, Tener (1963) completed the first and only comprehensive survey of both Peary caribou and muskoxen across the Queen Elizabeth Islands in a single season and estimated approximately 25,845 Peary caribou and 7421 muskoxen. The majority of caribou (approximately 94%) were located in the western Queen Elizabeth Islands (i.e. Bathurst Island Complex, Cornwallis, Melville, Prince Patrick, Eglinton, Emerald, Borden, Mackenzie King, Brock). A consequence of this finding was that subsequent surveys were focused in that area. The first population estimates for the southern Arctic islands included a 1972 estimate of 11,000 caribou on Banks Island (Urquhart, 1973); 4512 caribou in 1980 on northwestern Victoria Island (Jakimchuk and Carruthers,


**Figure 1:** Peary caribou range across the Canadian Arctic. Modified from COSEWIC (2004).

1980), 5515 caribou on Prince of Wales and Somerset Islands (Fisher and Duncan, 1976, values converted to all caribou in COSEWIC, 2004) and 561 caribou on the Boothia Peninsula in 1974 (Fisher and Duncan, 1976). Thus, when the first estimates of abundance on the southern Arctic Islands are combined with estimates from the QEI, it's possible that as many as 48,000 Peary caribou occupied the entire range historically (COSEWIC 2004).

For muskoxen, Tener (1963) estimated 7421 muskoxen on the Queen Elizabeth Islands in 1961, while an additional 3800 were estimated on Banks Island during the first systematic survey in 1971-72 (Urquhart, 1973). For Victoria Island, the population was estimated at 908 animals in 1958-59 (Macpherson, 1961) while systematic surveys in 1974-75 resulted in a total population estimate of 600 for Prince of Wales and located no muskoxen on Somerset Island or the Boothia Peninsula (Fisher and Duncan, 1976). These surveys suggest that approximately 12,700 muskoxen occurred in sympatry with Peary caribou in the early 1960-70s.

Between 1961 and 1974, subsequent aerial surveys for the western Queen Elizabeth Islands measured severe declines in both species (Miller et al., 1977) and in 1979, Peary caribou were assigned the status of Threatened by the Committee on the Status of Endangered Wildlife in Canada (Gunn *et al.,* 1981; COSEWIC, 2004). Peary caribou on Banks Island and the High Arctic islands (i.e. the Queen Elizabeth Islands) were re-assessed as Endangered in 1991 and Peary caribou in the lower Arctic stayed as Threatened (Miller, 1990a). In May 2004, the entire subspecies *pearyi* was reassessed as Endangered (COSEWIC) due to continued declines and expected changes in long-term weather patterns. The Endangered status triggered extensive


**Figure 2:** Muskox range across the Canadian Arctic Archipelago. Modified from Urquhart (1982).

consultations after which the Governor General in Council, in February 2011, amended Schedule 1 of the Species at Risk Act, to include Peary caribou as Endangered (Canada Gazette Part II, Vol 145, No4, 2011-02-16).

The decline of Peary caribou is characterized by four major die-offs which were observed primarily in the western Queen Elizabeth Islands between 1970 and 1998, and involved the synchronous crash of muskoxen (Miller *et al*., 1977a; Miller, 1998; Miller and Gunn, 2001; Gunn and Dragon, 2002; Miller and Gunn, 2003b). Die-off events have been associated with deep snow and icing, which can limit access to forage, increase energy requirements and lead to extreme under-nutrition and death (Parker *et al*., 1975; Miller *et al.,* 1977a; Gunn *et al*., 1981; Parker *et al*., 1984; Miller, 1990a; Miller, 1998; Miller and Gunn, 2003b; COSEWIC, 2004; Miller and Barry, 2009). Observations by local Inuit are in agreement, reporting up to 2 inches of ice in some years (Taylor, 2005; Jenkins *et al.,* 2010a. 2010b).

Fragmented data shows that periods of decline and recovery vary among island populations, and that factors such as anthropogenic activities and landscape changes, predation, hunting and competition may also contribute to the fluctuation of caribou and muskox populations (Riewe, 1973; Miller, Gunn and Dragon 1998, Gunn *et al*., 2000; Miller and Gunn, 2001, Gunn and Dragon, 2002, Jenkins *et* al., 2010a). Inuit in Resolute Bay (Cornwallis Island) and Grise Fiord (Ellesmere Island) have identified exploration activities (i.e., oil and gas, coal and base minerals) as an additional stressor for caribou during some winters (Jenkins *et al.,* 2010a, Jenkins *et al.,* 2010b). They suggest that, during years of high snow accumulation, industrial activities can and have inhibited caribou from moving into areas that were vital for their survival (Jenkins *et al.,* 2010a, Jenkins et al., 2010b). Tews *et al*. (2007a) argued that density-dependent mechanisms may also be important but agreed with other authors that major fluctuations in Peary caribou abundance are likely driven mainly by unpredictable environmental perturbations. Finally, it is recognized that hunting and predation could dampen recovery and exacerbate Peary caribou declines, particularly when populations are small and vulnerable to extinction (Gunn and Decker, 1984; Miller, 1990a; Gunn and Ashevak, 1990; Gunn and Dragon, 2002). The effect of predation on population size is currently unknown (Miller, 1990a; Gunn and Dragon, 2002) and detailed records of caribou harvest (i.e., number harvested, location, date) are not available for most areas. Uncertainties for the future include the potential negative impacts of climate change, (Post and Stenseth, 1999; Miller *et al*., 2005; Tews *et al.,.* 2007a; Tews *et al.,* 2007b; Miller and Barry, 2009), industrial exploration, development, and shipping (Vors and Boyce, 2009; Poole *et al.,* 2010).

Climate induced changes are expected to be the most severe in the Arctic (Maxwell 1997; Anisimov *et al*. 2007, Prowse *et al.* 2009). For example, it is predicted that surface air temperatures will increase in the Arctic at twice the global rate (McBean *et al*. 2005, Anisimov *et al* 2007) and average seasonal precipitation will increase significantly across all seasons (Rinke and Dethloff 2008). Some associated changes include reduced sea ice cover, shifts in the temporal and spatial distribution and composition of vegetation, increased snow cover, and the increased frequency of icing events (Post and Stenseth 1999, Anisimov *et al*. 2007, Post et al. 2008, Rinke and Dethloff 2008, Vors and Boyce 2009). Notably, both the severity and frequency of extreme winter events is expected (ACIA 2005, Tews *et al*. 2007b).

Nunavummiut are concerned about the conservation of Peary caribou and their habitat (Jenkins *et al*., 2010a; Jenkins *et al*., 2010b). Caribou are of major cultural, traditional and economic importance to Inuit, they are a vital part of the Arctic ecosystem and a valued food source (Ferguson and Messier*,* 1997; Miller and Gunn, 2001; Taylor, 2005). In Nunavut, Peary caribou harvest has not been restricted through legislation. Instead, from 1975 to ca. 1989, the Resolute Bay Hunters and Trappers Association (HTA) imposed voluntary harvest restrictions for caribou on the Bathurst Island Complex (Miller, 1990; DoE 2005). This action was triggered by a decline in caribou during the winter of 1973-1974 (Miller, 1990; DoE, 2005a; Nancy Amarualik, personal communication, Sept 2010). The Iviq HTA of Grise Fiord also imposed a 10-year prohibition on Peary caribou harvest (1986-1996) on southern Ellesmere Island due to scarcity of animals in the 1980s (DoE 2005b). However, Inuit knowledge is that conflicting land-use activities (such as mineral exploration) pose a greater potential threat to Peary caribou and their habitat than hunting (Jenkins *et al.,* 2010b).

Ultimately, the Department of Environment (DoE) of the Government of Nunavut (GN) is responsible for the management and conservation of caribou and muskoxen within its jurisdiction. This responsibility is outlined in the Nunavut Land Claim Agreement 1993, Article 5 (Indian and Northern Affairs Canada, 1993). However, for many populations of Peary caribou and muskoxen in Nunavut, estimates of abundance have not been recorded since 1961. Other populations have been surveyed infrequently and information about them is highly fragmented (Miller, 1990a; Miller and Gunn, 2003b). This has created significant knowledge gaps, which poses challenges for wildlife management decision-making.

Due to the fact that populations can change drastically and quickly, lengthy delays between surveys are risky. For example, the Peary caribou on Prince of Wales and Somerset Islands were not surveyed during a 15-year period. It was found that the numbers had declined from about 6000 in 1980 to just a few caribou by 1995 (Gunn and Dragon, 1998). To assess whether the caribou had recovered from such low numbers, these islands were part of our survey program in 2004.

The north central and eastern Queen Elizabeth Islands have not been surveyed since 1961 (i.e., Ellef Ringnes, Amund Ringnes, Axel Heiberg) and only a small number of partial aerial surveys of Ellesmere Island have been completed (Riewe, 1973; Case and Ellsworth, 1991; Gauthier, 1996). Part of the delay was uncertainty about the most efficient and effective approach for an aerial survey in this mountainous and glaciate region. This challenge was discussed at a workshop held in Grise Fiord in 1997, when Inuit hunters and biologists examined survey techniques and explored the idea of combined ground and aerial surveys (DoE, GN unpublished).

Bathurst Island Complex has been re-surveyed relatively frequently and by the early 1990s, the surveys revealed that Peary caribou and muskoxen on Bathurst and its neighbouring islands had returned to levels that Tener (1963) reported for 1961 (Miller, 1997a). However, during three consecutive severe winters marked by icing and deeper snow (1994-95; 1995-96; 1996-97), Peary caribou and muskox abundance dropped and Peary caribou numbered less than 100 by 1997 (Miller, 1997a; Gunn and Dragon, 2002). Subsequent to 1997, there was a need to determine if Peary caribou numbers were recovering on Bathurst and its neighboring islands as the population is particularly important for Inuit from Resolute Bay.

The gaps in information and the need for Nunavummiut to have updated information on the status and recovery of Peary caribou and muskoxen led to a large scale survey program during April and May, 2001 through 2008. In this report, we present the results from the multi-year systematic line transect aerial survey and non-systematic ground survey of Peary caribou and muskoxen across the Canadian Arctic Archipelago in Nunavut. Specifically, we describe population abundance, distribution and productivity estimates for both ungulates across their range in Nunavut (except Melville Island and Boothia Peninsula). This report updates and replaces the previous work of McLoughlin *et al*., (2006).

# 2.0 METHODS

## 2.1 POPULATIONS

### 2.1.1 <u>Peary Caribou</u>

At the subspecies level, Peary caribou vary in relative skeletal size through north-south and east-west gradients (Manning 1960; Thomas *et al*., 1976, 1977; Thomas and Everson, 1982). This diversity has been attributed to the geographic and environmental variation (i.e. climate) that characterizes the Canadian Arctic Archipelago. Peary caribou are smaller and have a lighter-coloured pelage than other caribou subspecies, and they tend to occur in small herds of three to five animals although group size varies seasonally and tends to be greater later in summer (Miller *et al*., 1977). Owing to their low density, small group size, and extensive spatial distribution across islands, these caribou are generally referred to at the scale of 'populations' and not herds (Zittlau 2004).

Peary caribou are usually described as geographic (island) populations, defined by island or island complex boundaries (Gunn *et al*., 1997; Zittlau 2004). Grouping islands is necessary as some Peary caribou are known to make seasonal movements between islands (Miller *et al*., 1977b; Miller 1990b; Miller, 1995a; Miller, 2002; Miller and Barry, 2003; Miller et al. 2005a; Taylor 2005; Jenkins in prep.). We grouped the islands based on the literature (Tener, 1963; Gauthier, 1996; Gunn and Fournier, 2000; Gunn and Dragon, 2002; Miller and Gunn, 2003a; Zittlau, 2004; Miller *et al,*. 2005b; Taylor 2005; Gunn *et al,*. 2006, Miller and Barry 2009; Jenkins in prep) and refer to each population by the ‘Island Group’ name (Table 1, Figure 3). Each Island Group is comprised of multiple islands, which are detailed in Table A, Appendix 1. The level of information used to define each ‘Island Group’ varied, and in Table 1, we identify the ‘Island Groups’ within corresponding larger scale eco-units, metapopulations and conservation units (Miller, 1990a; Gunn *et al.,* 1997; Zittlau, 2004; Miller *et al.,* 2005b; Miller and Barry, 2009).

Melville Island and Boothia Peninsula were excluded from this study.

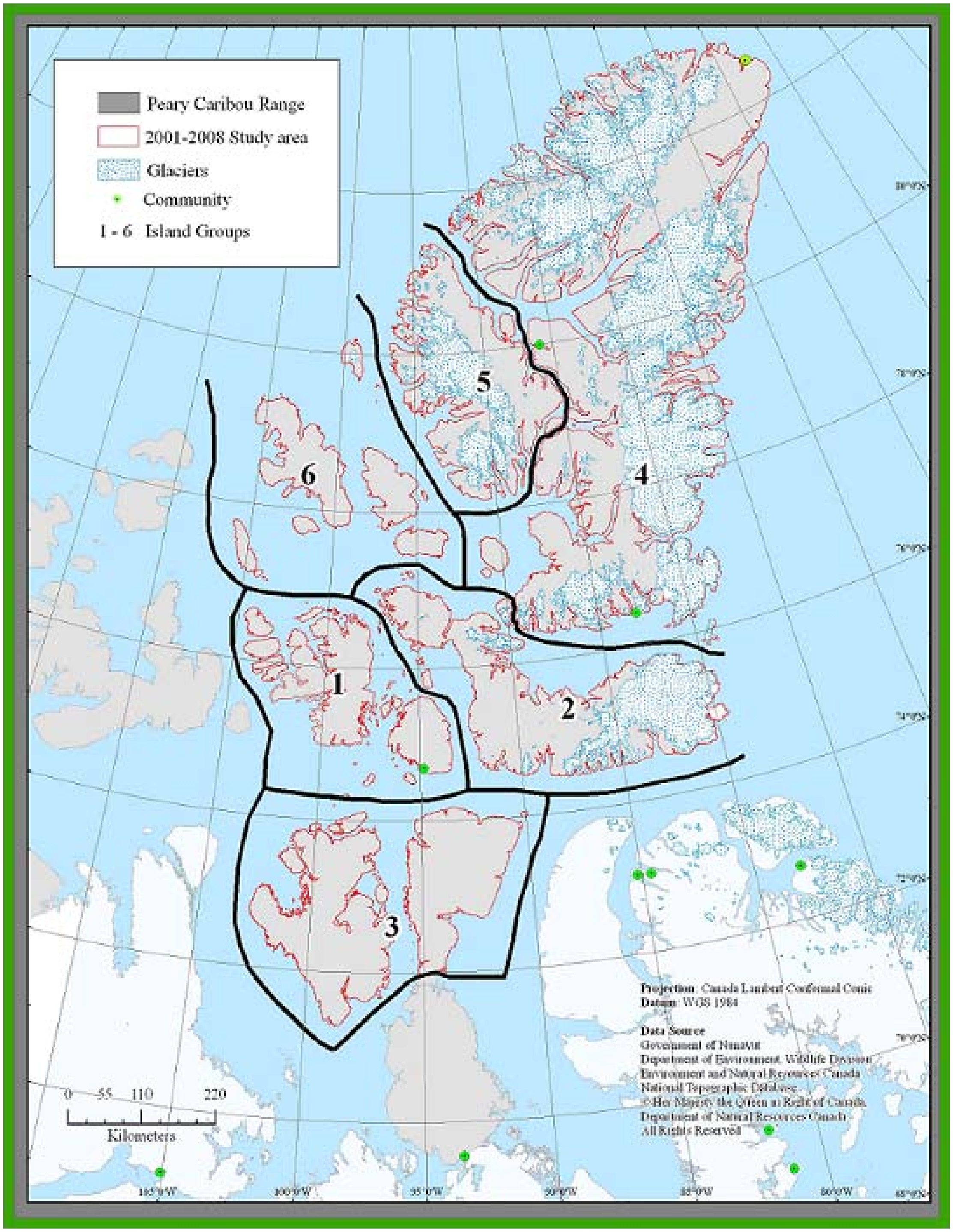


**Figure 3:** Organization of survey area into Island Groups; 1) Bathurst Island Group, 2) Devon Island Group, 3) Prince of Wales/Somerset Island Group, 4) Ellesmere Island Group, 5) Axel Heiberg Island Group, 6) Ringnes Island Group

**Table 1:** Peary caribou Island Groups in the Arctic Archipelago, Canada. Island Groups highlighted in blue, occur in Nunavut and were included in this study. Areas that occur (primarily) in the Northwest Territories are highlighted in gray.

| | | Organization as Applied to this Study | | |
|---|---|---|---|---|
| **Metapopulation (Conservation Unit)** | **Ecounits** | **Island Group** | **Survey Area (SA)** | **Survey Year** |
| Western Queen Elizabeth Islands | South-central | The Bathurst Island Group | Bathurst Island Complex | 2001 |
| | | | Cornwallis/Little Cornwallis | 2002 |
| | Southwestern | Melville Island Group | n/a | n/a |
| | Northwestern | Prime Minister Island Group | n/a | n/a |
| Eastern Queen Elizabeth Islands | Eastern | Ellesmere Island Group | S. Ellesmere | 2005 |
| | | | N. Ellesmere | 2006 |
| | | Axel Heiberg Island Group | Axel Heiberg | 2007 |
| | | Devon Island Group | Devon | 2008 |
| | | | North Kent | 2008 |
| | | | Baillie Hamilton | 2008 |
| | | | Dundas/Margaret | 2008 |
| | North-central | Ringnes Island Group | Ellef Ringnes | 2007 |
| | | | Amund Ringnes | 2007 |
| | | | Cornwall | 2007 |
| | | | King Christian | 2007 |
| | | | Meighen | 2007 |
| | | | Lougheed | 2007 |
| Prince of Wales and Somerset Island Complex (includes Boothia) | n/a | Prince of Wales/Somerset Island Group | Prince of Wales (incl. Russell) | 2004 |
| | | | Somerset | 2004 |
| Boothia Peninsula | n/a | n/a | n/a | n/a |
| Banks Island - Northwestern Victoria Island | n/a | n/a | n/a | n/a |
| **References** | | **References** | | |
| Gunn *et al.* , 1997; Zittlau, 2004; COSEWIC, 2004 | Miller, 1990a; Miller *et al.*, 2005b; Miller and Barry, 2009 | Miller et al., 1977b; Miller 1990b; Gauthier, 1996; Gunn and Fournier, 2000; Miller 2002, Gunn and Dragon, 2002; Miller and Gunn, 2003b; Zittlau, 2004; Taylor, 2005; Miller et al. 2005a; Miller and Barry, 2009; Jenkins in prep. | | |

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### 2.1.2 Muskoxen

We used the same Island Groups for muskoxen as we used for Peary caribou.

## 2.2 STUDY AREA

The Arctic Islands of Nunavut and the Northwest Territories, and the Boothia Peninsula (Nunavut), are the principle range of Peary caribou. The area lies within the Arctic Cordillera and Northern Arctic Ecozones of Canada, which are characterized by a severe climate, shallow soils, sparse dwarfed plant growth, and large areas of permanent ice or exposed bedrock (i.e., Edlund and Alt, 1989; Edlund, 1990; Natural Resources Canada, 2007). Our study area encompassed 25 major islands (area $\geq$ 200 $km^2$), 40 minor islands (area <200 $km^2$), and numerous smaller unnamed islands with a collective island landmass of approximately 407,599 $km^2$ (Figure 3; Table A, Appendix 1). The majority of these islands are uninhabited by humans. There are only two residential communities within the study area: Resolute Bay (74°41'51''N, 094°49'56''W) on Cornwallis Island and Grise Fiord (76°25'03''N, 082°53'38''W) on the southern coast of Ellesmere Island. The settlement of Alert is situated on the north coast of Ellesmere Island (82°30'05''N, 062°20'20''W) and functions as both a base for the Canadian Forces and an Environment Canada weather station (National Defence 2010). Eureka, located on the west central coast of Ellesmere Island (79°58'59''N 85°56'59''W), serves as a permanent research center and the site of an Environment Canada Weather Station (Environment Canada 2011).

***The Bathurst Island Group*** --. This group of islands includes the Bathurst Island Complex (BIC), surveyed in 2001 and Cornwallis/Little Cornwallis Islands surveyed in 2002. The BIC (19,644 $km^2$) includes Bathurst Island and four major satellite islands (> 200 $km^2$; Cameron, Vanier, Alexander, Massey, and Helena), and three minor satellite islands (Table A, Appendix 1). The islands are low-lying with few areas exceeding 300 m elevation. The terrain is sparsely vegetated (Edlund, 1981; Edlund, 1983; Edlund and Alt 1989; Walker *et al*., 2005). Low-lying wetlands such as the Goodsir-Bracebridge Inlet have a higher cover of sedges and low-growing willows (Edlund and Alt 1989).

Cornwallis and Little Cornwallis islands (7,474 $km^2$ including small proximal islands), surveyed in 2002, are low-lying with uplands and hills below 300 m and mostly polar desert with sparse vegetation (Babb and Bliss, 1974). Portions of the western coastline and Eleanor Lake watershed (Cornwallis Island) support more diverse vegetation, including prostrate shrubs in moderately moist habitats, and sedges in the wet areas (Edlund and Alt, 1989)

***Devon Island Group*** --. Devon Island (55,534 $km^{2,}$;including small proximal islands) is characterized by several mountain ranges (e.g., Cunningham Mountains, Treuter Mountains, and the Douro Range), coastal lowlands, and extensive glaciers. The Devon Ice Cap covers a large portion of eastern Devon Island and reaches 1920 m in elevation (Statistics Canada 2010). Extensive uplands stretch west of the Ice Cap across central Devon Island. Low-lying areas occur in coastal areas, primarily along the north and western coast (the Truelove lowlands), but also Philpots Island (a peninsula), portions of the Grinnell Peninsula, Croker Bay, and Cape Sherard (Figure 4).

The landscape of this island is predominantly polar desert with sparse cover of vascular plants (Babb and Bliss, 1974; Edlund and Alt, 1989); however, coastal regions, such as the Truelove Lowlands and portions of the Grinnell Peninsula, support a greater diversity of vegetation dominated by prostrate shrubs (i.e. *Salix arctica* and/or *Dryas integrifolia*) and sedges (Edlund and Alt, 1989). North Kent, Dundas/Margaret, and Baille Hamilton Islands are part of the Island Group.


**Figure 4:** Devon Island Group.

***Ellesmere Island Group*** *--.* Ellesmere Island is the largest of the Queen Elizabeth Islands (197,577 $km^2$). It is approximately 500 km wide and 800 km long (Figure 3). The island is largely covered by mountain ranges and glaciers that are separated by a series of east-west passes. Several glaciers flow into adjoining bays and fiords. These features fragment the island, particularly where the north end of Vendom Fiord approaches the Prince of Wales Ice Cap, and divides the southern portion of the island from the north. Graham (1,387 $km^2$) and Buckingham (137 $km^2$) islands were included in the survey (Figure 5) along with a number of small islands proximal to Ellesmere.

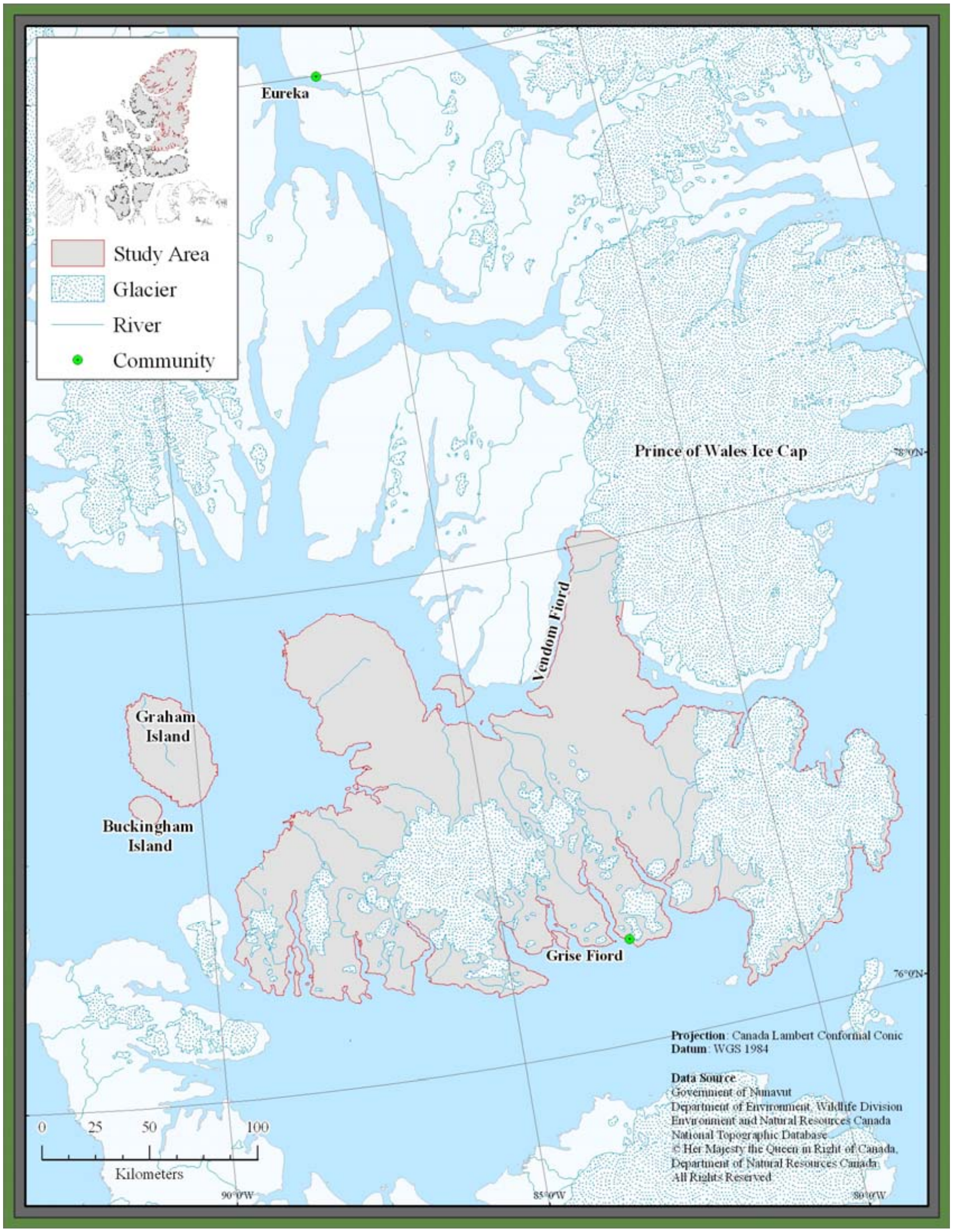



**Figure 5:** Southern Ellesmere survey area.

***Axel Heiberg Group*** **--.** Axel Heiberg Island (42,319 km$^2$) is separated from Ellesmere Island by Nansen and Eureka Sound (Figure 3). This island is mountainous and includes the Princess Margaret Range, which runs north to south through its center. Large ice caps cover much of the landmass (e.g., Muller Ice Cap, Steacie Ice Cap) and spawn many glaciers that flow primarily to the west. Elevations on the island vary, with many mountains topping 1200 m. The highest point occurs centrally at Outlook Peak (2210 m; Statistics Canada 2010). East of the Princess Margaret Range, vegetation progresses from an herb-shrub transition zone at higher elevations to an enriched prostrate shrub zone along the low-lying coast. The plant flora can be diverse and dense, dominated by shrubs (i.e., *Salix arctica* and/or *Dryas integrifolia*) and sedge meadows (Edlund and Alt, 1989). West of the Princess Margaret Range, vegetation is less diverse with large areas of sparse herbaceous communities (Edlund and Alt, 1989).

***Ringnes Island Group --.*** Ellef Ringnes, Amund Ringnes, Lougheed, King Christian, Cornwall, and Meighen Islands are all situated to the west of Axel Heiberg Island and north of the Bathurst Island Complex. Lougheed Island (1,321 $km^2$), is the most westerly island in the study area and lacks significant topography (maximum elevation 124 m). The vegetation on Lougheed Island is described as entirely herbaceous (Edlund and Alt, 1989) with rich vegetation patches (Tener, 1963). Lougheed is the largest of five small islands that form the Findlay Group.  Ellef Ringnes Island, approximate area 11,428 $km^2$, is sparsely vegetated with low plant diversity. The vegetation is almost entirely herbaceous, with few decumbent shrubs and sedges (Edlund and Alt, 1989). Portions of the island are hilly (i.e., Isachsen Dome, Dumbbells Dome, Baker Hill) with elevations reaching 263 m (Department of Natural Resources, 2006). King Christian Island is located southwest of Ellef Ringnes, has an area of 647 km$^2$, and is characterized by a dry central plateau and low coastline (Tener, 1963). Its vegetation is described as entirely herbaceous with low diversity (Edlund and Alt, 1989). Amund Ringnes Island, approximate area 5,299 km$^2$, is relatively low lying but features greater relief in the north. Elevations reach a maximum of 316 m and regional vegetation is entirely herbaceous. The southern half of the island supports more diverse vegetation, primarily herbaceous plants with some shrubs and sedges (Edlund and Alt, 1989). To the south of Amund Ringnes is Cornwall Island, a small hilly landmass with elevations rising to 350 m at Mt. Nicoley on the north-central coast (Tener 1963, Department of Natural Resources). Cornwall is also dominated by herbaceous vegetation (Edlund and Alt, 1989). Meighen Island (approximately 933 km$^2$), to the northeast of Amund Ringnes, is low-lying with sparse herbaceous vegetation and a large centrally located glacier (the Meighen Ice Cap) that reaches a maximum elevation of 265 m (Department of Natural Resources, 2006)

***Prince of Wales/Somerset Island Group*** *--.* Prince of Wales (33,274 km$^2$) is a tundra-covered island that features many small inland lakes. Although the island is generally below 300 m in elevation, some uplands occur along the eastern coast and across the north. Russell Island and Prescott Island (included in the study area) are small proximal islands north and east of Prince of Wales, respectively. Somerset Island (24,548 km$^2$), separated from the Prince of Wales Island by Peel Sound, is hilly with extensive uplands (higher than 300 m elevation) throughout (Department of Natural Resources, 2000).

In addition to supporting caribou and muskoxen, many of the islands surveyed in this study are known habitat for polar bear (*Ursus maritimus*), arctic wolf (Canis lupus), arctic fox (*Alopex lagopus*), arctic hare (*Lepus arcticus*), snowy owls (*Bubo scandiacus*) and rock ptarmigan (*Lagopus muta*). Arctic wolves are known to prey on both caribou and muskoxen (Miller, 1993b; Mech, 2005).

## 2.3 SURVEY METHODS

Representatives from nearby communities were consulted to determine the most appropriate survey design. Given the extensive landmasses within the survey area, uncertain weather conditions, and rugged terrain, a combination of both ground and aerial survey methods were selected. The aerial survey design needed to balance between increasing estimate accuracy and precision with safety and logistical practicality. The design had to be standardized to be repeatable and to deal with low densities over large areas for two species with different sightability, which led us to select Distance Sampling methodology (Buckland et al., 2001; Thomas *et al.,* 2002)

### 2.3.1 Ground Survey

Ground surveys were conducted by hunters on snowmobiles from 2001-2006. The purpose of the ground surveys was to delineate specific areas occupied and unoccupied by caribou and muskoxen based on observations of recent tracks, foraging sites and animals. This information was provided to an aerial survey crew for the purpose of stratifying aerial survey effort. Specifically, ‘areas occupied’ by caribou and muskoxen were included in the aerial survey program, while areas ‘not occupied’ were excluded from the aerial survey and assigned an abundance of zero. When the terrain was too rugged for ground crews to be certain of wildlife occupancy, the area was surveyed using aerial methods.

Ground teams recorded all observations and their geographical locations in field books, including information on wildlife sightings, group size and location. Observations of animal sign were also recorded (e.g., tracks in snow, feeding sites) and samples were collected (e.g., fecal pellets or shed antlers). Hand-held GPS units (Garmin© GPSmap 76S) were used to record locations and to log the survey routes of each snowmobile (called track logs). GPS data were downloaded into a Geographical Information System (GIS). Field observations were entered into Microsoft Excel© spreadsheets and integrated with the survey track data. After 2004, the ground survey program continued but information was not used to direct the aerial survey program. In 2007 and 2008, ground surveys were discontinued due primarily to logistical constraints, including safety (rugged terrain, harsh weather) and remoteness.

#### 2.3.2 Aerial Survey

Peary caribou and muskoxen are dispersed over large geographic areas. A complete census is not possible and abundance estimates are based on sampling methods. We used a distance sampling line transect aerial survey method (Buckland *et al*., 2001; Thomas *et al*., 2002) to estimate densities of Peary caribou and muskoxen for each of the island groups identified above. This was done using a systematic line-transect design with a random start location (Figure 6). Lines were spaced 5 km apart and ran east–west across the study site, except for Prince of Wales and Somerset

Islands, where transect spacing was 10 km (Figure 6). Transect spacing was selected to maximize aerial coverage with the limited available resources for the study. Transect orientation was parallel to lines of latitude with the first transect placed randomly.

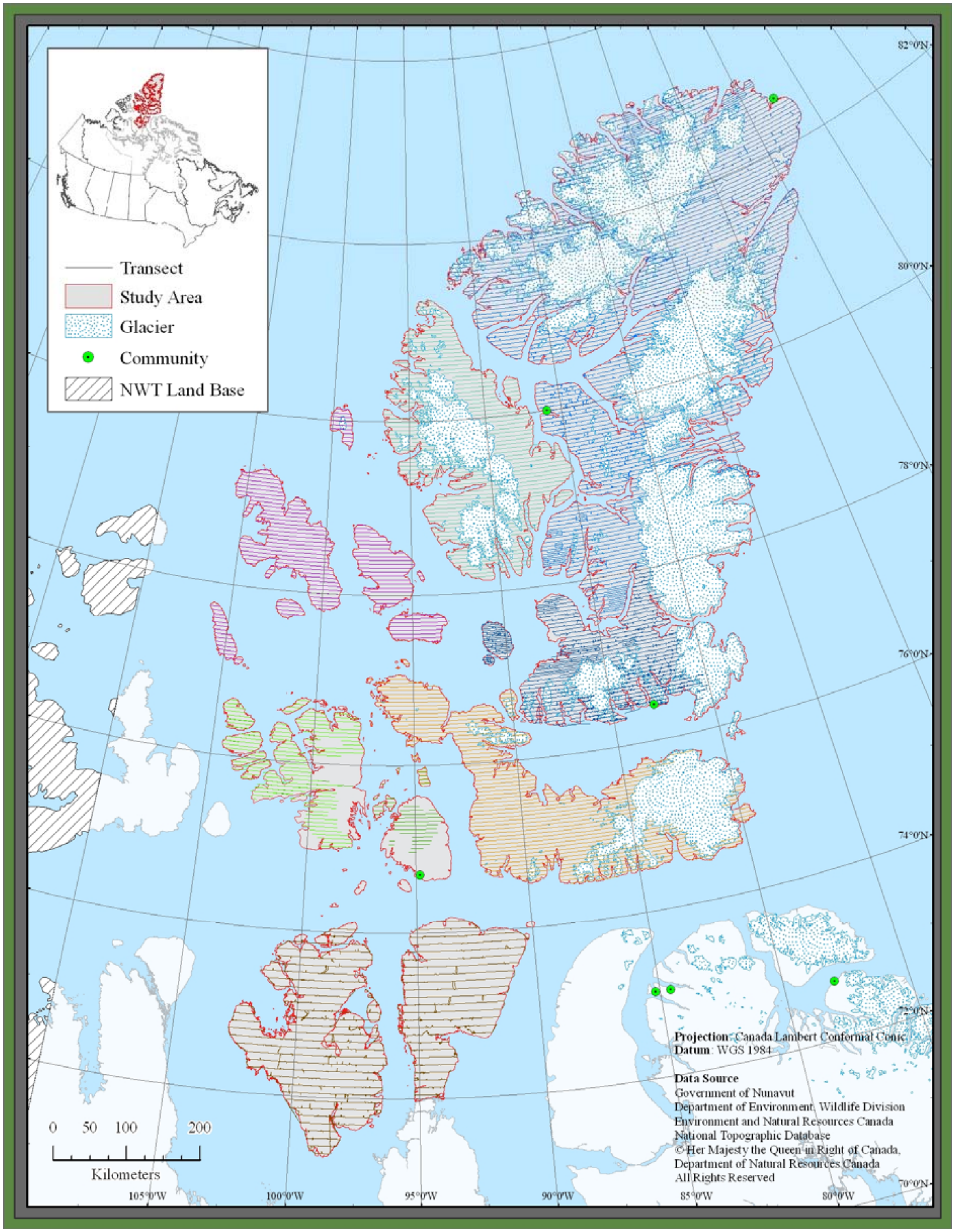



**Figure 6:** Systematic aerial line-transects for the aerial survey program 2001-2008.

From 2001 through 2008, the line-transect coordinates were imported into ArcView© (www.ESRI.com) and uploaded onto hand-held GPS units (Garmin© 76 and 269 from 2001-2004, Garmin© GPSmap 176 and 276C from 2005-2008) to assist the aircraft along the specified transects. Additionally, from 2005 to 2008, survey routes were plotted in Map Source© and uploaded to duplicate Garmin© GPSmap 176 and 276C units to aid the pilot in navigating each transect.  In general, primary transects, identified as “A” transects, covered the entire land base with the exception of extensive ice fields or glaciers. For the initial aerial surveys (2001-2004), a concurrent ground surveys were used to inform aerial crews of areas “not occupied” by Peary caribou and muskoxen. These areas were eliminated from the aerial survey. As well, upon observing caribou along systematically random A transects, aerial crews also sampled additional lines along secondary transects (“B” transects) positioned midway between the primary transects. These additional transects were flown as a form of adaptive sampling, to intensify effort when caribou were seen.  Because B transects were not systematically random in their occurrence and they were not part of the survey design across years, observations and flight effort from B transects were excluded from our analysis.

We flew line transects using a Bell 206L or Bell206L4 helicopter at about 120 m above ground level and at an average estimated speed of 130 km/hr. The survey team consisted of four observers, including the pilot. The pilot and forward observer focused on the transect line in front of the helicopter including a search area approximately 45 degrees to the right and left of the helicopter. The two rear observers focused to each side of the helicopter with forward overlap with the front observers’ search area. We collected wildlife observations with no fixed transect width (unbounded line transect; Buckland *et al.,* 2001).

Upon detection of target animals (individuals or social groups), the helicopter diverted to fly perpendicular to the transect line to the animals to record location, species, group size, and the sex and age of individuals. The helicopter then circled back to the transect line so that no portions of the line would be missed. From 2007 on, no sex and age classifications were attempted if newborns were present. Hereafter, we refer to each wildlife observation as a cluster, defined for our purposes as an individual animal or group of animals of the same species observed within roughly 100 m of each other. Animal care and safety were priorities, and observation time was kept to a minimum to reduce disturbance. In particular, for muskoxen clusters that included newborns, a first count and location were recorded, a photo was taken (to confirm information), and the aircraft then left the site. Clusters observed while not flying along transects (i.e., while ferrying) were recorded and identified as off-transect observations. We recorded all data in field books and locations as waypoints on hand-held GPS units (Garmin© 76, 269, 176 and/or 276C). The GPS units also recorded automatically the helicopter location every 20-30 seconds, which were downloaded as track logs for each flight. When animal care and environmental conditions permitted, fecal pellets from caribou and muskoxen were collected for genetic analysis (Jenkins in prep).

All survey work was initiated and completed between the months of March and May, when snow cover enhanced visibility of both animals and their sign (i.e. tracks, foraging sites, bedding sites, craters). Survey data were integrated into ArcMap 9.1© (a

Geographical Information System) and used to map the distribution of caribou and muskoxen clusters. The perpendicular distance of wildlife clusters from each transect and the actual transect lengths flown were measured in ArcMap 9.1© following Marques *et al*. (2006). To reduce measurement error, we used a North Pole Azimuthal Equidistant Coordinate System that was centered on each of the survey areas and a map scale of 1:180,000 for transect length measurements. For measurements involving wildlife clusters, the scale was always less than 1:5000.

During our field program we took care to meet the three key assumptions of distance sampling (below) in order to produce an unbiased estimate of density (Anderson *et al*., 2001; Buckland *et al*., 2001):

1) All animals of interest that were directly on the transect line were detected.

2) Animals of interest were detected at their initial location before they moved in response to the observer (i.e., away from the aircraft).

3) Perpendicular distance (x) from the transect line to each detected cluster was measured accurately.

To address assumption # 1, our survey platform (the helicopter) was designed with two forward-sitting observers who had a clear view and direct focus on the transect line ahead of the helicopter. Thus, it can be assumed that no caribou and muskoxen on the ground directly beneath our flight path were missed. This was reasonable given the platform design, but also the relatively large mobile animals of interest, the general occurrence of these animals in groups, the snowy-white backdrop we had for observing due to time of year, and the treeless environment.

Assumption #2 relates to the concern for the sampling of animals that move to hiding places when startled by observers or for animals that are attracted to the observer and move prior to being sited (Buckland *et al*., 2001). However, both the field protocols and study area were conducive to spotting wildlife prior to movement. That is, the open barren landscape allowed for early detection of animals, and a lack of features such as vegetation meant that animals did not have access to shelter for hiding. As well, forward observers on the survey tried to minimize location error by looking ahead of the helicopter as the area was searched. If movement occurred subsequent to initial sighting, the original location of detection was recorded. Animal movement was generally random and slow relative to the speed and direction of the helicopter, and this eliminated the likelihood of serious sampling issues. Finally, we found that wildlife generally did not run from the helicopter except when they were very close to the transect line; thus, animals were generally detected in advance of movement and their original locations were easily recorded. For muskoxen, animals generally did not run from the helicopter but instead formed defense circles. To minimize disturbance, particularly as newborns might have been present in muskox clusters, the helicopter climbed to a higher altitude as soon as the animals were observed. This reduced noise and made the group less apt to move.

Finally, to address the third assumption, we followed Marques *et al*. (2006) and relied on post-sampling analyses using a Geographical Information System (GIS) to determine the perpendicular distance of clusters (given by the overhead GPS position of the animal cluster at the point where first observed) to the plotted transect flown by the pilot. Measurement error was minimized by using a North Pole Azimuthal Equidistant Projection centered on the island group of interest.

### 2.3.3 Age and Sex Composition

To evaluate herd structure and recruitment, the helicopter, after waypointing the location of the initial cluster observation, reduced altitude and briefly over flew the cluster. All caribou sighted were sexed (male or female) and aged (newborn calves- less than 1 month of age; calves or ‘short yearlings’ - 10-12 months; yearling - 22-24 months; adult: older than 2 years ). Sex was determined based on the presence or absence of a vulva patch and/or urine staining on the rump (Miller, 1991). Supplemental information on the presence/absence of antlers and their size and shape was relatively diagnostic. Non-pregnant barren-ground females typically shed their antlers in April but less is known about the timing of shedding antlers in Peary caribou (Miller, 1991)

For muskoxen, during most survey years, detailed sex and age information was not collected. This was a response to calving and the presence of newborn calves within muskoxen groups. Thus, most muskoxen were categorized in two age classes: newborn calves (less than 2 months) and adult (one year or older). In some surveys, calves or ‘short yearlings’ (the previous year’s calves, approximately 11-12 months) were recorded separately.

For both caribou and muskoxen, newborn calves were excluded from the analysis of density and abundance due to expected low survival rates.

## 2.4 ANALYSIS

### 2.4.1 Density and Abundance

To estimate population density, we followed Buckland *et al*. (2001) and used the software Program Distance, Version 5.0, Beta 3 (Thomas *et al*., 2005) to model the line-transect data for each species. We derived density estimates using Conventional Distance Sampling for line-transect data and detection function models (key function/series expansions) recommended by Buckland *et al*. (2001). Each density estimate was multiplied by the survey area to derive an abundance estimate. We defined the survey area as the area within which systematic line (A) transects were surveyed (Aars *et al.,* 2008).

Distance sampling method assumes that some animals will be missed and that the number of observations will diminish with perpendicular distance away from the transect line. In many field surveys, only a small percentage of the animals of interest are detected (Anderson *et al*., 2001; Buckland *et al*., 2001); however, unbiased estimates of density can still be made for these populations using distance sampling methods. Thus, although we knew that not all groups of caribou and muskoxen would be detected during a given survey, this method allowed the average proportion detected $P_a$ to be estimated based on the perpendicular distance of animal clusters from the transect line. This was accomplished by computing a detection function g(x), where:

g(x) = the probability of detecting the animal (or, in this case, cluster of animals) given that it is at perpendicular distance x from the centerline of the transect being flown

and, $P_a$ ( the probability that a cluster in the survey area is detected):

$$\hat{P}_a = \frac{\int_0^w \hat{g}(x)dx}{w}$$

where $\hat{g}(x)$ is the estimated detection function and w is the strip width, or in this case the truncation distance. We used Program Distance v. 5.0 (Thomas *et al*., 2005) to calculate $\hat{g}(x)$, $\hat{P}_a$, and the estimated standard error (SE) of $\hat{P}_a$, the effective strip width (ESW, as defined below), as well as estimates of density (D, estimated as $\hat{D}$) and precision for the objects of interest. Here, $\hat{D}$ is estimated from standard line-transect theory:

$$\hat{D} = \frac{n}{2wL\hat{P}_a} \qquad \text{or} \qquad = n / (2 \times L \times ESW)$$

where $n$ is the number of sightings, $\hat{P}_a$ is the estimated (average) proportion of objects detected within the covered region, $L$ is the total length of the transect line, and ESW is the effective strip half-width (and can be substituted into the equation). This refers to distance on either side of the transect line where by as many objects are detected beyond the distance as are missed within it (Buckland *et al*. 2001, p424). $\hat{D}$ is, in effect, an estimate of the average density during the time of the survey and it is based on the total sampling effort.

As noted, observations in this study are clusters of animals. Therefore, the density of animals $D$ is expressed as a product of the density of clusters $\hat{D}$ (above) multiplied by the average cluster size E(s):

$$D = \hat{D} \ x\ E(s)$$

The probability of detection may be a function of cluster size such that the sample of cluster size exhibits size bias. In the absence of size bias, we used E(s) = the mean size of the detected clusters. When size bias was present, we used the regression method to estimate cluster size and correct for size bias (Buckland *et al*., 2001: 73-75). Buckland *et al*. (2001) presents details on the estimated sampling variance of D which is calculated using program Distance 5.0© (Thomas *et al*., 2005).

In order to model the detection function, we pooled data by species across all transect lines by survey area within island groups. Newborn calves were excluded from the analysis due to low expected survival rates. We considered several recommended models for the estimated detection function: half-normal (adjusted with cosine or Hermite polynomials), uniform (adjusted with cosine series or simple polynomial series), and hazard rates (adjusted with cosine series or simple polynomial series; Buckland *et al.,* 2001). Preliminary analysis allowed us to evaluate the distance data and the identification of an appropriate truncation distance which is recommended to delete outliers, to address size bias in detected clusters, and to facilitate modeling of the data (Buckland *et al*. 2001). In our final analysis, several robust models were tested and we used Akaike's Information Criterion (AIC) to select the model with best fit. We accepted the best-fit model if it had a non-significant goodness-of-fit value ($\chi^2$) and a non-significant Kolmogorov-Smirnov Test. For a full description of modeling rationale and options available in program Distance 5.0©, consult Buckland *et al*. (2001) and Thomas *et al*., (2005).

### **2.4.2 Age and Sex Composition**

When our data allowed, we estimated the proportion of calves in the population. For caribou, this was defined as the number of calves (or short yearlings) divided by the total number of caribou seen on transect.  For muskoxen, this was defined as the number of newborn calves divided by the total number of muskoxen seen on transect.

The difference in approach between species was necessary as most surveys occurred during muskoxen calving and 1-2 months prior to caribou calving.

For caribou, we also determined adult sex ratios. This was defined as the number of adult males per 100 adult females.

# 3.0 RESULTS

## 3.1 STUDY AREA FINDINGS

### 3.1.1 Ground Surveys

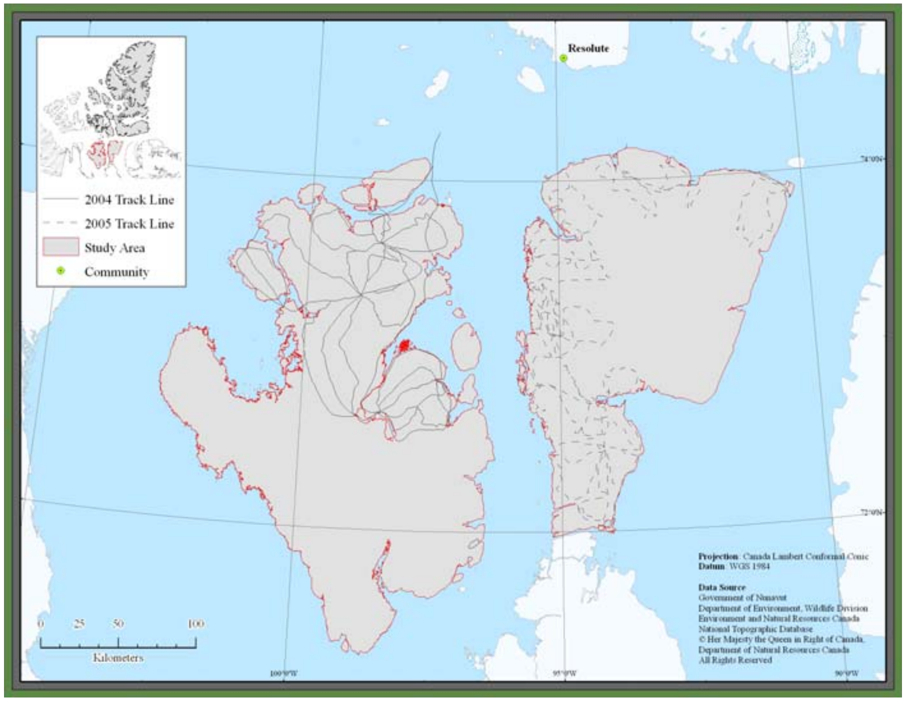
Ground surveys were completed in April-May of 2001, 2002, 2004, 2005 and 2006 on islands or portions of islands that originally corresponded with the aerial survey program. As noted, the original design was that information from ground teams would help direct the aerial survey effort; however, rugged terrain, harsh weather conditions, and areas of deep or no snow precluded some areas from being investigated on the ground. On occasion, whiteout conditions and severe winds made it impossible for ground crews to operate for days (Seeglook Akeeagok and Jeffrey Qaunaq, personal communication, September 2010). Thus, integration of the two methods was difficult and by 2004 the ground and aerial teams were working independently from a survey perspective. For example, Somerset Island was surveyed by aerial methods in 2004 and by ground methods in 2005. Ground surveys were not included in the 2007 and 2008 study program due to logistical constraints, including safety (rugged terrain, harsh weather) and remoteness.

Overall, from 2001 through 2006, snowmobile teams logged a total of 18,513 km of survey track on Bathurst, Cornwallis, western Devon, Prince of Wales and Somerset Islands, and portions of Ellesmere Island (Figures 7-8). The teams observed 44 Peary caribou clusters (137 individual caribou; Table 2) and 110 clusters of muskoxen (605 individuals; Table 3).

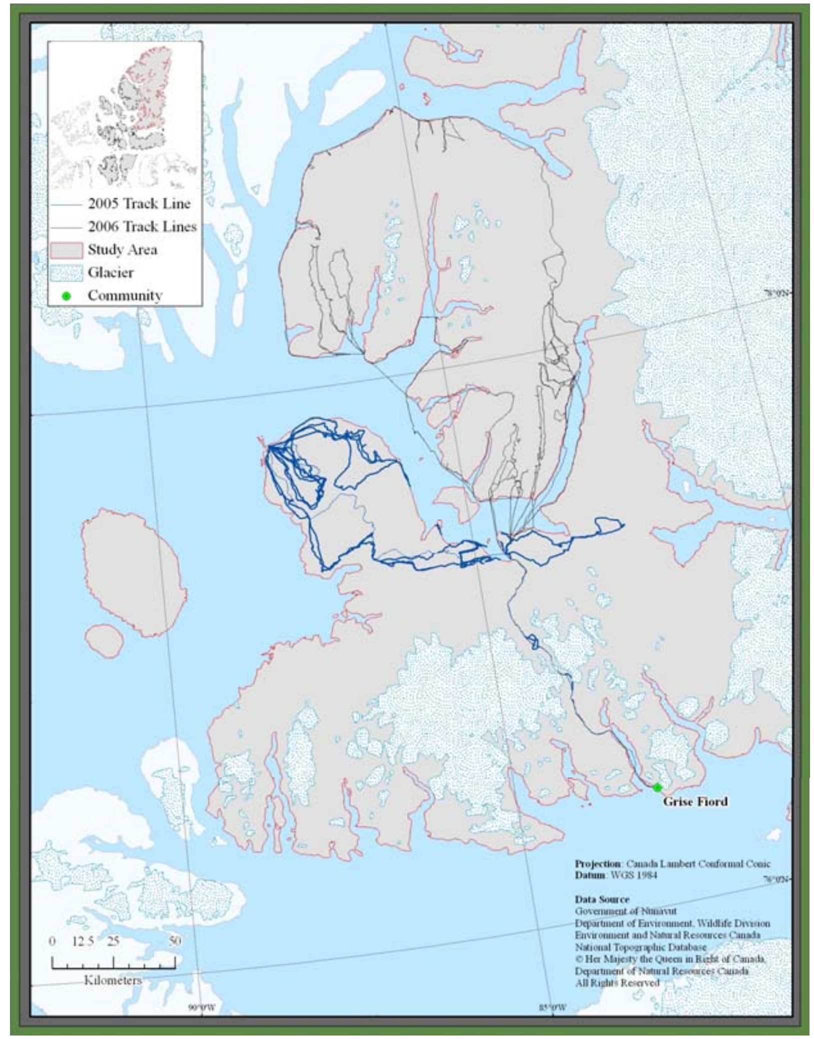

A)


(B)

**Figure 7:** Survey routes recorded by ground crews within 3 survey areas: (A) Bathurst Island Complex (2001) and (B) Cornwallis Group and Devon Island (2002).




A)




(B)

**Figure 8:** Survey routes recorded by ground crews within 4 survey areas: (A) Prince of Wales Island (2004), Somerset Island (2005), and (B) Southern Ellesmere Island (2005), and Northern Ellesmere Island (2006).

**Table 2:** Peary caribou ground survey results, 2001-2006.

| Geographical Area | Year Surveyed | Distance (km) | Total # Clusters Observed | # of Caribou Observed | # Newborn Calves | COMPOSITION Male | Female | Unknown | Clusters per 1000 km travelled | Tracks Observed | Carcasses Observed | Feeding Areas Observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bathurst Island | 2001 | 3887 | 18(1) | 46 | 4 | 13 | 12 | 25 | 4.6 | 20 | 0 | 7 |
| Cornwallis Island | 2002 | 1566 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Devon Island | 2002 | 3642 | 7(1) | 18 | 4 | 6 | 4 | 12 | 1.9 | 5 | 2** | 1 |
| Prince of Wales Island | 2004 | 1968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Somerset Island | 2005 | 2864*** | 2 | 3 | 1 | 1 | 1 | 2 | 0.7 | 1 | 0 | 1 |
| Ellesmere Island S. | 2005 | 1662 | 6 | 17 | ^^ | ^^ | ^^ | 17 | 3.6 | 1 | 0 | ^ |
| Ellesmere Island N. | 2006 | 2924 | 11 | 44 | 0 | 8 | 19 | 17 | 3.8 | 13 | 3 | ^ |

Notes: ** These specimens were recorded as ' found a bone' so not neccessarily a carcass. *** Distance travelled as per snowmobile odometers was 2936 km. () Figures in brackets represent duplicate cluster observations. ^ Not recorded in the only area where caribou were present. ^^ Not recorded. # of Caribou Observed = number of caribou 10 months or older.

**Table 3:** Muskoxen ground survey results, 2001-2006.

| Georaphical Area | Year Surveyed | Distance (km) | Total # Clusters Observed | # of Muskox Observed | # Newborn Calves | COMPOSITION Male | Female | Unknown | Clusters per 1000 km travelled | Tracks Observed | Carcasses Observed | Feeding Areas Observed | Feces Observed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bathurst Island | 2001 | 3887 | 3 | 28 | 2 | 3 | 8 | 19 | 0.77 | 9 | 1 | 6 | 3 |
| Cornwallis Island | 2002 | 1566 | 8 | 22 | 0 | 4 | 3 | 15 | 5.11 | 6 | 0 | 9 | 1 |
| Devon Island | 2002 | 3642 | 11** | 45** | 9 | 3 | 3 | 48 | 3.02 | 3 | 0 | 2 | 1 |
| Prince of Wales Island | 2004 | 1968 | 14~ | 160 | ^ | ^ | ^ | ^ | 7.11 | ^ | 0 | ^ | |
| Somerset Island | 2005 | 2864*** | 24 | 134 | **** | ^ | ^ | ^ | 6.98 | 3 | 17 | 2 | 9 |
| Ellesmere Island S. | 2005 | 1662 | 23 | 56 | 0 | 3 | 1 | 52 | 13.84 | 3 | 6 | ^ | |
| Ellesmere Island N. | 2006 | 2924 | 27 | 187 | 16 | 21 | 32 | 150 | 9.23 | 6 | 3 | ^ | 2 |

Notes: ** Includes one group of three, however no location was provided. *** Distance travelled as per snowmobile odometers was 2936km. **** 5 calves were recorded however it is unclear whether they were calves of the year or just turned 1 year old. ~ Includes one group of 6 muskoxen observed on the sea ice. () Figures in brackets represent duplicate cluster observations. ^ Not recorded. # of Muskox Observed = number of muskoxen one year or older.

### 3.1.2 Aerial Surveys

We flew 51,832 km on transect from April to May, 2001 to 2008. The survey area included the non-glaciated portion of 65 islands (plus small proximal unnamed islands: Appendix 1. Table A), in the six Island Groups (Figure 3).

Across the entire study area we tallied 398 observations of caribou that included 1,605 individual caribou (10 months or older) and 10 newborns. Although the timing of the survey work was designed as pre-calving, newborns were observed on Bathurst Island Complex as the survey was flown in late May 2001. The majority of Peary caribou clusters were in the eastern Queen Elizabeth Islands, primarily within the Axel Heiberg (31%) and Ellesmere (32%) Island Groups (Table 4, Figure 9). Abundance estimates were generated based on 305 observations of 1,336 caribou (10 months or older) that were seen on transect. Details are presented by survey area and Island Group in Table 4, Figure 9.

We tallied a total of 1,371 clusters of 11,191 muskoxen (1 year or older) and 1,492 newborn calves across the study area (Table 5, Figure 10). No muskoxen were observed on Ellef Ringnes, Meighen, and Lougheed Island in the Ringnes Island Group The number of clusters and the total number of individuals (both on- and off transect) are presented by survey area and Island Group in Table 5.

The majority of muskox clusters were observed in the eastern Queen Elizabeth Islands, primarily within the Ellesmere (57%) and Axel Heiberg (22%) Island Groups. Abundance estimates (Table 5) were generated based on 1,305 observations of 10,856 muskoxen (1 year of age or older).

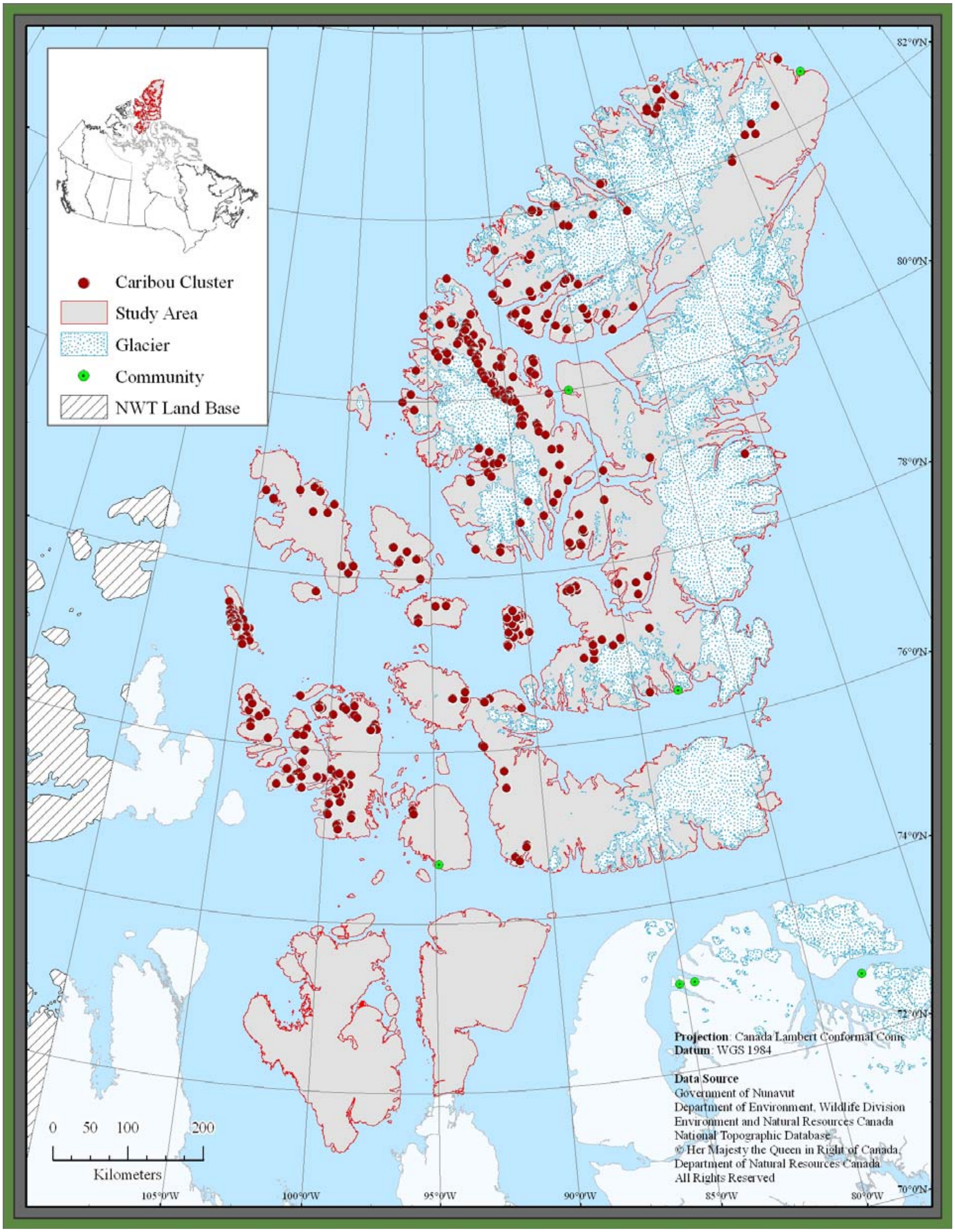



**Figure 9:** Peary caribou observations over the entire study area from 2001 to 2008.

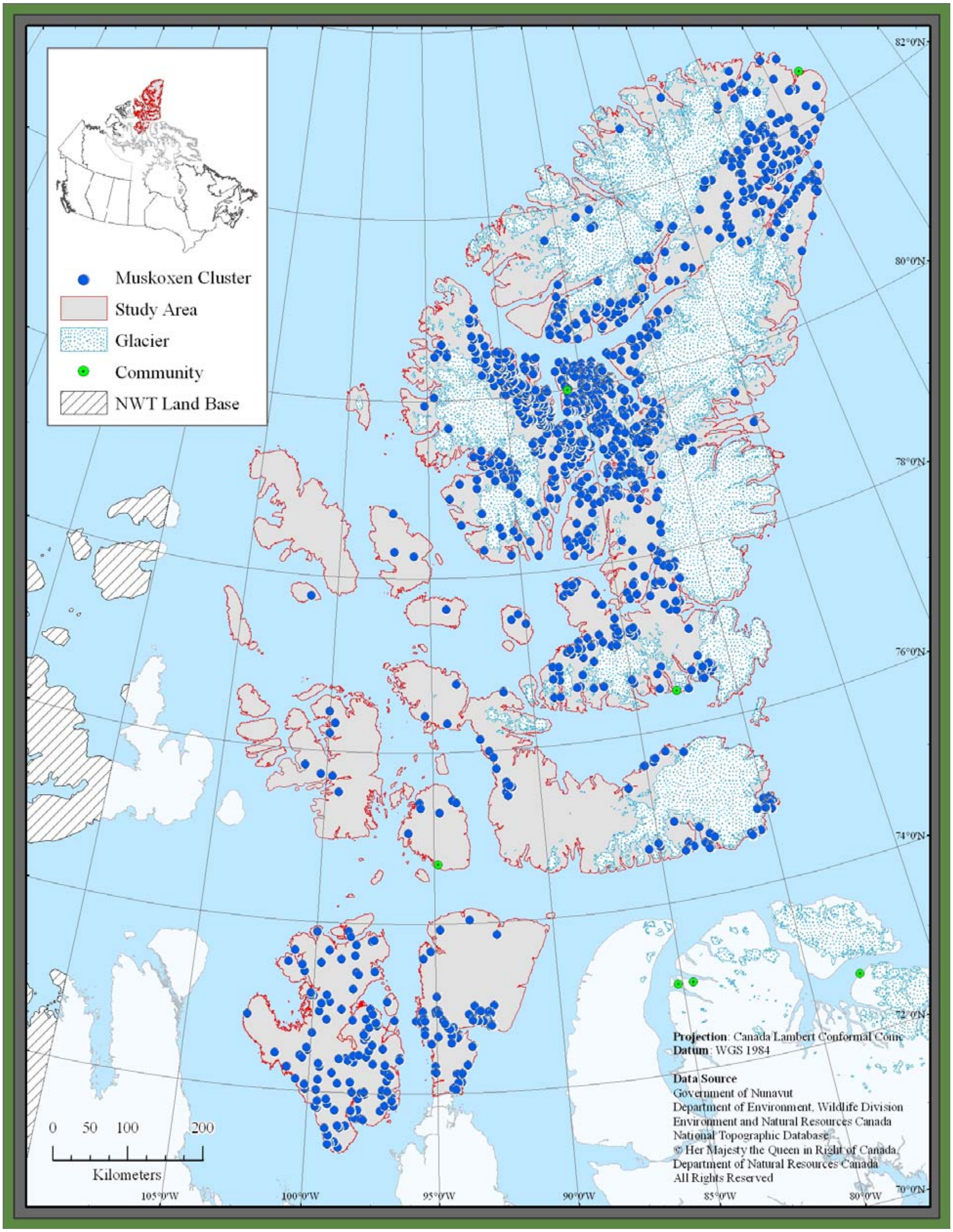



**Figure 10:** Muskox observations over the entire study area from 2001 to 2008.

**Table 4:** Peary caribou aerial survey observations, density and abundance estimates for 2001-2008, by Island Group.

| STUDY AREA | Area (km sq) | Year | DATE | | Effort (m) | ALL OBSERVATIONS | | | ON-TRANSECT | | | OFF-TRANSECT | | | B-TRANSECT (OFF) | | | Density | 95% CI | | CV | Abund. | 95% CI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Start | Finish | | # Cls. | # PC | # NB | # Cls. | # PC | # NB | # Cls. | # PC | # NB | # Cls. | # PC | # NB | | LCI | UCI | | | LCI | UCI |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Bathurst Island Complex | 15,307 | 2001 | 15-May | 31-May | 2886113 | 67 | 152 | 10 | 24 | 52 | 5 | 8 | 11 | 0 | 35 | 89 | 5 | 0.0095 | 0.0053 | 0.0168 | 0.2957 | 145 | 81 | 257 |
| Adjusted BIC | *19,644 | " " | " " | " " | " " | | | | | | | | | | | | | " " | " " | " " | " " | *187 | 104 | 330 |
| Cornwallis | 3,411 | 2002 | 10-May | 11-May | 618640 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Min Count | | | 1 | Min Count | |
| **Devon Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Baillie Hamilton | 290 | 2002 | 28-May | 28-May | 54200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Min Count | | | 0 | Min Count | |
| West Devon | 12,316 | 2002 | 08-May | 30-May | 2217730 | 13 | 35 | 0 | 5 | 18 | 0 | 3 | 6 | 0 | 5 | 11 | 0 | 35 | Min Count | | | **40 | Adjusted Min Count | |
| Devon | 39,731 | 2008 | 22-Apr | 10-May | 7985397 | 4 | 17 | 0 | 4 | 17 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 17 | Min Count | | | 17 | Min Count | |
| North Kent | 440 | 2008 | 22-Apr | 10-May | 83115 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |
| Baillie Hamilton | 290 | 2008 | 22-Apr | 10-May | 53320 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |
| Dundas/Margaret | 61 | 2008 | 22-Apr | 10-May | 13577 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |
| **Prince of Wales - Somerset Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Prince of Wales | 34,765 | 2004 | 10-Apr | 18-Apr | 3430308 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Min Count | | | 0 | Min Count | |
| Somerset | 24,549 | 2004 | 20-Apr | 25-Apr | 2420364 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Min Count | | | 0 | Min Count | |
| **Ellesmere Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| S Ellesmere | 23,767 | 2005 | 04-May | 30-May | 4299116 | 41 | 118 | 0 | 19 | 57 | 0 | 0 | 0 | 0 | 22 | 61 | 0 | 0.0092 | 0.0046 | 0.0186 | 0.3609 | 219 | 109 | 442 |
| N Ellesmere | 96,567 | 2006 | 06-Apr | 22-May | 17535130 | 86 | 413 | 0 | 72 | 344 | 0 | 2 | 7 | 0 | 12 | 62 | 0 | 0.0083 | 0.0055 | 0.0125 | 0.2103 | 802 | 531 | 1207 |
| **Axel Heiberg Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Axel Heiberg | 30,877 | 2007 | 19-Apr | 03-May | 5871988 | 124 | 658 | 0 | 120 | 642 | 0 | 4 | 16 | 0 | N/A | N/A | N/A | 0.0742 | 0.053 | 0.1039 | 0.172 | 2291 | 1636 | 3208 |
| **Ringnes Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Amund Ringnes | 5,364 | 2007 | 15-Apr | 17-Apr | 1063944 | 9 | 26 | 0 | 9 | 26 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | | | | | | | |
| Cornwall Island | 2,273 | 2007 | 19-Apr | 19-Apr | 448344 | 4 | 16 | 0 | 4 | 16 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | | | | | | | |
| Ellef Ringnes | 11,549 | 2007 | 06-Apr | 15-Apr | 2275504 | 16 | 32 | 0 | 14 | 26 | 0 | 2 | 6 | 0 | N/A | N/A | N/A | | | | | | | |
| King Christian | 647 | 2007 | 14-Apr | 14-Apr | 117421 | 1 | 6 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | | | | | | | |
| Meighen | 849 | 2007 | 22-Apr | 22-Apr | 170546 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | | | | | | | |
| **Pooled Results** | **20,682** | | | | **4075759** | **30** | **80** | **0** | **28** | **74** | **0** | **2** | **6** | **0** | **N/A** | **N/A** | **N/A** | **0.0136** | **0.0076** | **0.02442** | **0.3** | **282** | **157** | **505** |
| Lougheed | 1,415 | 2007 | 13-Apr | 13-Apr | 286882 | 32 | 131 | 0 | 32 | 131 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0.2626 | 0.145 | 0.475 | 0.3 | 372 | 205 | 672 |

*Notes: # Cls.= number of Peary caribou clusters. #PC= number of Peary caribou 10 months or older. # NB = number of newborn calves.*
**Adjusted based on ground and aerial observations outside the aerial survey area on Bathurst Island. Area adjusted to incorporate all of Bathurst Island.*
*** Adjusted based on ground observations outside aerial survey area. The survey area could not be adjusted as the boundaries of the ground survey were not known.*

**Table 5:** Muskox aerial survey observations, density and abundance estimates for 2001-2008, by Island Group.

| STUDY AREA | Area (km sq) | Year | DATE | | Effort (m) | ALL OBSERVATIONS | | | ON-TRANSECT | | | OFF-TRANSECT | | | B-TRANSECT (OFF) | | | Density | 95% CI | | CV | Abund. | 95%CL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Start | Finish | | # Cls. | # MX | # NB | # Cls. | # MX | # NB | # Cls. | # MX | # NB | # Cls. | # MX | # NB | | LCI | UCI | | | LCI | UCI |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Bathurst Island Complex | 15,307 | 2001 | 15-May | 31-May | 2886113 | 7 | 82 | 21 | 3 | 32 | 8 | 1 | 10 | 6 | 3 | 40 | 7 | 82 | Min Count | | | 82 | Min Count | |
| Cornwallis | 3411 | 2002 | 10-May | 11-May | 618640 | 7 | 18 | 0 | 5 | 15 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 18 | Min Count | | | | | |
| Cornwallis (All) | 7474** | " " | | | | | | | | | | | | | | | | | | | | 22* | Adjusted Min Count | |
| **Devon Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| West Devon | 12316 | 2002 | 08-May | 30-May | 2217730 | 10 | 68 | 7 | 9 | 59 | 7 | 0 | 0 | 0 | 1 | 9 | 0 | 68 | Min Count | | | 68 | Min Count | |
| Baillie Hamilton | 290 | 2002 | 28-May | 28-May | 54200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Devon | 39,731 | 2008 | 22-Apr | 10-May | 7985397 | 69 | 391 | 61 | 61 | 354 | 58 | 8 | 37 | 3 | N/A | N/A | N/A | 0.0129 | 0.0076 | 0.0218 | 0.267 | 513 | 302 | 864 |
| North Kent | 440 | 2008 | 22-Apr | 10-May | 83115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | | |
| Baillie Hamilton | 290 | 2008 | 22-Apr | 10-May | 53320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | | |
| Dundas/Margaret | 61 | 2008 | 22-Apr | 10-May | 13577 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | | |
| **Prince of Wales - Somerset Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Prince of Wales | 34,765 | 2004 | 10-Apr | 18-Apr | 3430308 | 111 | 1483 | 27 | 111 | 1483 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0600 | 0.0455 | 0.0790 | 0.1386 | 2086 | 1582 | 2746 |
| Somerset | 24,549 | 2004 | 20-Apr | 25-Apr | 2420364 | 69 | 988 | 47 | 66 | 967 | 46 | 3 | 21 | 1 | 0 | 0 | 0 | 0.0778 | 0.0392 | 0.1545 | 0.3466 | 1910 | 962 | 3792 |
| **Ellesmere Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| S Ellesmere | 23,767 | 2005 | 04-May | 30-May | 4299116 | 118 | 316 | 2 | 99 | 273 | 2 | 2 | 4 | 0 | 17 | 39 | 0 | 0.0192 | 0.0131 | 0.0282 | 0.1939 | 456 | 312 | 670 |
| N Ellesmere | 96,567 | 2006 | 06-Apr | 22-May | 17535130 | 666 | 5127 | 927 | 645 | 4999 | 907 | 14 | 77 | 9 | 7 | 51 | 11 | 0.0840 | 0.0687 | 0.1028 | 0.1028 | 8115 | 6632 | 9930 |
| **Axel Heiberg Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Axel Heiberg | 30,877 | 2007 | 19-Apr | 03-May | 5871988 | 309 | 2697 | 400 | 301 | 2653 | 396 | 8 | 44 | 4 | N/A | N/A | N/A | 0.1372 | 0.1092 | 0.1725 | 0.1162 | 4237 | 3371 | 5325 |
| **Ringnes Island Group** | | | | | | | | | | | | | | | | | | | | | | | | |
| Amund Ringnes | 5,364 | 2007 | 15-Apr | 17-Apr | 1063944 | 3 | 13 | 0 | 3 | 13 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 13 | Min Count | | | 13 | Min Count | |
| Cornwall Island | 2,273 | 2007 | 19-Apr | 19-Apr | 448344 | 1 | 6 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 6 | Min Count | | | 6 | Min Count | |
| Ellef Ringnes | 11,549 | 2007 | 06-Apr | 15-Apr | 2275504 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |
| King Christian | 647 | 2007 | 14-Apr | 14-Apr | 117421 | 1 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 2 | Min Count | | | 2 | Min Count | |
| Meighen | 849 | 2007 | 22-Apr | 22-Apr | 170546 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |
| Lougheed Group | 1,415 | 2007 | 13-Apr | 13-Apr | 286882 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | 0 | Min Count | | | 0 | Min Count | |

*Notes: #Cls. = # of muskox clusters. #MX = number of muskoxen one year or older. #BN = number of newborn calves.*
** Adjustment based on ground observations outside aerial survey area.*
*** Additional Area was surveyed using ground methods*

## 3.2 SURVEY FINDINGS BY ISLAND GROUP

### 3.2.1 Bathurst Island Group

(Survey Areas - *Bathurst Island Complex, and Cornwallis Group*)

#### *3.2.1.1 Bathurst Island Complex Survey Area*

**Caribou**

*Ground Survey:* In 2001, crews traveled 3,887 km$^2$ (Figure 11) on the Bathurst Island Complex (BIC) and observed 18 clusters of Peary caribou representing 50 individuals (4.6 clusters/1000 km surveyed) (Figure 11). Two clusters (four animals in total) were observed in areas that were excluded from the aerial survey. Tracks were recorded on 20 occasions and seven feeding sites were noted (Table 3).

*Aerial Survey:* The BIC aerial survey was conducted May 15-31, 2001. The total length of A transects flown was 2,886 km and the total area surveyed was approximately 15,305 km$^2$ (Table 4, Figure 12). The remaining area (approximately 4,339 km$^2$) was not surveyed based on information from concurrent ground surveys. A total of 24 clusters of caribou were observed on transect, including 24 female and 11 male adults, two yearlings, 15 calves or 'short yearlings' and five newborns. The first newborn observed was spotted on May 27, 2001. The proportion of calves or 'short yearlings' is 29% of those animals seen on transect (excluding newborns). The ratio of adult males to females was 46:100.

An additional 43 caribou clusters were observed off transect (not including those seen while ferrying to site), and these represented 100 caribou (10 months or older) and five newborns. These 105 caribou were located by following tracks, by maintaining a 1 km field of vision on either side of the transect (by eliminating topography) and by flying additional transects in areas where caribou were detected (G.Hope, personal communication, April 14, 2011). Given the flight effort to investigate caribou sightings and sign, and to eliminate topography as an obstacle to observations, the combination of on- and off-transect observations provides a thorough count of caribou in the survey area.

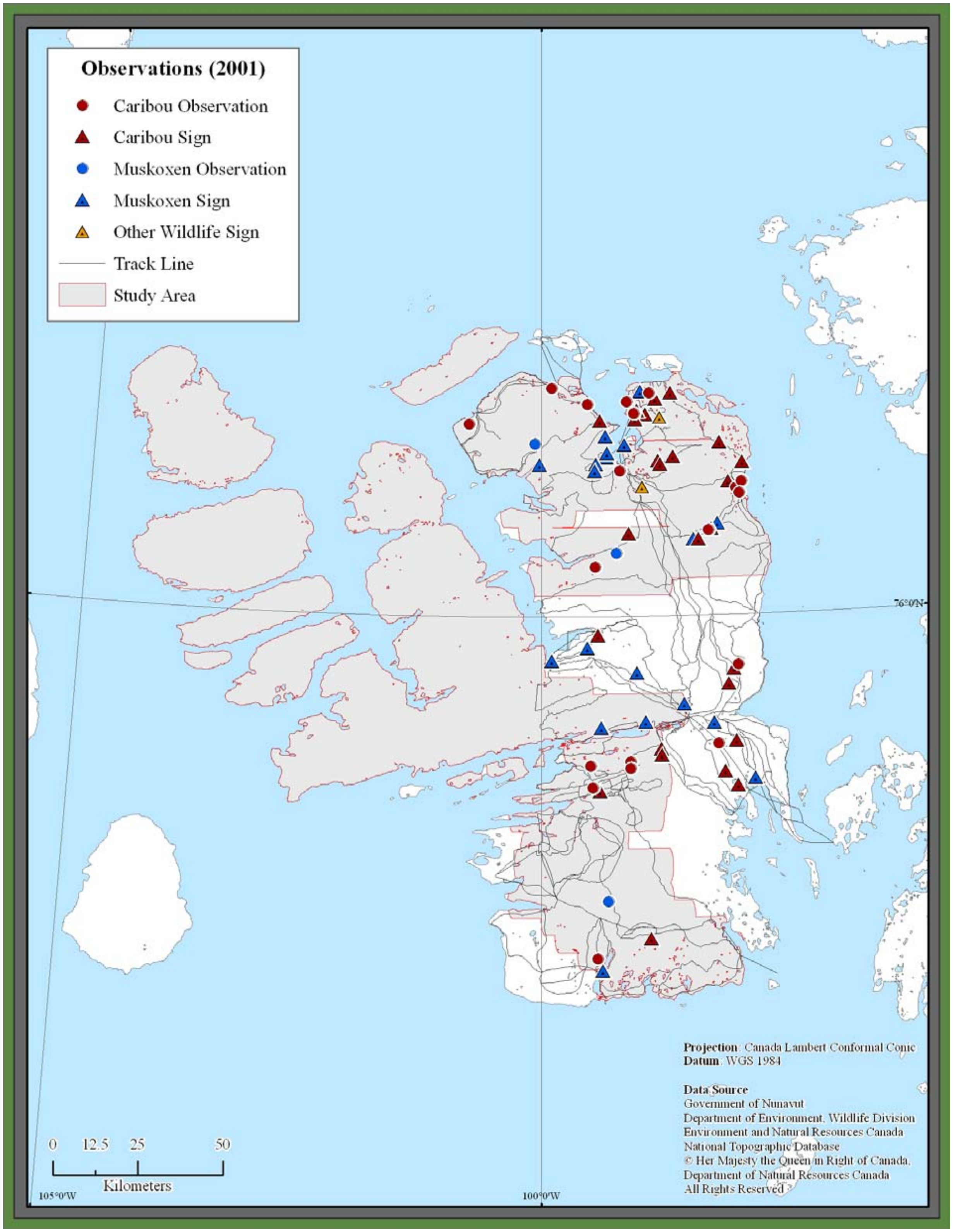



**Figure 11:** Ground survey observations within the Bathurst Island Complex (BIC) survey areas, 2001.

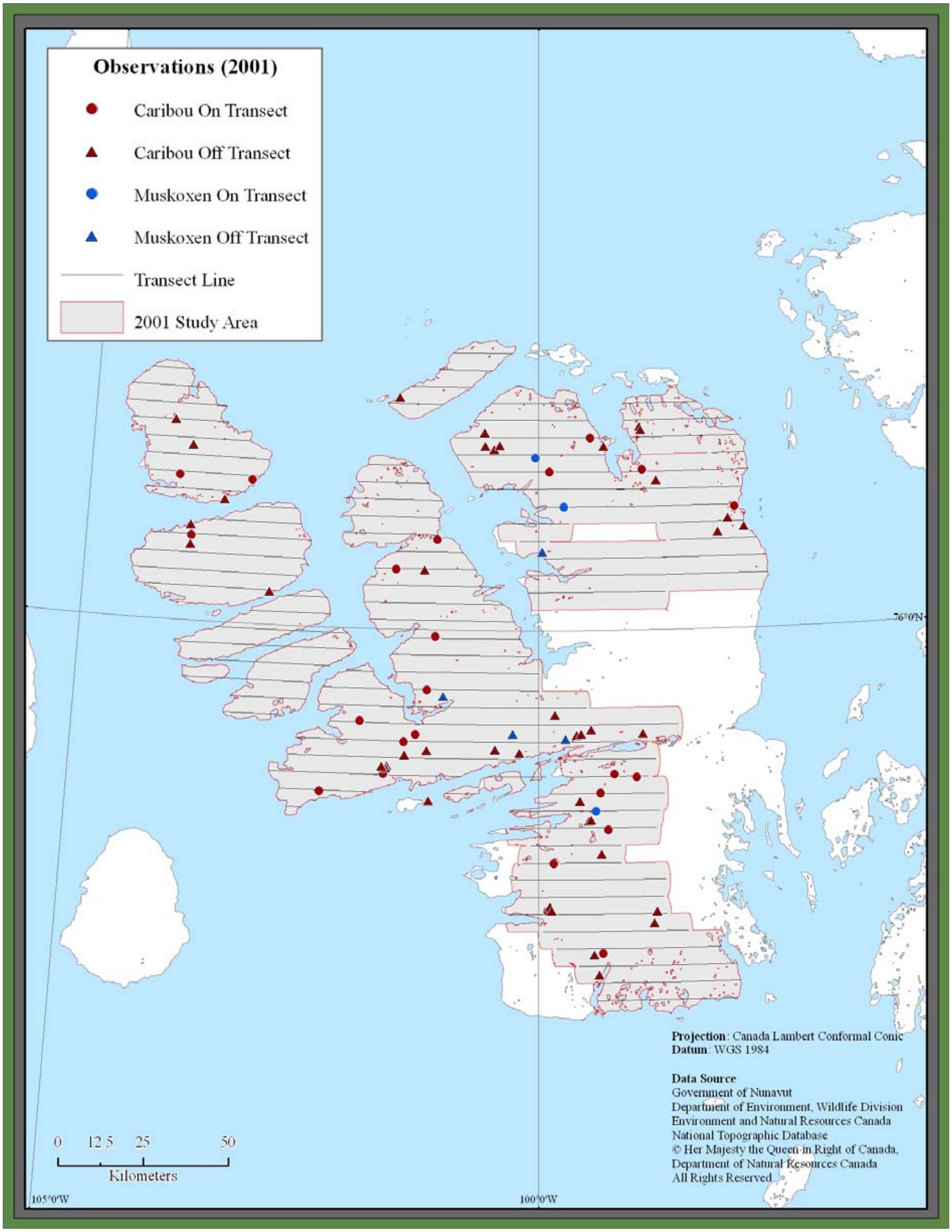



**Figure 12:** Aerial survey observations of Peary caribou and muskoxen clusters for the Bathurst Island Complex (BIC) survey area, 2001.

After fitting all recommended models to the data, the uniform key model with single order cosine adjustment was selected (Table 6). The selected model was characterized by a small shoulder (Figure 13) and a non-significant Chi-square Goodness of Fit test, suggesting good fit of the data ( $\chi^2$=0.8164, p= 0.6486)

We estimated the probability of detecting a cluster of caribou on either side of the transect line as $P_a$ = 0.660 (95% CI 0.472–0.922) and estimated the effective strip width (ESW) to be 876 m (95% CI 627–1224 m). The mean cluster size for the BIC survey area was 2.08 caribou/cluster (SE 0.29), and this was the smallest cluster size noted for all survey areas**.** The estimated density of caribou inhabiting the BIC survey area was 9.5 caribou/1000 $km^2$ (95% CI 5.3–16.8 caribou/1000 $km^2$) or 145 caribou (95% CI 77-260) approximately 10 months of age and older.

The original survey design specified that non-surveyed areas would represent space 'not occupied by caribou' and result in counts of zero caribou. On Bathurst Island, data from the ground survey indicates that there were some caribou in these areas (two non-repeat groups representing 4 caribou were detected) as did observations collected by aerial crew during flights to and from Bathurst Island (5 non-repeating observations representing 10 caribou). To address this, we applied the results (the density estimate) obtained in the covered areas across the non-surveyed areas of Bathurst Island and assumed that the detection function would be similar. This is reasonable given the lack of topography and barren landscape. Thus, the BIC area increased to 19,644 $km^{2,}$ and generated an abundance estimate of 187 caribou (95% CI 104-330).

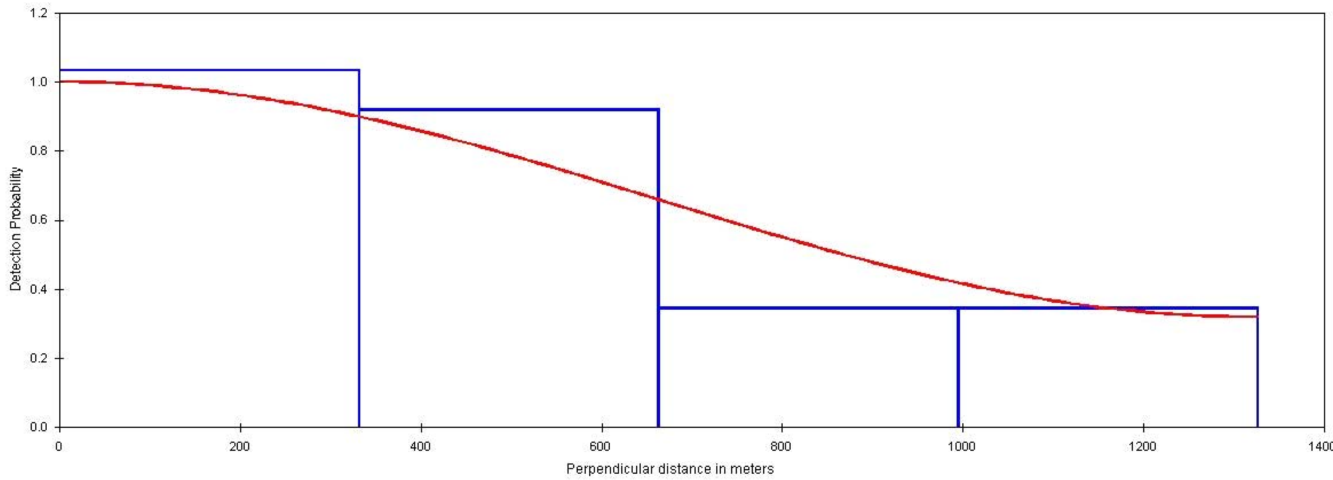



**Figure 13:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou observed within the Bathurst Island Complex survey area, May 2001. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 332 m.

**Table 6:** Summary of candidate models used in the line-transect analysis for Peary caribou of the Bathurst Island Complex survey area, May 2001. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| **Bathurst Island Complex - Peary caribou** | | | | | **Density** | **95% CI** | | |
|---|---|---|---|---|---|---|---|---|
| **Name** | **Par** | **Delta AIC** | **AIC** | **ESW (m)** | **(caribou/km$^2$)** | **LCI** | **UCI** | **CV** |
| Uniform Cosine | 1 | 0.00 | 329.28 | 875.75 | 0.0095 | 0.0053 | 0.0169 | 0.296 |
| Half-normal Hermite Poly | 1 | 0.83 | 330.11 | 929.97 | 0.0089 | 0.0050 | 0.0160 | 0.299 |
| Half-normal Cosine | 1 | 0.83 | 330.11 | 929.97 | 0.0084 | 0.0047 | 0.0150 | 0.297 |
| Uniform Simple Poly | 0 | 1.49 | 330.77 | 1327.00 | 0.0063 | 0.0039 | 0.0102 | 0.247 |
| Hazard-rate Simple Poly | 2 | 1.79 | 331.07 | 649.40 | 0.0102 | 0.0041 | 0.0252 | 0.472 |
| Hazard-rate Cosine | 2 | 1.79 | 331.07 | 649.40 | 0.0102 | 0.0041 | 0.0252 | 0.472 |

**Muskoxen**

*Ground Survey:* Ground crews reported seeing 3 clusters of muskoxen for a total of 30 animals after driving 3,887 km on the BIC or 0.77 clusters/1000 km traveled. Observations of muskox sign were also reported, including one carcass (Table 3, Figure 11).

*Aerial Survey:* A total of three clusters of muskoxen were observed on transect (Table 5, Figure 12) which included 32 muskoxen (one year or older) and eight newborn calves. The proportion of newborn calves was 20% of those animals seen on transect. Four additional groups were identified as off transect; these were observed while investigating other clusters, or following tracks, or when flying B transects

The scarcity of muskoxen and the overall lack of observations prevented calculating a density estimate. Instead, we report a minimum count of 82 muskoxen (one year or older) for the BIC survey area in 2001.

### *3.2.1.2 Cornwallis Survey Area*

**Caribou**

*Ground Survey:* The ground crew observed no caribou during 1,566 km (Table 2, Figure 14) of snowmobile travel on Cornwallis Island in 2002. However, the crew recorded four observations of caribou sign, including two feeding sites and two observations of caribou tracks.

*Aerial Survey:* We flew 619 km of transect on May 10-11, 2002 during the aerial survey of Cornwallis, Little Cornwallis, Milne, Crozier and Baring Islands (Figure 15) and observed only two clusters of Peary caribou (Table 4). Field notes indicate that these clusters may, be a duplicate count of a single adult female caribou. No other caribou or their sign (e.g., incidental observations) were observed from the air. Some areas of Cornwallis Island were excluded from the aerial survey based on ground reconnaissance. These areas were identified as ”not occupied by caribou” with zero observations of caribou or caribou sign.

The observation of the single caribou limits the results to a minimum count of one caribou (10 months or older) in the Cornwallis Island Group survey area during 2002.

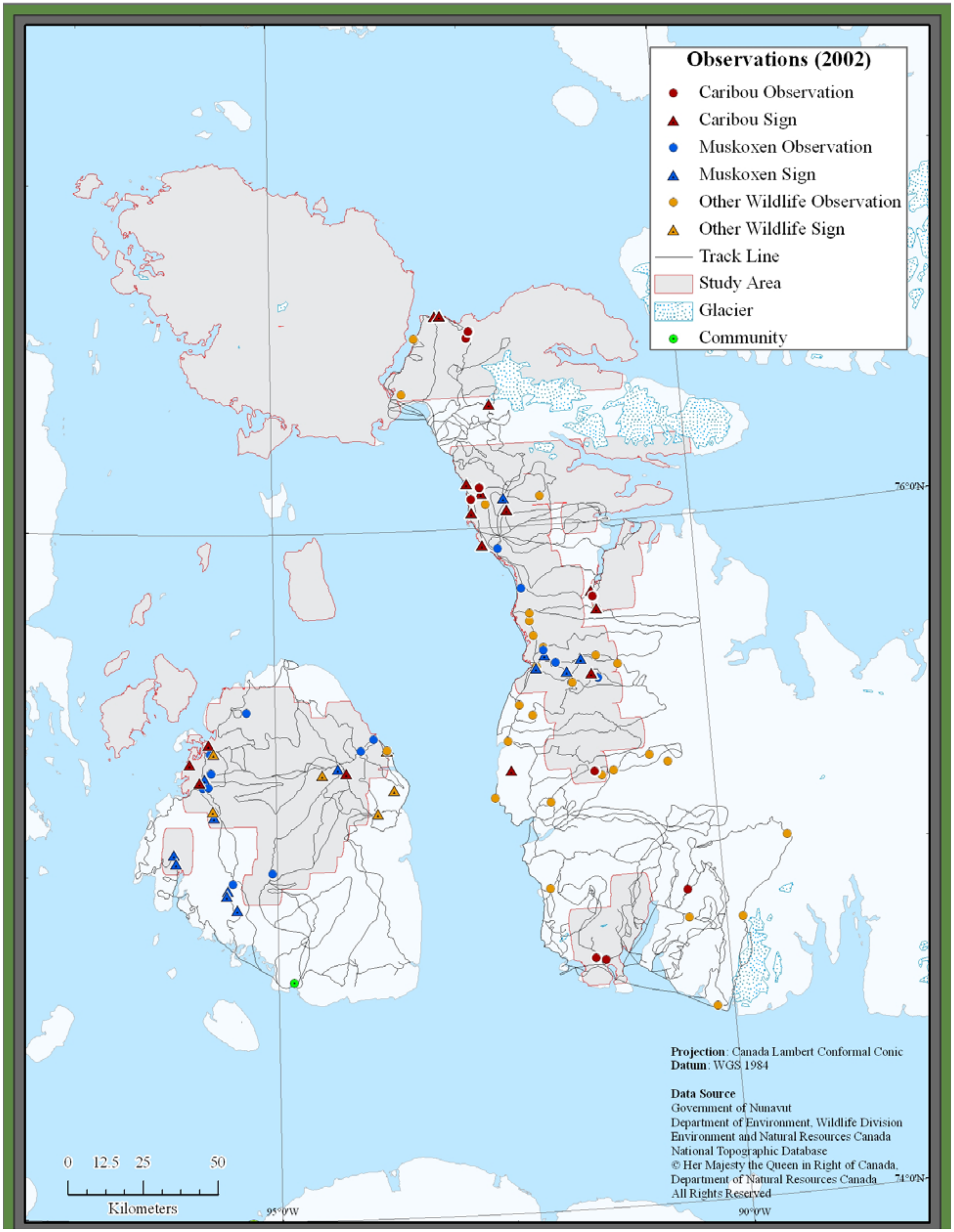



**Figure 14:** Ground survey observations within the Cornwallis Group and W. Devon survey area, 2002

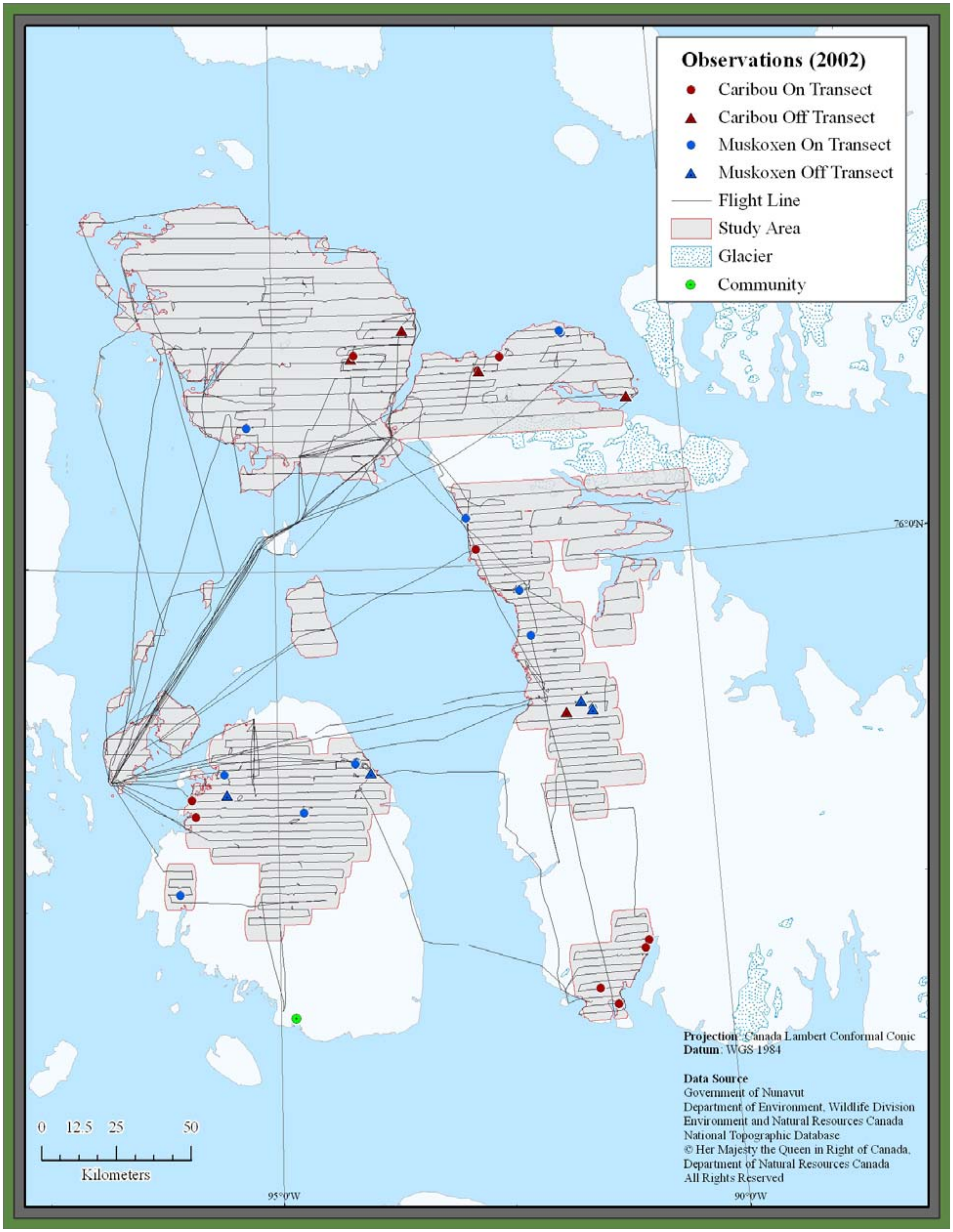



**Figure 15:** Aerial observations of Peary caribou and muskoxen clusters for the Cornwallis Group and W. Devon survey area, 2002.

**Muskoxen**

*Ground Survey:* In driving 1,566 km on Cornwallis Island, the ground crew observed eight clusters of muskoxen with 22 animals total (Table 3), or 5.11 clusters per 1000 km traveled. The crew also reported six observations of muskox tracks and nine feeding areas (Figure 14). One cluster of 4 adults and one newborn was observed in an area not surveyed by aerial methods. A minimum count of 4 is therefore reported for this area.

*Aerial Survey:* A total of seven clusters of muskoxen (18 animals with no newborns) were observed within the survey area during 619 km of flying (Table 5, Figure 15). Five of these clusters were observed on transect which is too few to derive a density estimate. Instead, we report a minimum count of 22 animals for the Cornwallis Island Group survey area in 2002, a figure which incorporates results from both the ground and aerial survey.

Of the muskoxen observed on transect, 15 were adults (1 year or older) and there were zero newborn calves. The proportion of newborn calves was 0% of those animals seen on transect

### 3.2.2 Devon Island Group

*(Survey Areas - Devon, North Kent, Ballie Hamilton, and Dundas/Margaret Islands)*

#### *3.2.2.1 Devon Island Survey Area*

**Caribou**

*Ground Survey:* After driving 3,642 km in 2002, the ground crew observed seven separate clusters of caribou for a total of 22 animals. This represents approximately 1.9 clusters/1000 km of ground surveyed. Caribou sign was also recorded, with tracks observed on five occasions, carcasses (or bones) recorded twice, and one feeding site noted (Table 2, Figure 14). One group of 5 caribou was observed in an area not surveyed by aerial methods in 2002.

*Aerial Survey:* Portions of the western coast of Devon Island were surveyed by air on May 8-30, 2002. A total of 2,218 km of (A) transects were flown and observations of Peary caribou and muskoxen recorded. Additional observations were collected during flights of secondary (B) transects and when following tracks (Figure 16). Within the survey area defined by the systematic A-transect design (12,316 km$^2$), 13 non-repeated clusters of Peary caribou were observed but only five of these were on transect (Figure 15). The total number of caribou was 35 animals (Table 4), with 18 seen on transect. Composition as estimated from the air was eight female and four male adults, three yearlings, three calves or ‘short yearlings’ and zero newborns. The proportion of calve or ‘short yearlings’ is 17% of those animals seen on transect. The ratio of adult males to females is 50:100.

Baille Hamilton Island was also surveyed in 2002 as part of the Devon Island Group (54 km of transect) and no caribou were observed.

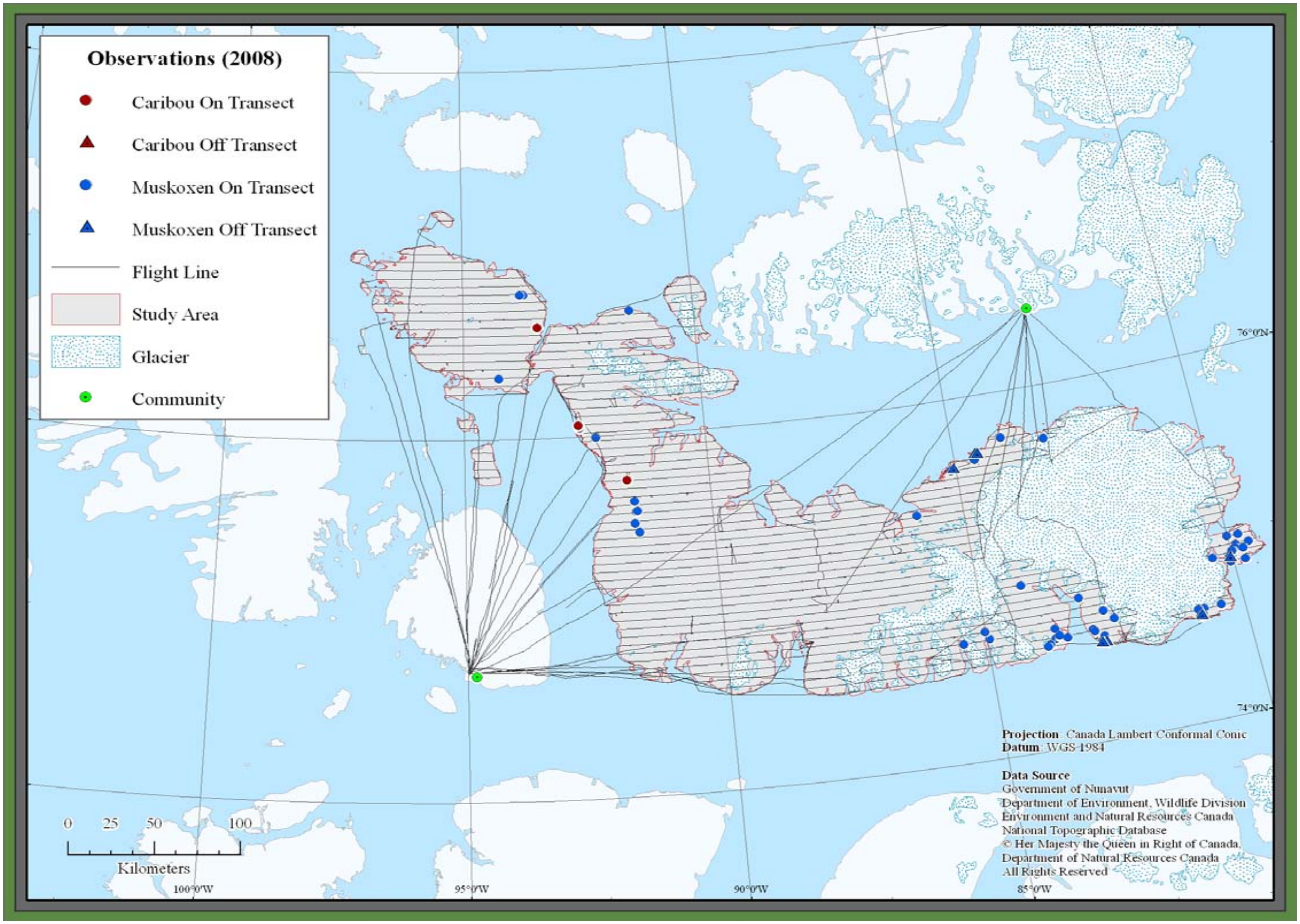



**Figure 16:** Aerial survey observations of Peary caribou and muskoxen clusters for the Devon Island Group, 2008.

Since there were so few observations of caribou clusters on transect, we were unable to use distance sampling methods to estimate caribou density.  We report a minimum count of 40 caribou for the western coast of Devon Island in 2002.  This result incorporates ground survey observations of caribou beyond the aerial survey area.

Given the overall size of Devon Island, the limited survey area covered in 2002, and Inuit reports of Peary caribou inhabiting other areas of the island (e.g., the Truelove Lowlands; Taylor 2005), a complete island survey was undertaken between April 22 and May 10, 2008. Flight effort (7,985 km) was applied systematically to all non-glaciated areas of Devon Island and small proximal islands (see Table 4). Additional flights totaling 150 km were made over North Kent, Baille Hamilton, Dundas and Margaret islands (Figure 16). Together, all flights yielded four observations of Peary caribou clusters representing 17 caribou in total, with all observations on transect and located in western Devon Island. Composition was eight female and 6 male adults, two yearlings, 1 calf or 'short yearling' and zero newborns.  The proportion of calves or 'short yearlings' is 6 % of those animals seen on transect.  The ratio of adult males to females is 75:100.

The scarcity of caribou and insufficient number of observations precluded estimation of population density and abundance. We report a minimum count of 17 caribou for the Devon Island Group in 2008.

**Muskoxen**

*Ground Survey:* After driving 3642 km in May 2002, 11 observations of muskoxen (a total of 54 animals including nine newborns) were recorded in west Devon Island (Table 3). This represents 3.02 clusters/1000 km traveled.

*Aerial Survey:* Portions of the west coast of Devon Island were surveyed by air from May 8-30, 2002. A total of 2,218 km of A transect were flown and 9 clusters of muskoxen, including 59 adults (one year or older) and 7 newborn calves were reported on transect. Unfortunately, due to the small number of observations, a density estimate could not be derived for muskoxen in this part of the Devon Island Group.

In 2008, as described above for caribou, the aerial survey was expanded across Devon Island (39,731 $km^2$, including small proximal islands) and to large off-shore islands (North Kent, Baille Hamilton, Dundas and Margaret; 945 $km^2$ in total for these). Between April 22 and May 10 of 2008, 61 observations of muskoxen were recorded on transect (354 adults [1 year or older] and 58 newborns): the proportion of newborn calves was 14%.

For analysis of muskoxen abundance in the Devon Island Group, we excluded the steep-walled islands of Baille Hamilton, North Kent, Dundas and Margaret, where no muskoxen were observed. We truncated the largest 10% of the distance data to address outliers and facilitate fitting the detection function. We selected the uniform model with single-order cosine adjustment as the best model (Table 7, Figure 17). This model had a non-significant goodness-of fit value ($\chi^2$ = 0.5931, p= 0.74338), which indicated good fit of the data.

We estimated the probability of detecting a cluster of muskoxen within the defined area as $P_a$ = 0.578 (95% CI 0.498-0.670). The estimated ESW was 1,143 m (95% CI 986-1326 m). The expected cluster size was 4.21 muskoxen/cluster (SE 0.49), whereas mean cluster size was 5.51 muskoxen/cluster (SE 0.52). The estimated density of muskoxen was 12.9 /1000 km$^2$ (95% CI 7.6-21.8/1000 km$^2$). Based on findings in the survey area (39,731 km$^2$) we estimated that there were 513 muskoxen one year or older (95%CI 302-864) throughout the Devon Island Group.

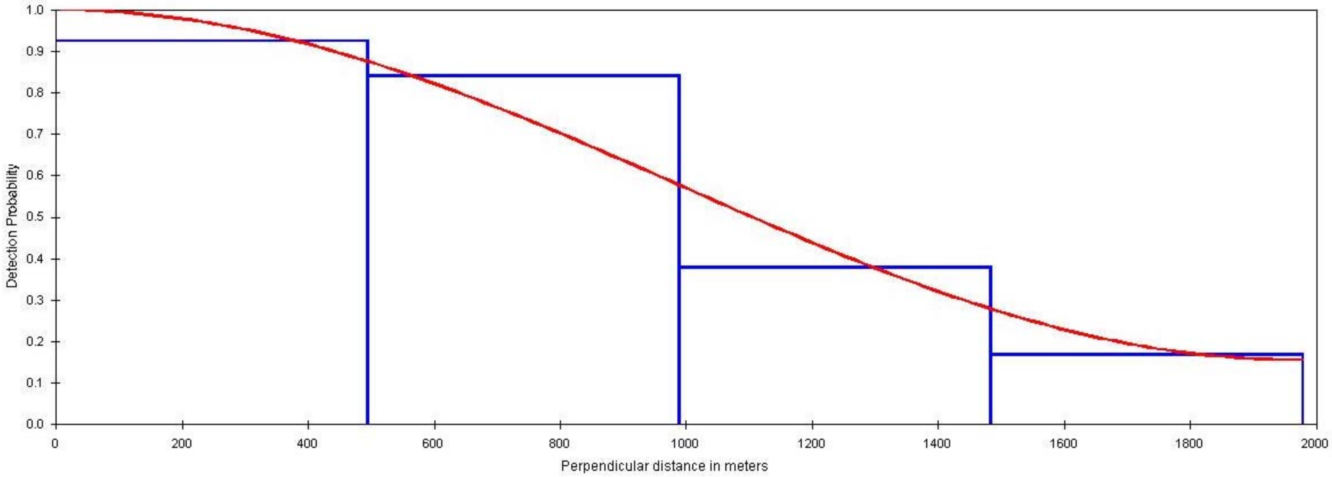



**Figure 17:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Devon Island Group survey area, April-May 2008. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 495 m.

**Table 7:** Summary of candidate models used in the line-transect analysis for muskoxen of the Devon Island Group survey area, April-May 2008. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Devon - Muskoxen | | | | | Density | | | |
|---|---|---|---|---|---|---|---|---|
| Name | Par | Delta AIC | AIC | ESW (m) | Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
| Uniform Cosine | 1 | 0.00 | 818.94 | 1143.65 | 0.0129 | 0.0077 | 0.0218 | 0.267 |
| Uniform Simple Poly | 2 | 0.98 | 819.92 | 1126.65 | 0.0132 | 0.0076 | 0.0230 | 0.285 |
| Half-normal Hermite Poly | 1 | 1.47 | 820.41 | 1135.07 | 0.0130 | 0.0076 | 0.0222 | 0.275 |
| Half-normal Cosine | 1 | 1.47 | 820.41 | 1135.07 | 0.0130 | 0.0076 | 0.0222 | 0.275 |
| Hazard-rate Simple Poly | 2 | 1.67 | 820.61 | 1113.23 | 0.0137 | 0.0076 | 0.0248 | 0.307 |
| Hazard-rate Cosine | 2 | 1.67 | 820.61 | 1113.23 | 0.0137 | 0.0076 | 0.0248 | 0.307 |

### 3.2.3 Prince of Wales – Somerset Island Group

(*Survey Areas* - *Prince of* Wales*, Russell, and Somerset islands*)

#### *3.2.3.1 Prince of Wales Survey Area (incl. Russell Island)*

**Caribou**

*Ground Survey:* Ground surveyors reported no caribou or caribou sign during 1,968 km of snowmobile travel on Prince of Wales Island during April 2004 (zero clusters/1000 km of ground surveyed) (Table 2, Figure 18).

*Aerial Survey*: An aerial survey of Prince of Wales Island, as well as Russell, Prescott, and Pandora Islands, was completed April10-18, 2004. A total of 3,430 km of A transect was flown across the islands and we saw no Peary caribou (Table 4, Figure 19).

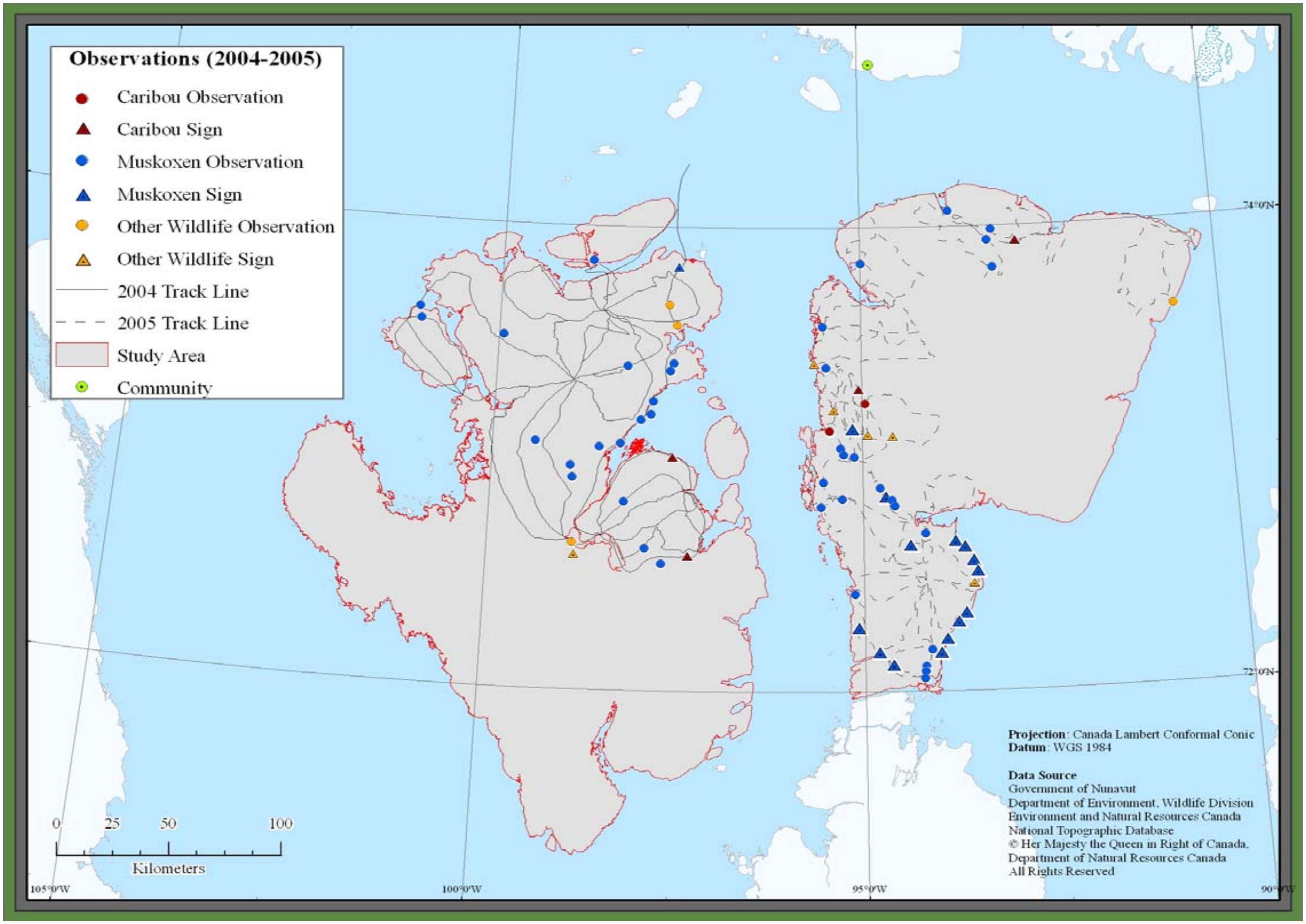



**Figure 18:** Ground survey observations within the Prince of Wales (2004) and Somerset Island (2005) survey areas.

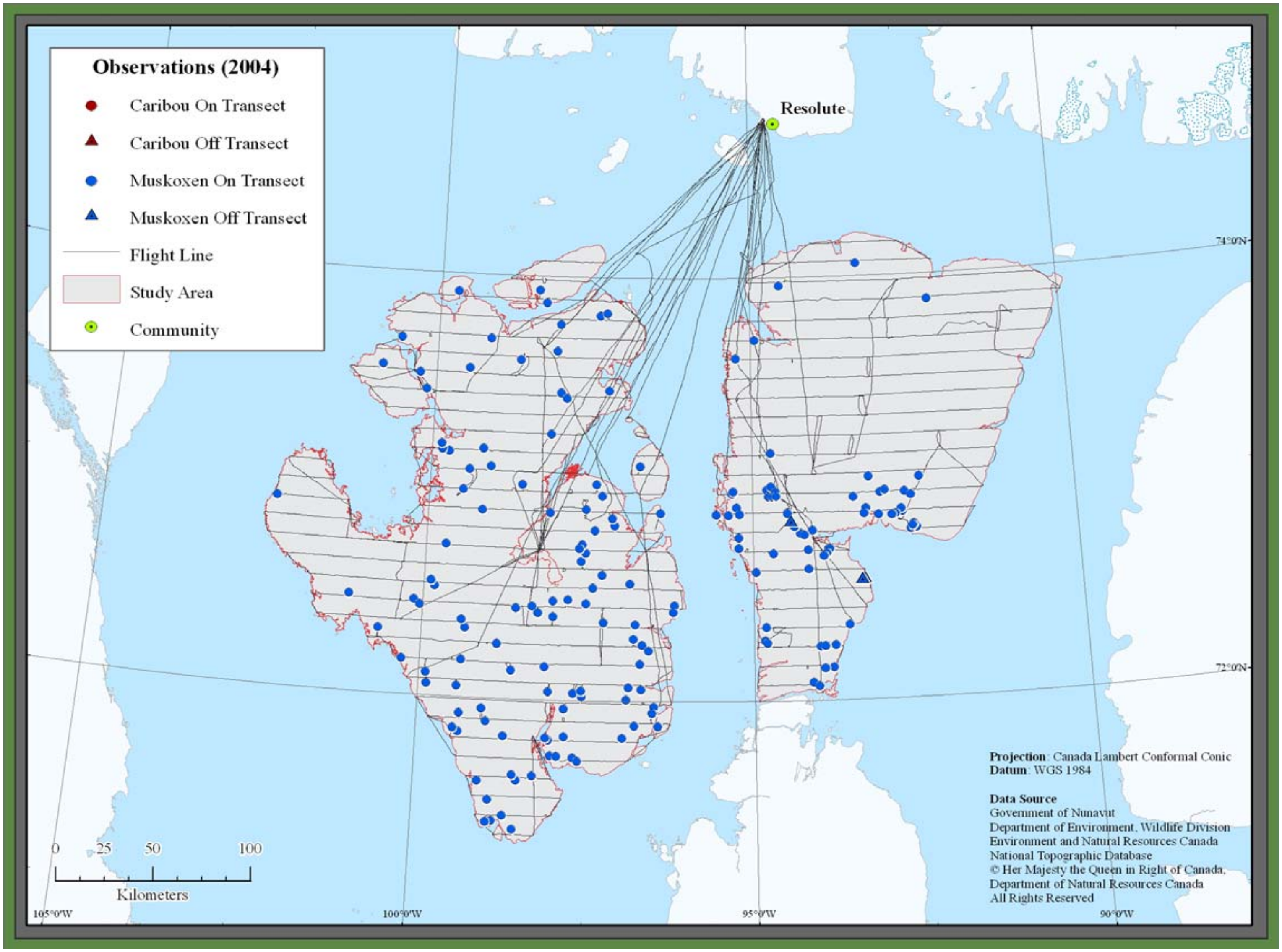



**Figure 19:** Aerial survey observations of Peary caribou and muskoxen clusters for the Prince of Wales - Somerset Island Group, 2004.

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**Muskoxen**

*Ground Survey*: The ground crew recorded 14 clusters of muskoxen (160 individuals) on Prince of Wales Island during 1,968 km of snowmobiling in 2004 (Table 3, Figure 18). This represents an encounter rate of 7.11 muskoxen clusters/1000 km traveled. No other observations were recorded.

*Aerial Survey*: In April 2004, 111 clusters of muskoxen were observed on transect, in the Prince of Wales Island Group survey area with totals of 1,483 muskoxen (1 year or older) and 27 newborn calves (Table 5, Figure 19). The proportion of calves was 2%.

Preliminary analysis supported 5% truncation of the distance data. After truncation, the uniform key model with simple polynomial adjustment was selected as the final detection function (Table 8, Figure 20). The overall model $\chi^2$ was non-significant, suggesting good fit of the data ($\chi^2$ = 7.9149, p= 0.8491)

The probability of detecting a cluster of muskoxen in the defined area on either side of the transect in the Prince of Wales Island Group survey area was estimated as $P_a$ = 0.736 (95% CI 0.656-0.827). The ESW was estimated to be 3438.5 m (95% CI 3062.5-3860.7 m). The expected cluster size was estimated at 13.39 muskoxen/cluster (SE 1.10), whereas mean cluster size was 13.49 muskoxen/cluster (SE 0.82).

The estimated density of muskoxen was 60/1000 $km^2$ (95% CI 45.5-79.0/1000 $km^2$). Given the survey area of 34,765 $km^2$ the estimated abundance was 2,086 (95% CI 1,582-2,746) muskoxen (one year and older) for the Prince of Wales Island Group in 2004.

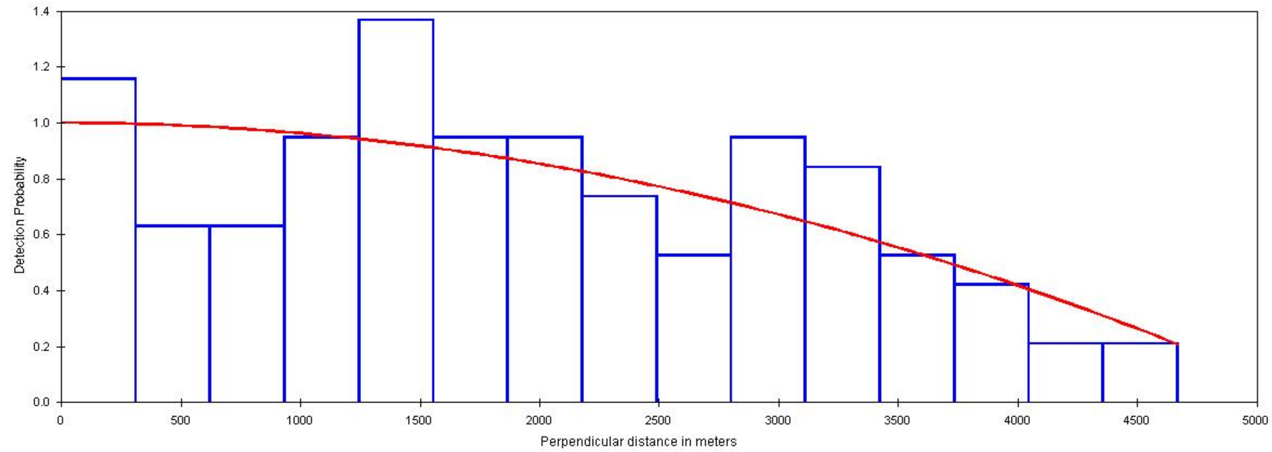



**Figure 20:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen observed within in the Prince of Wales Island survey area, April 2004. The g(x) is estimated using a uniform model with simple polynomial adjustment. Bin size is 311 m.

**Table 8:** Summary of candidate models used in the line-transect analysis for muskoxen of the Prince of Wales Island survey area, April 2004. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Prince of Wales - Muskoxen<br>Name | Par | Delta AIC | AIC | ESW (m) | Density<br>Caribou/Km$^2$ | 95% LCI | 95% UCI | CV |
|---|---|---|---|---|---|---|---|---|
| Uniform Simple Poly | 1 | 0.00 | 1764.18 | 3438.54 | 0.0600 | 0.0456 | 0.0790 | 0.139 |
| Half-normal Hermite Poly | 1 | 0.91 | 1765.09 | 3320.02 | 0.0622 | 0.0454 | 0.0851 | 0.159 |
| Half-normal Cosine | 1 | 0.91 | 1765.09 | 3320.02 | 0.0622 | 0.0454 | 0.0851 | 0.159 |
| Hazard-rate Simple Poly | 2 | 1.28 | 1765.46 | 3804.92 | 0.0542 | 0.0410 | 0.0718 | 0.142 |
| Hazard-rate Cosine | 2 | 1.28 | 1765.46 | 3804.92 | 0.0542 | 0.0410 | 0.0718 | 0.142 |
| Uniform Cosine | 2 | 1.93 | 1766.11 | 3457.14 | 0.0597 | 0.0403 | 0.0884 | 0.201 |

#### *3.2.3.2 Somerset Island Survey Area*

**Caribou**

*Ground Survey:* Ground surveyors observed two clusters of caribou (four individuals) during 2,863 km of travel on Somerset Island in 2005. This represents 0.7 clusters/1000 km of ground surveyed. One set of caribou tracks and one feeding site were also recorded (Table 2; Figure 18).

*Aerial Survey:* During April 20-25, 2004, an aerial survey of total transect length 2,420 km was conducted on Somerset Island. The survey crew detected no Peary caribou.

**Muskoxen**

*Ground Survey*: The ground crew reported 24 clusters of muskoxen (134 individuals) on Somerset Island in 2005. Given a survey effort of 2863 km, the estimated encounter rate is 6.98 clusters/1000 km. The crew observed 17 muskox carcasses (Table 3, Figure 18).

Aerial Survey: The aerial survey crew observed 66 clusters of muskoxen on transect in April 2004, representing 967 muskoxen (1 year or older) and 46 newborn calves (Table 5, Figure 19). The proportion of newborn calves was 5%.

Preliminary analysis of the distance data revealed no obvious outliers and right truncation at the largest observed distance from transect was applied. The uniform key model with single cosine adjustment was selected as the final detection function, with the lowest AIC score and a non-significant $\chi^2$ value that suggested good fit of the data ($\chi^2$ = 2.5576, p= 0.95899; Figure 21, Table 9)

The probability of detecting a cluster of muskoxen within the Somerset Island survey area was estimated as $P_a$ = 0.610 (95% CI 0.511-0.729). The estimated ESW was 2193.9 m (95% CI 1836.5-2620.9 m). The expected cluster size was estimated at 12.5 muskoxen (SE= 1.35), whereas mean cluster size was 14.6 muskoxen (SE 1.49). The estimated density of muskoxen (one year and older) was 77.7/1000 $km^2$ (95% CI 39.2-154.5/1000 $km^2$). Based on finding in the Somerset Island survey area (24,549 $km^2$), the abundance estimate for muskoxen (one year and older) in 2004 was 1,910 (95% CI 962-3,792).

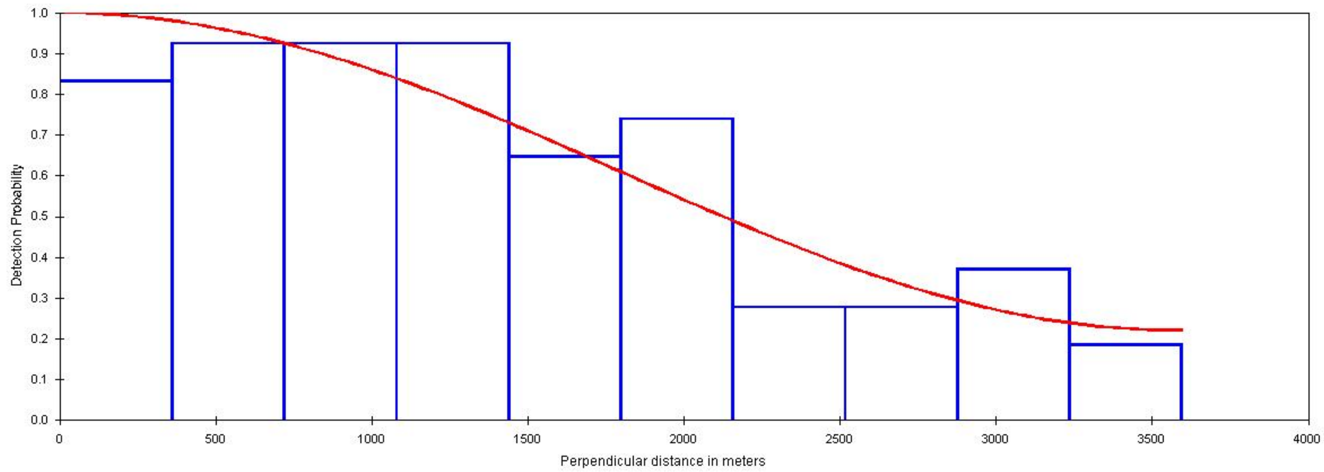



**Figure 21:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Somerset Island survey area, April 2004. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 360 m.

**Table 9:** Summary of candidate models used in the line-transect analysis for muskoxen in the Somerset Island survey area, April 2004. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Somerset - Muskoxen Name | Par | Delta AIC | AIC | ESW (m) | Density Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
|---|---|---|---|---|---|---|---|---|
| Uniform Cosine | 1 | 0.00 | 1069.07 | 2193.90 | 0.0778 | 0.0392 | 0.1545 | 0.347 |
| Half-normal Hermite Poly | 1 | 0.07 | 1069.14 | 2256.73 | 0.0764 | 0.0381 | 0.1529 | 0.352 |
| Half-normal Cosine | 1 | 0.07 | 1069.14 | 2256.73 | 0.0764 | 0.0381 | 0.1529 | 0.352 |
| Uniform Simple Poly | 1 | 1.15 | 1070.23 | 2553.26 | 0.0700 | 0.0357 | 0.1374 | 0.339 |
| Hazard-rate Simple Poly | 2 | 1.37 | 1070.45 | 2436.85 | 0.0732 | 0.0363 | 0.1476 | 0.357 |
| Hazard-rate Cosine | 2 | 1.37 | 1070.45 | 2436.85 | 0.0732 | 0.0363 | 0.1476 | 0.357 |

## 3.2.4 Ellesmere Island Group

*(Survey Areas - S. Ellesmere (incl. Graham Island) and N. Ellesmere)*

### *3.2.4.1 Southern Ellesmere Island Survey Area*

**Caribou**

*Ground Survey*: In 2005, ground crews traveled 1,662 km on southern Ellesmere Island, primarily on the Bjorne Peninsula north of the Sydcap Icecap. Harsh weather and difficult terrain limited travel to other areas. The crews observed six clusters of caribou (17 individuals) for an encounter rate of 3.6 clusters/1000 km (Table 2, Figure 22).

*Aerial Survey*: In May 4-30, 2005, we flew a total of 4,299 km of A transect distributed across southern Ellesmere Island and Graham Island (Figure 23). The survey area encompassed the entire landmass except glaciers and ice fields. During the flights, 19 clusters of caribou were observed on transect, representing a total of 57 caribou (Table 4). The majority of observations were made on Graham Island. The composition was 36 female and 17 male adults, 3 yearlings, zero calves or 'short yearlings', and zero newborns. We recorded one adult of unknown sex. The proportion of calves or 'short yearlings' was zero, and the ratio of adult males to females was 47:100.

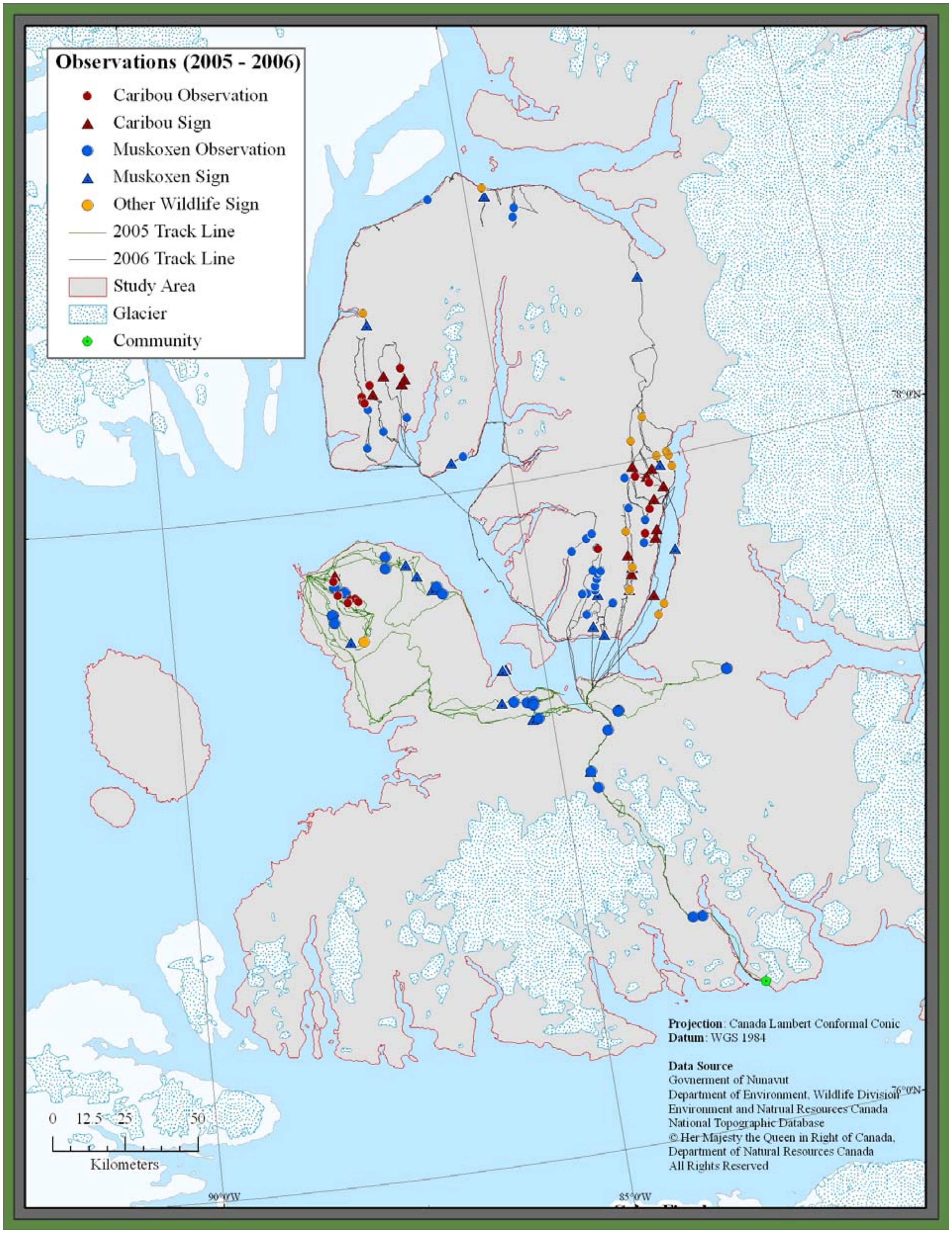



**Figure 22:** Ground survey observations within the Southern Ellesmere survey area, (2005) and Northern Ellesmere survey area (2006).

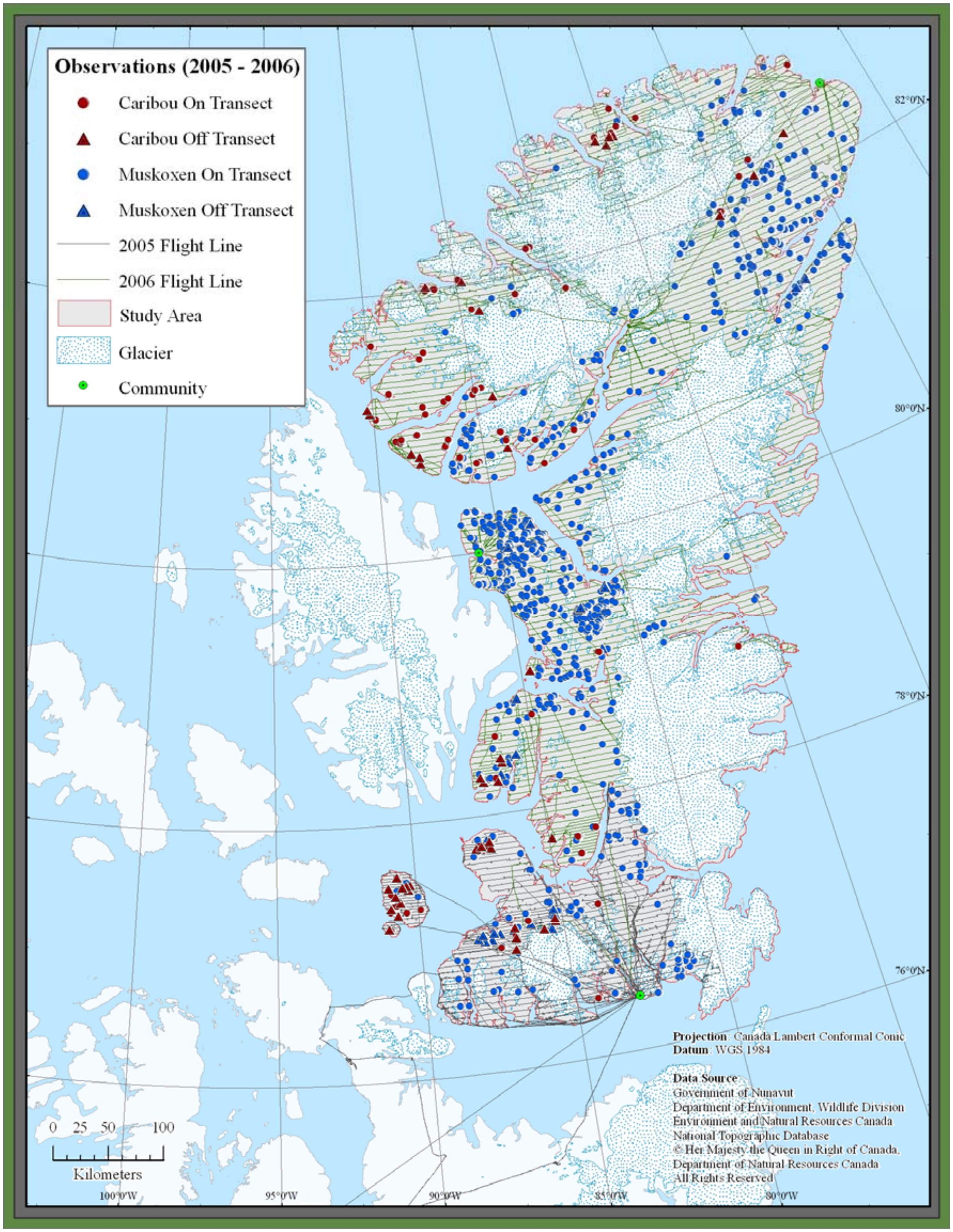



**Figure 23:** Peary caribou and muskox observations reported for aerial surveys of Southern Ellesmere survey area (2005) and Northern Ellesmere survey areas (2006).

Owing to the small number of observations and absence of outliers, the distance data were truncated at the largest distance from the transect line. We ran all recommended models (Buckland et al., 2001; Figure 24, Table 10) and the uniform key model with single-order cosine adjustment was selected as the final detection function. The selected model was non-significant, suggesting good fit of the data ( $\chi^2$ = 0.2394, p= 0.88720).

We estimated the probability of detecting a cluster of caribou on either side of any given transect line as $P_a$ = 0.633 (95% CI 0.440–0.910). The ESW was estimated to be 655 m (95% CI 456–942 m). The expected cluster size was 2.75 caribou/cluster (SE 0.39), whereas mean cluster size was 3.0 caribou/cluster (SE 0.34). The estimated density of caribou in the Southern Ellesmere Island survey area was 9.2/1000 $km^2$ (95% CI 4.6–18.6/1000 $km^2$). Based on the area surveyed (23,767 $km^2$), the estimated abundance of caribou (10 months or older) throughout Southern Ellesmere Island in 2005 was 219 (95% CI 109-442).

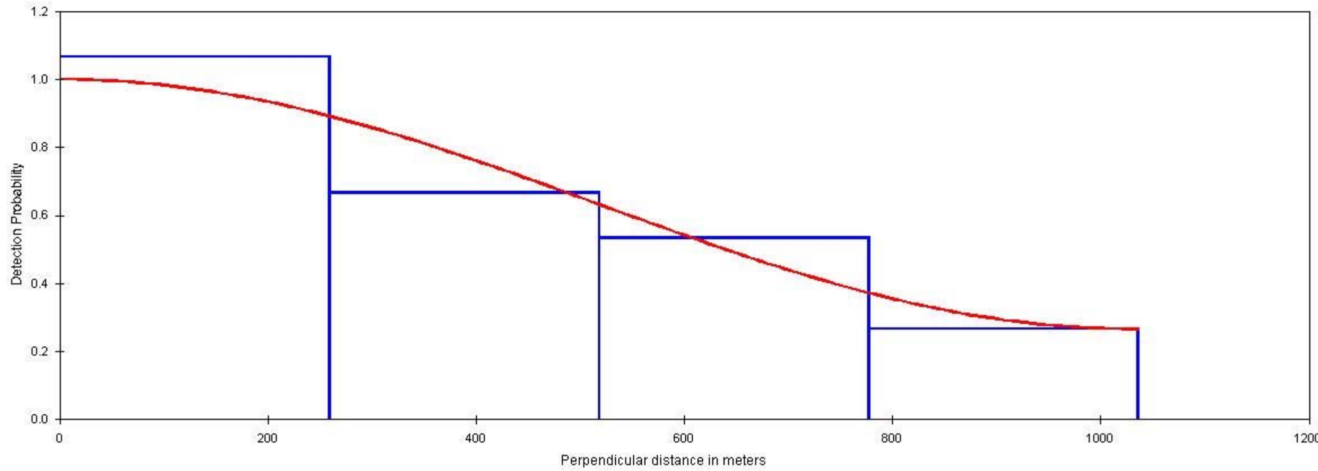



**Figure 24:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Southern Ellesmere Island survey area, May 2005. The g(x) is estimated using a uniform model with single cosine adjustment. Bin size is 259 m.

**Table 10:** Summary of candidate models used in the line-transect analysis for Peary caribou of the Southern Ellesmere Island survey area, May 2005. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Southern Ellesmere - Peary Caribou | | | | | Density | | | |
|---|---|---|---|---|---|---|---|---|
| Name | Par | Delta AIC | AIC | ESW (m) | Carbiou/km$^2$ | 95% LCI | 95% UCI | CV |
| Uniform Cosine | 1 | 0.00 | 262.28 | 655.76 | 0.0092 | 0.0046 | 0.0186 | 0.361 |
| Half-normal Hermite Poly | 1 | 0.32 | 262.60 | 676.39 | 0.0091 | 0.0045 | 0.0185 | 0.367 |
| Half-normal Cosine | 1 | 0.32 | 262.60 | 676.39 | 0.0091 | 0.0045 | 0.0185 | 0.367 |
| Uniform Simple Poly | 1 | 1.02 | 263.30 | 780.66 | 0.0082 | 0.0042 | 0.0157 | 0.338 |
| Hazard-rate Simple Poly | 2 | 1.20 | 263.49 | 486.09 | 0.0113 | 0.0034 | 0.0375 | 0.640 |
| Hazard-rate Cosine | 2 | 1.20 | 263.49 | 486.09 | 0.0113 | 0.0034 | 0.0375 | 0.640 |

## Muskoxen

*Ground Survey:* In 2005, ground crews traveled 1,662 km in the south of Ellesmere Island, primarily on the Bjorne Peninsula north of the Sydcap Icecap. Harsh weather and difficult terrain limited travel to other areas. The crews observed 23 clusters of muskoxen (56 individuals) for an encounter rate of 13.84 clusters/1000 km traveled (Table 3, Figure 22). They also observed six carcasses.

*Aerial Survey*: In 2005, during 4,299 km of flying in the southern part of Ellesmere Island (Figure 23), we observed 99 muskoxen clusters with 273 muskoxen (1 year or older) and two newborns, all on transect (Table 4). The proportion of newborn calves is 2 %. Preliminary evaluation of the distance data supported truncating the largest 5% of these data. The half-normal key model with Hermite polynomial adjustment was selected as the final detection function, with the lowest AIC score and a non-significant $\chi2$ that suggested good fit of the data ($\chi2$ = 10.877, p= 0.5395; Figure 25, Table 11).

We estimated the probability of detecting a cluster of muskoxen on either side of any given transect line as $P_a$ = 0.695 (95% CI 0.573–0.844). The estimated ESW was 1540.5 m (95% CI 1269.1–1869.9 m). The expected cluster size for the Southern Ellesmere Island survey area was 2.77 muskoxen/cluster (SE 0.20), whereas mean cluster size was 2.71 muskoxen/cluster (SE 0.38). The estimated density of muskoxen in the Southern Ellesmere Island survey area was 19.2/1000 km$^2$ (95% CI 13.1-

128.2/1000 $km^2$). Based on findings in this survey area (23,767 $km^2$), the estimated abundance of muskoxen (one year and older) throughout Southern Ellesmere Island in May 2005 was 456 (95% CI 312-670).

Notably, 19 separate clusters of muskox carcasses (20 carcasses total) were observed on transect during the aerial survey; a total of 40 muskox carcasses were reported during the 2005 aerial survey (Campbell 2006). Two observations of single adult muskoxen in very poor condition or dying were excluded from the analysis.

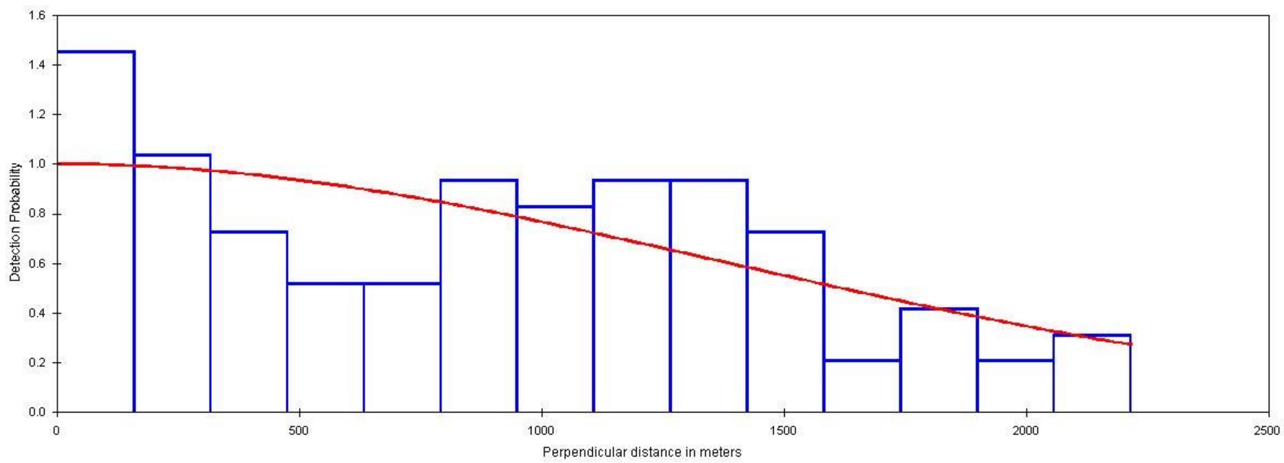



**Figure 25:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Southern Ellesmere survey area, May 2005. The g(x) is estimated using a half-normal model with Hermite polynomial adjustment. Bin size is 158 m.

**Table 11:** Summary of candidate models used in the line-transect analysis for muskoxen of the Southern Ellesmere survey area, May, 2005. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Southern Ellesmere - Muskoxen Name | Par | Delta AIC | AIC | ESW (m) | Density Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
|---|---|---|---|---|---|---|---|---|
| Half-normal Hermite Poly | 1 | 0.00 | 1438.82 | 1540.49 | 0.0192 | 0.0131 | 0.0282 | 0.194 |
| Half-normal Cosine | 1 | 0.00 | 1438.82 | 1540.49 | 0.0192 | 0.0131 | 0.0282 | 0.194 |
| Uniform Simple Poly | 1 | 0.12 | 1438.94 | 1639.92 | 0.0181 | 0.0127 | 0.0257 | 0.178 |
| Uniform Cosine | 1 | 0.53 | 1439.36 | 1479.07 | 0.0201 | 0.0137 | 0.0292 | 0.192 |
| Hazard-rate Simple Poly | 2 | 0.89 | 1439.72 | 1748.81 | 0.0170 | 0.0118 | 0.0244 | 0.185 |
| Hazard-rate Cosine | 2 | 0.89 | 1439.72 | 1748.81 | 0.0170 | 0.0118 | 0.0244 | 0.185 |

### *3.2.4.2 Northern Ellesmere Island Survey Area*

**Caribou**

*Ground Survey:* In 2006, ground crews snowmobiled 2,924 km in the northern part of Ellesmere Island, primarily on the Svendson Peninsula and observed 11 clusters of Peary caribou (44 individuals, Figure 22) for an encounter rate of 3.8 clusters/1000 km traveled. They also reported finding three caribou carcasses (Table 2). Travel in northern Ellesmere was limited by the remote location, harsh weather and terrain (Jeffery Qaunaq, personal communication, Sept 2010).

*Aerial Survey:* Crews flew a total of 17,535 km of A transects across the northern part of Ellesmere Island in 2006 (Figure 23). They recorded 72 clusters of caribou on transect with a total of 344 individual caribou, including 191 female and 108 male adults, 26 yearlings, zero calves or 'short yearlings', and zero newborns. An additional 19 unclassified adults were recorded. The survey team also recorded an additional 14 caribou clusters off transect (Table 4). The proportion of calves or 'short yearlings' was 0% of those animals seen on transect. The ratio of adult males to females was 56:100

To facilitate modeling of the data, we truncated distance observations at 1500 m, where detection probability was approximately 0.15 (Buckland *et al*., 2001). A half-normal key model with single cosine adjustment was selected as the final detection function (Table 12). The selected model was characterized by a small shoulder (Figure

26) and the overall model was non-significant, suggesting good fit of the data ($\chi^2$ = 3.4776, p= 0.32368).

We estimated the probability of detecting a caribou cluster on either side of any given A transect line in the Northern Ellesmere Island survey area as $P_a$ = 0.59057 (95% CI 0.48100–0.72500). The ESW was estimated to be 885.85 m (95% CI 721.51–1087.6 m). The expected cluster size was 4.10 caribou/cluster (SE 0.39), whereas mean cluster size was 4.57 caribou/cluster (SE 0.38). The estimated density of caribou in the Northern Ellesmere Island survey area was 8.3/1000 $km^2$ (95% CI 5.5-12.5/1000 $km^2$). Based on the area surveyed (96,567 $km^2$), our abundance estimate for caribou (10 months or older) throughout Northern Ellesmere Island in 2006 was 802 animals (95% CI 531-1207).

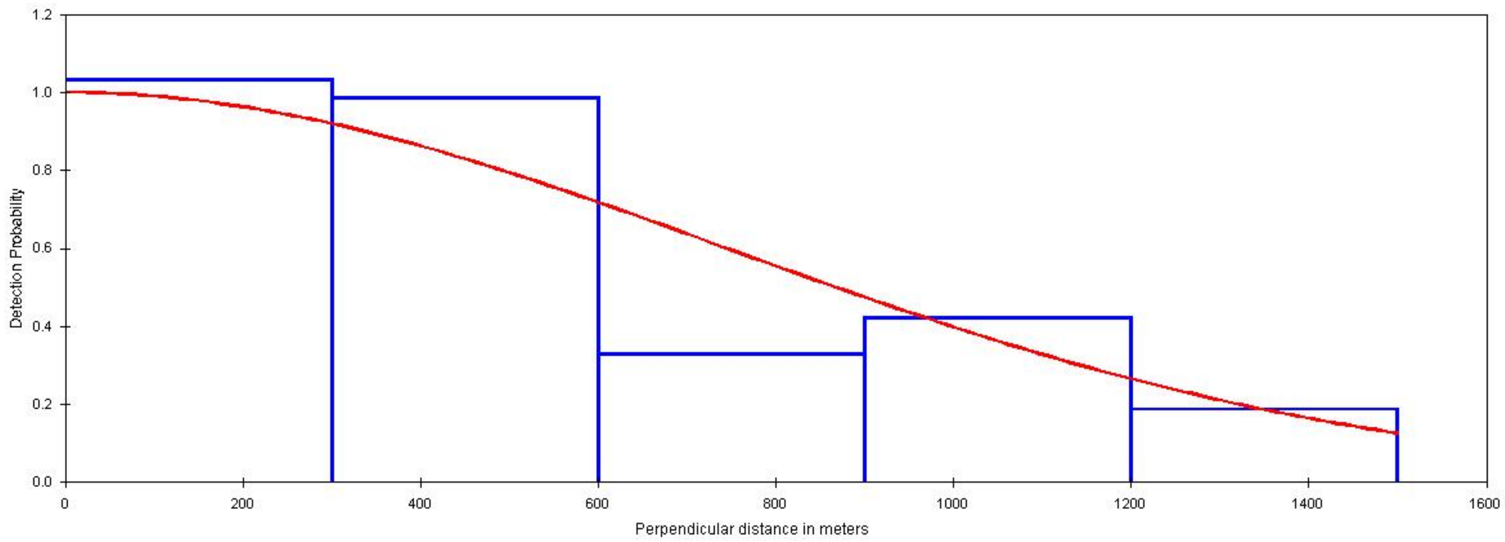



**Figure 26:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou observed within the Northern Ellesmere survey area for April-May 2006. The g(x) is estimated using a half-normal key with cosine adjustment. Bin size is 300 m.

**Table 12:** Summary of candidate models used in the line-transect analysis for Peary caribou of the Northern Ellesmere survey area, April-May 2006. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Northern Ellesmere - Peary caribou | | | | | Density | | | |
|---|---|---|---|---|---|---|---|---|
| Name | Par | Delta AIC | AIC | ESW (m) | Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
| Half-normal Cosine | 1 | 0.00 | 906.60 | 885.85 | 0.0083 | 0.0055 | 0.0125 | 0.210 |
| Half-normal Hermite Poly | 1 | 0.00 | 906.60 | 885.85 | 0.0083 | 0.0055 | 0.0125 | 0.210 |
| Uniform Cosine | 1 | 0.29 | 906.89 | 891.02 | 0.0082 | 0.0056 | 0.0122 | 0.202 |
| Uniform Simple Poly | 1 | 1.22 | 907.82 | 1011.54 | 0.0076 | 0.0053 | 0.0111 | 0.191 |
| Hazard-rate Simple Poly | 2 | 1.51 | 908.11 | 791.05 | 0.0088 | 0.0050 | 0.0153 | 0.289 |
| Hazard-rate Cosine | 2 | 1.51 | 908.11 | 791.05 | 0.0088 | 0.0050 | 0.0153 | 0.289 |

## Muskoxen

*Ground Survey:* In 2006, ground crews snowmobiled 2,924 km of the northern portion of Ellesmere Island, primarily on the Svendson Peninsula, and observed 27 clusters of muskoxen (203 individuals: Figure 22) for an encounter rate of 9.2 clusters/1000 km traveled. They also recorded three muskox carcasses (Table 3). Additional travel in the region was limited by the remote location, harsh weather and terrain (Jeffery Qaunaq, personal communication, Sept 2010)

Aerial Survey: Flights were conducted totaling 17,535 km of A transects across the north of Ellesmere Island (Figure 23) in 2006. The crews observed 645 clusters of muskoxen on transect with totals of 4,999 muskoxen (1 year or older) and 907 newborn calves (Table 5). Based on preliminary analysis of the observations, 5% of the observations farthest from the transect line were discarded. A half-normal key model with single cosine adjustment was selected as the final detection function (Table 13). The selected model was characterized by a shoulder (Figure 27) and the overall model was non-significant, suggesting good fit of the data ( $\chi^2$ = 2.4211, p = 0.93292).

We estimated the probability of detecting a cluster of muskoxen on either side of any given A transect as $P_a$ = 0.494 (95% CI 0.445-0.549). The estimated ESW was 1381.7 m (95% CI 1244.4-1534.1 m). The expected cluster size was calculated at 6.64 muskoxen (SE 0.25), whereas mean cluster size was 7.51 muskoxen. The estimated density for muskoxen in the Northern Ellesmere Island survey area is 84.0/1000 km$^2$

(95% CI 68.7-102.8/1000 $km^2$). Based on the non-glaciated survey area (96,567 $km^2$), our estimate for abundance of muskoxen (one year and older) throughout Northern Ellesmere Island in 2006 was 8,115 (95% CI 6,632-9,930).

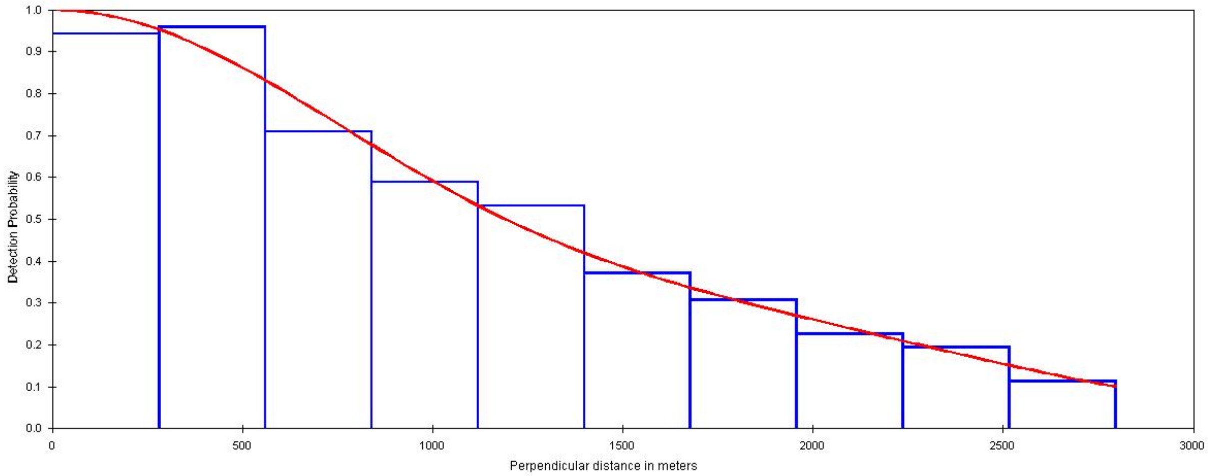



**Figure 27:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Northern Ellesmere survey area, April-May 2006. The g(x) is estimated using a half-normal model with cosine adjustment. Bin size is 280 m.

**Table 13:** Summary of candidate models used in the line-transect analysis for muskoxen of the Northern Ellesmere survey area, April-May 2006. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Northern Ellesmere - Muskoxen Name | Par | Delta AIC | AIC | ESW (m) | Density Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
|---|---|---|---|---|---|---|---|---|
| Half-normal Cosine | 2 | 0.00 | 9518.26 | 1381.69 | 0.0840 | 0.0687 | 0.1028 | 0.103 |
| Uniform Cosine | 3 | 0.99 | 9519.25 | 1362.46 | 0.0848 | 0.0691 | 0.1040 | 0.104 |
| Hazard-rate Simple Poly | 3 | 1.88 | 9520.14 | 1432.48 | 0.0819 | 0.0658 | 0.1018 | 0.111 |
| Hazard-rate Cosine | 2 | 2.14 | 9520.40 | 1442.23 | 0.0816 | 0.0664 | 0.1003 | 0.105 |
| Half-normal Hermite | 1 | 4.16 | 9522.42 | 1550.12 | 0.0778 | 0.0647 | 0.0935 | 0.093 |
| Uniform Simple Poly | 3 | 5.65 | 9523.91 | 1491.84 | 0.0798 | 0.0660 | 0.0966 | 0.097 |

### <u>3.2.5 Axel Heiberg Island Group</u>
*(Survey Area - Axel Heiberg Island)*

#### *3.2.5.1 Axel Heiberg Survey Area*

**Caribou**

*Ground Survey:* A ground survey was not completed within this Island Group.

*Aerial Survey:* In total 5,872 km of transect were flown across the Axel Heiberg Island Group in 2007 (Figure 28). We observed 120 clusters of caribou on transect, with a total of 642 individual caribou that included 379 female and 242 male adults (possibly some yearlings and short yearlings), 17 calves or ‘short yearlings’, and zero newborns. In addition, 4 adults of unknown sex where recorded. The proportion of calves or ‘short yearlings’ is uncertain as some groups were not aged due to rugged terrain and animal care protocols. The ratio of adult males to females is 64:100 (but may include members from other cohorts). An additional four caribou clusters were observed off transect (Table 4).

After preliminary analysis of the distance data, observations exceeding 1400 m from transect were discarded to address outliers. Several robust models were run and the half-normal key model with single-order cosine adjustment was selected as the final detection function in accordance with AIC (Figure 29, Table 14). The Chi-square goodness-of-fit test was non-significant, suggesting good fit of the data ($\chi^2$ = 2.21, p= 0.69634).

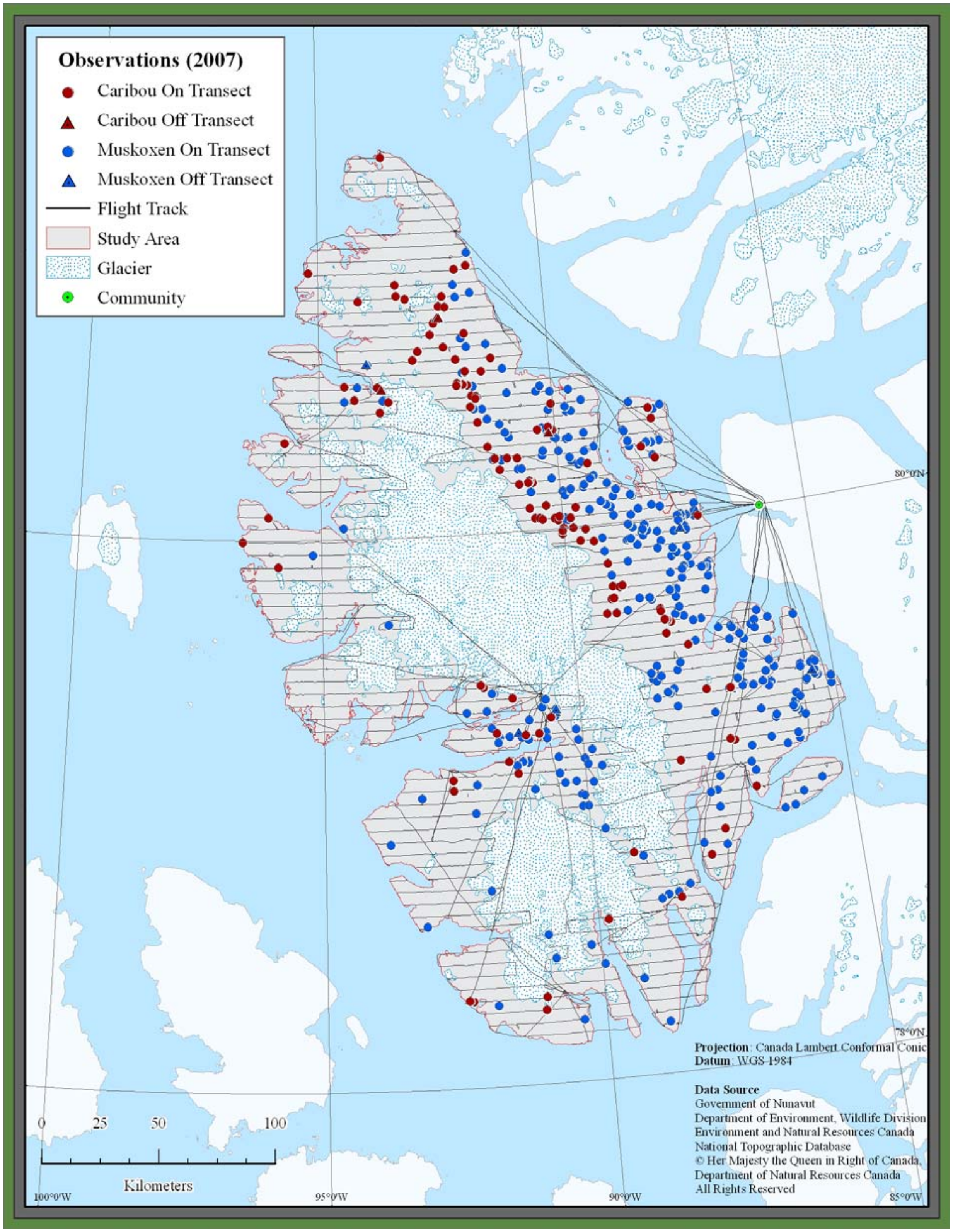



**Figure 28:** Aerial survey observations of Peary caribou and muskoxen clusters for the Axel Heiberg Island Group, 2007.

We estimated the probability of detecting a cluster of caribou on either side of any given A transect line as $P_a$ = 0.402 (95% CI 0.325–0.498). The ESW was calculated as 563.59 m (95% CI 455.72–696.99 m). Mean cluster size was 5.31 caribou/cluster (SE 0.32), which was the largest value for this parameter among all survey strata in our entire study. The estimated density of caribou (approximately 10 months or older) in the Axel Heiberg Island Group survey area was 74.2/1000 $km^2$ (95% CI 53.1–103.9/1000 $km^2$). Based on the survey area of 30,877 $km^2$, the estimated abundance of Peary caribou inhabiting the Axel Heiberg Island Group in 2007 was 2,291 (95% CI 1,636-3,208).

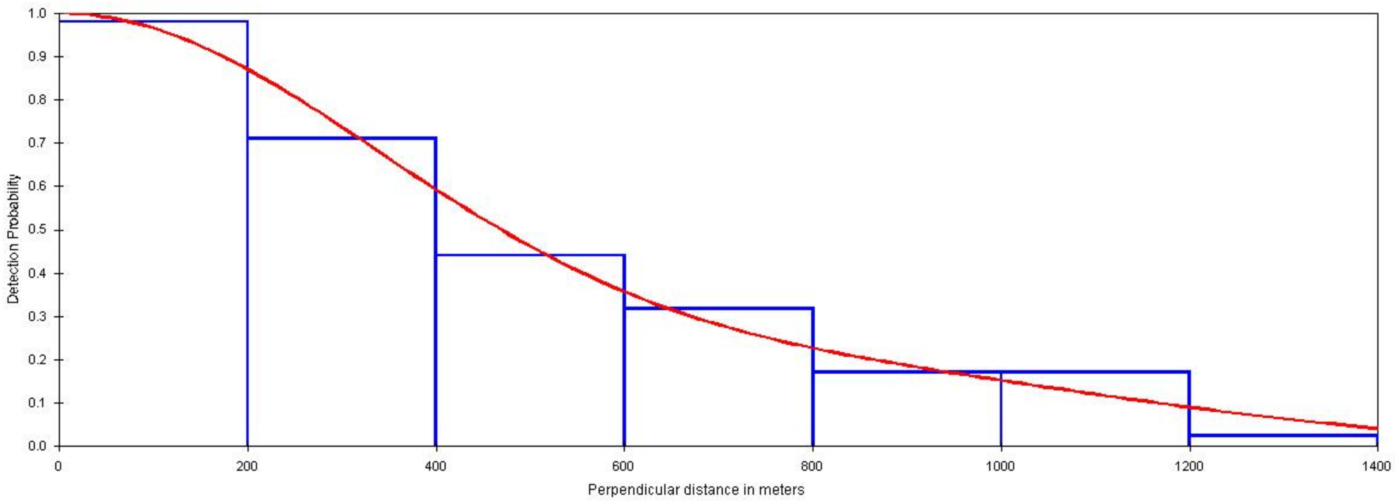



**Figure 29:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Axel Heiberg Island Group, April-May 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 200 m.

**Table 14:** Summary of candidate models used in the line-transect analysis (October, 2009) for Peary caribou of the Axel Heiberg Island Group, April-May 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score**.**

| Axel Heiberg - Peary caribou Name | Par | Delta AIC | AIC | ESW (m) | Density Caribou/km$^2$ | 95% LCI | 95% UCI | CV |
|---|---|---|---|---|---|---|---|---|
| Half-normal Cosine | 2 | 0.00 | 1601.01 | 563.59 | 0.0742 | 0.0531 | 0.1039 | 0.172 |
| Half-normal Hermite Poly | 1 | 0.49 | 1601.50 | 655.79 | 0.0666 | 0.0496 | 0.0893 | 0.150 |
| Uniform Cosine | 3 | 0.72 | 1601.72 | 538.29 | 0.0769 | 0.0549 | 0.1077 | 0.172 |
| Hazard-rate Simple Poly | 2 | 1.78 | 1602.78 | 644.24 | 0.0686 | 0.0490 | 0.0960 | 0.172 |
| Hazard-rate Cosine | 2 | 1.78 | 1602.78 | 644.24 | 0.0686 | 0.0490 | 0.0960 | 0.172 |
| Uniform Simple Poly | 1 | 8.52 | 1609.53 | 853.86 | 0.0543 | 0.0414 | 0.0712 | 0.138 |

**Muskoxen**

*Ground Survey:* A ground survey was not completed within the Axel Heiberg Island Group.

*Aerial Survey:* In total 5,872 km of transect were flown across the Axel Heiberg Island Group in 2007 (Figure 28). During the survey, 301 clusters of muskoxen were observed on-transect, with totals of 2,653 muskoxen (1 year or older) and 396 newborn calves (Table 5). We encountered our first newborn on April 22, 2007 and the overall proportion of newborn calves was 13%.

Analysis of the distance data supported 5% right truncation. We considered several robust models of the detection function (Table 15, Figure 30) and used AIC, which identified a half-normal key function with Hermite polynomial adjustment as the best model. A non-significant goodness-of-fit test ($\chi 2 = 9.0817$, $p = 0.82578$) supported model selection.

We estimated the probability of detecting a muskox cluster on either side of an A transect as $P_a = 0.636$ (95%CI 0.573-0.705). The ESW was calculated as 1547.6 (95%CI 1395-1716.9). The expected cluster size was estimated at 8.68 muskoxen/cluster (SE 0.53), whereas the mean cluster size was 8.69 muskoxen/cluster (SE 0.43). The estimated density of muskoxen in the Axel Heiberg Island Group survey area was 137.2 muskoxen/1000 km$^2$ (95%CI 109.2 –172.5). Based on the area surveyed (30,877 $km^2$), the estimated abundance of muskoxen (1 year and older) throughout the Axel Heiberg Island Group in 2007 was 4,237 (95% CI 3,371-5,325).

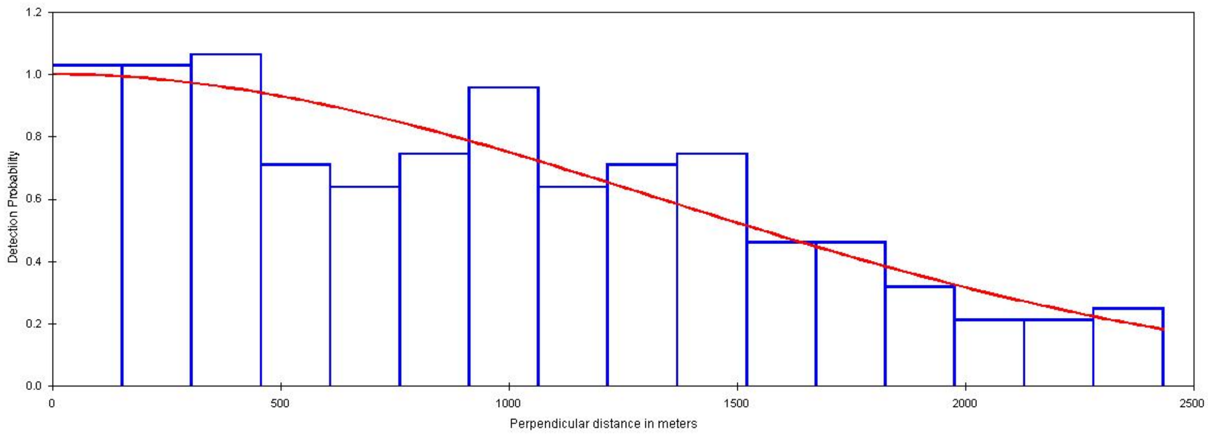



**Figure 30:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of muskoxen in the Axel Heiberg Island Group survey area in April-May 2007. The g(x) is estimated using a half-normal model with Hermite polynomial adjustment. Bin size is 152 m.

**Table 15:** Summary of candidate models used in the line-transect analysis for muskoxen of the Axel Heiberg Island Group survey area, April-May 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| **Axel Heiberg - Muskoxen Name** | **Par** | **Delta AIC** | **AIC** | **ESW (m)** | **Density Caribou/km$^2$** | **95% LCI** | **95% UCI** | **CV** |
|---|---|---|---|---|---|---|---|---|
| Half-normal Hermite Poly | 1 | 0.00 | 4421.99 | 1547.60 | 0.1372 | 0.1092 | 0.1725 | 0.116 |
| Half-normal Cosine | 1 | 0.00 | 4421.99 | 1547.60 | 0.1372 | 0.1092 | 0.1725 | 0.116 |
| Uniform Cosine | 1 | 0.28 | 4422.27 | 1496.33 | 0.1419 | 0.1137 | 0.1772 | 0.113 |
| Uniform Simple Poly | 3 | 0.64 | 4422.63 | 1661.92 | 0.1278 | 0.0989 | 0.1651 | 0.131 |
| Hazard-rate Simple Poly | 2 | 1.90 | 4423.89 | 1756.59 | 0.1209 | 0.0964 | 0.1517 | 0.115 |
| Hazard-rate Cosine | 2 | 1.90 | 4423.89 | 1756.59 | 0.1209 | 0.0964 | 0.1517 | 0.115 |

### 3.2.6 Ringnes Island Group

( Survey Areas - *Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, Meighen, and Lougheed Islands)*

#### *3.2.6.1 Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Survey Area*

**Caribou**

*Ground Survey:* A ground survey was not completed in 2007 for this survey area.

*Aerial Survey*: During April 6-22, 2007, we flew 4,076 km of transect across Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands (Figure 31). The survey area encompassed all the landmasses except glaciers and ice fields. The crew observed 28 clusters of caribou (74 individual caribou) on transect, with a range of 0-14 observations per island (Table 4). The composition estimated from on-transect observations was 32 female and 32 male adults (possibly included some yearlings), 10 calves or 'short yearlings' and zero newborns. The proportion of calves or 'short yearlings' was 14% of those animals seen on transect. The ratio of adult males to females is 100:100.

We pooled the data across these islands and post-stratified our analysis by island to estimate a combined detection function, cluster size, and density. As preliminary analysis revealed no obvious outliers, we truncated the distance data at the largest perpendicular distance from the transect (Table 16, Figure 32). The uniform model with cosine adjustment was identified as the best model, characterized by a pronounced shoulder and a non-significant $\chi 2$, suggesting good fit of the data ($\chi 2$ = 0.6741, p= 0.95448). The probability of detecting a cluster of caribou on either side of the A transects was $P_a$ = 0.575 (95% CI 0.453-0.729). The ESW was estimated at 665.59 m (95%CI524.96-843.88 m). The expected cluster size was 2.72 caribou/cluster (SE 0.35), whereas mean cluster size was 2.64 caribou/cluster (SE 0.28).

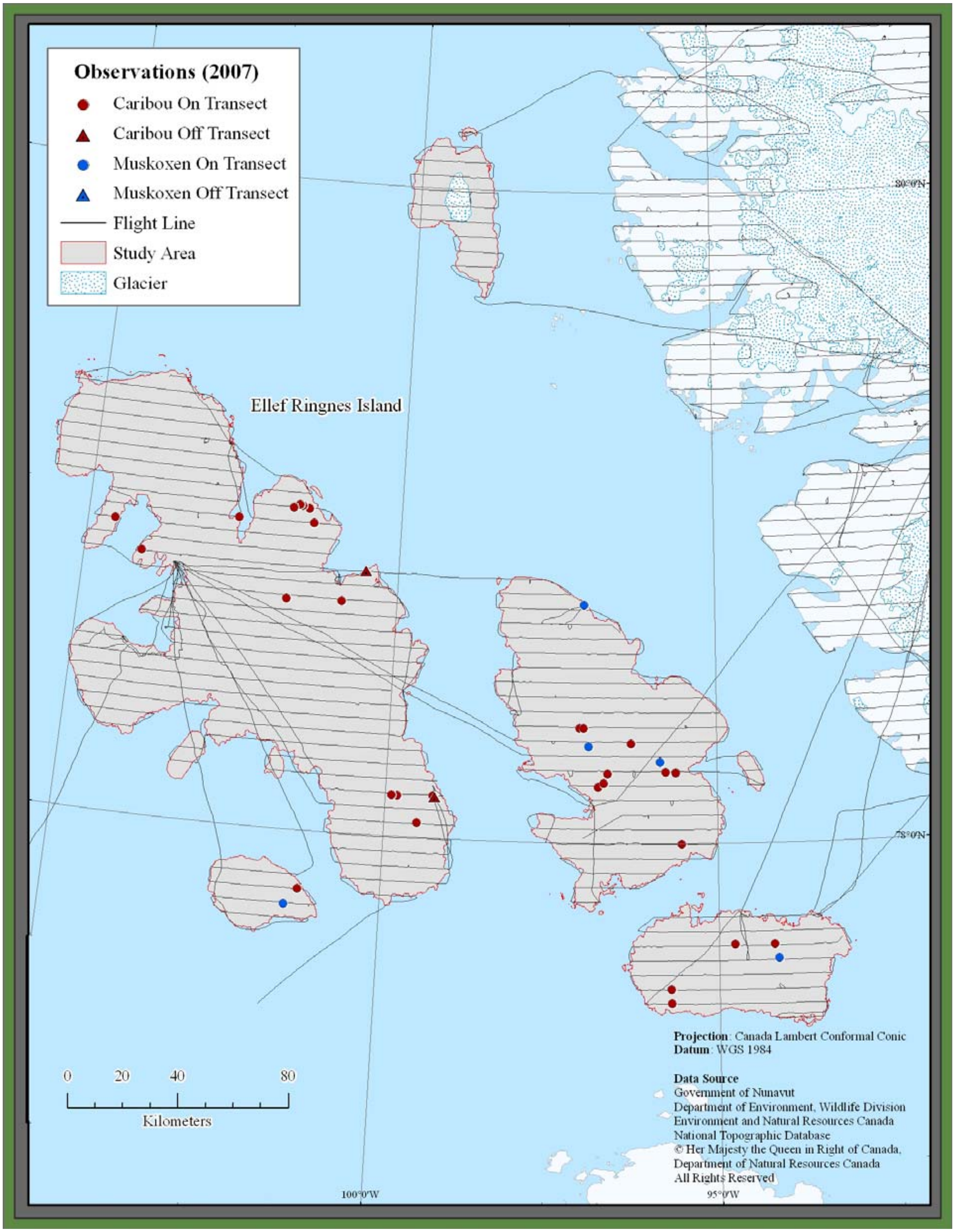



**Figure 31:** Aerial survey observations of Peary caribou and muskoxen clusters for the Ringnes Island Group survey area, 2007.

The estimated density of caribou detected in the Ringnes Island Group survey area was 13.6/1000 km$^2$ (95% CI 7.6-24.4/1000 km$^2$) and the estimated abundance of caribou (10 months or older) on the five islands in 2007 was 282 caribou (95% CI 157-505). Density estimates for each island were derived but not reported due to high uncertainty.  This was a consequence of low encounter rates, small sample size, and the low number of observations per island.

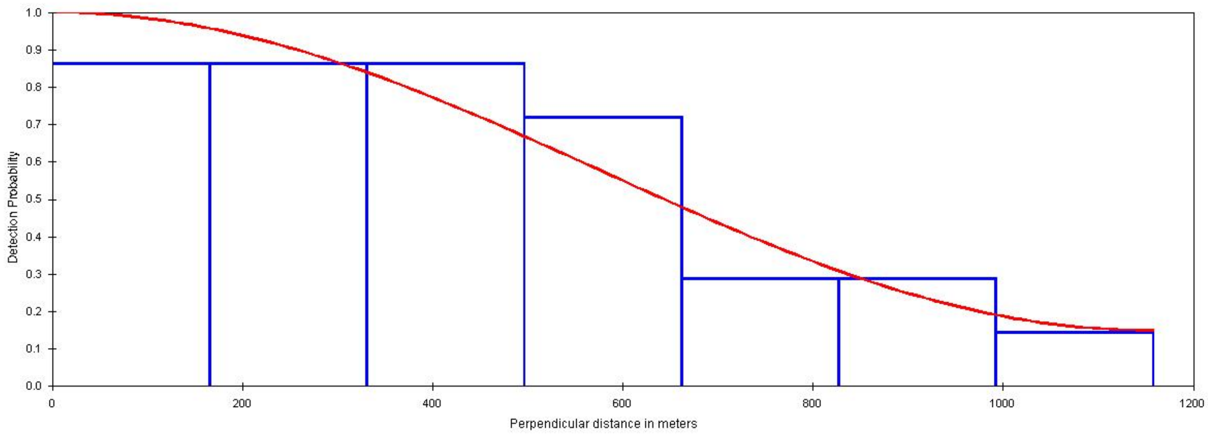



**Figure 32:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou on the Ringnes Island Group survey area in April 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 165 m.

**Table 16:** Summary of candidate models used in the line-transect analysis for Peary caribou of the Ringnes Island Group survey area, April 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| Ellef, Amund, King Christian, Cornwall, Meighen - Peary caribou | | | | | Density | | | |
|---|---|---|---|---|---|---|---|---|
| **Name** | **Par** | **Delta AIC** | **AIC** | **ESW (m)** | **Caribou/km$^2$** | **95% LCI** | **95% UCI** | **CV** |
| Uniform Cosine | 1 | 0.00 | 389.21 | 665.59 | 0.0136 | 0.0076 | 0.0244 | 0.300 |
| Half-normal Hermite Poly | 1 | 0.41 | 389.62 | 685.33 | 0.0132 | 0.0071 | 0.0246 | 0.319 |
| Half-normal Cosine | 1 | 0.41 | 389.62 | 685.33 | 0.0132 | 0.0071 | 0.0246 | 0.319 |
| Uniform Simple Poly | 2 | 1.58 | 390.79 | 655.67 | 0.0138 | 0.0075 | 0.0257 | 0.319 |
| Hazard-rate Simple Poly | 2 | 1.93 | 391.14 | 783.53 | 0.0116 | 0.0063 | 0.0214 | 0.318 |
| Hazard-rate Cosine | 2 | 1.93 | 391.14 | 783.53 | 0.0116 | 0.0063 | 0.0214 | 0.318 |

**Muskoxen**

*Ground Survey:* A ground survey was not completed in 2007

*Aerial Survey:* Throughout 4,076 km of transect flown across the five islands in the Ringnes Island Group in April 2007 (Figure 31), five clusters of muskoxen were observed (Ellef Ringnes zero clusters, Amund Ringnes three clusters, King Christian one cluster, Cornwall one cluster, and Meighen zero clusters) for a total of 21 individuals (one year and older). No newborn calves were observed.  Due to scarcity of muskoxen and the small number of observations, it was not possible to derive a density estimate for this survey area. Instead, we report a minimum count of muskoxen for each island surveyed (Table 5).

#### ***3.2.6.2  Lougheed Island Survey Area***

**Caribou**

*Ground Survey:* A ground survey was not carried out in the Lougheed Island Group.

*Aerial Survey*: On April 13, 2007 we flew 287 km across the Lougheed Island Group and observed 32 clusters of caribou (131 individuals) on transect (Figure 33). Composition was 62 female and 51 male adult caribou (possibly included yearlings), 18 calves or 'short yearlings' and zero newborns. The proportion of calves or 'short yearlings’ is 14% of those animals seen on transect. The ratio of adult males to females was 82:100

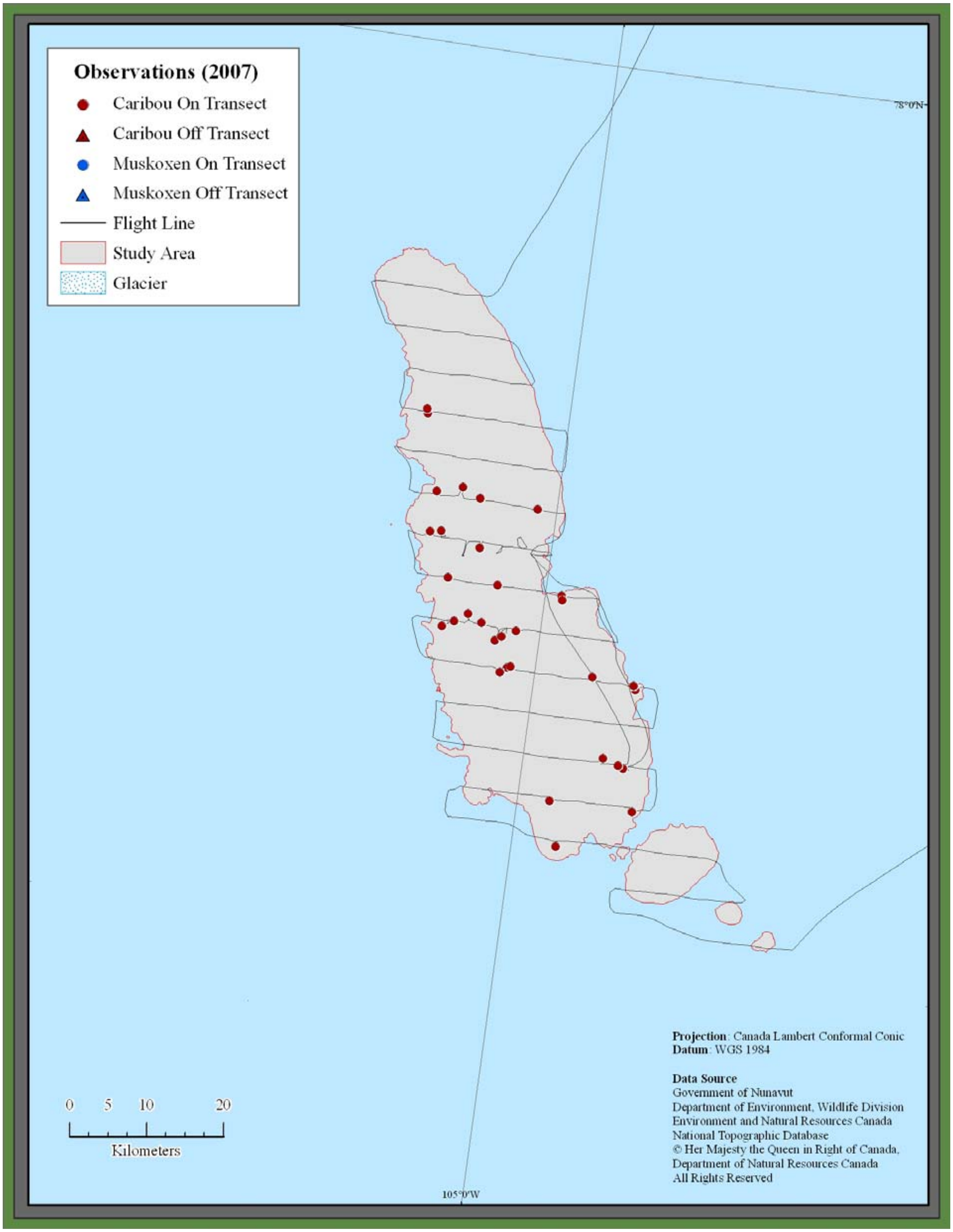



**Figure 33:** Peary caribou and muskox observations reported for aerial surveys of the Lougheed Island survey area in 2007.

For analysis, we applied 5% right truncation to address outliers (Buckland et al., 2001). From a series of models, we selected the uniform key model with single-order cosine adjustment as the final detection function (Table 17). This model was characterized by a small shoulder (Figure 34) and the Chi-square goodness-of-fit test was non-significant, suggesting good fit of the data ( $\chi^2$ = 0.1679, p= 0.98260).

The probability of detecting a cluster of caribou within the defined area on each side of the transect was estimated as $P_a$ = 0.59524 (95%CI 0.47108-0.75212). The expected cluster size was 3.31 caribou/cluster (SE= 0.52), whereas mean cluster size was 4.07 caribou/cluster (SE 0.55). The ESW was estimated as 658.93 m (95% CI 521.49-832.6 m). The estimated density of caribou in the Lougheed Island Group survey area was 262.6/1000 $km^2$ (95% CI 145-475 caribou/1000 $km^2$). Based on the area surveyed (1,415 $km^2$), the estimated abundance of Peary caribou throughout the Lougheed Island Group in 2007 was 372 (95%CI 205-672).

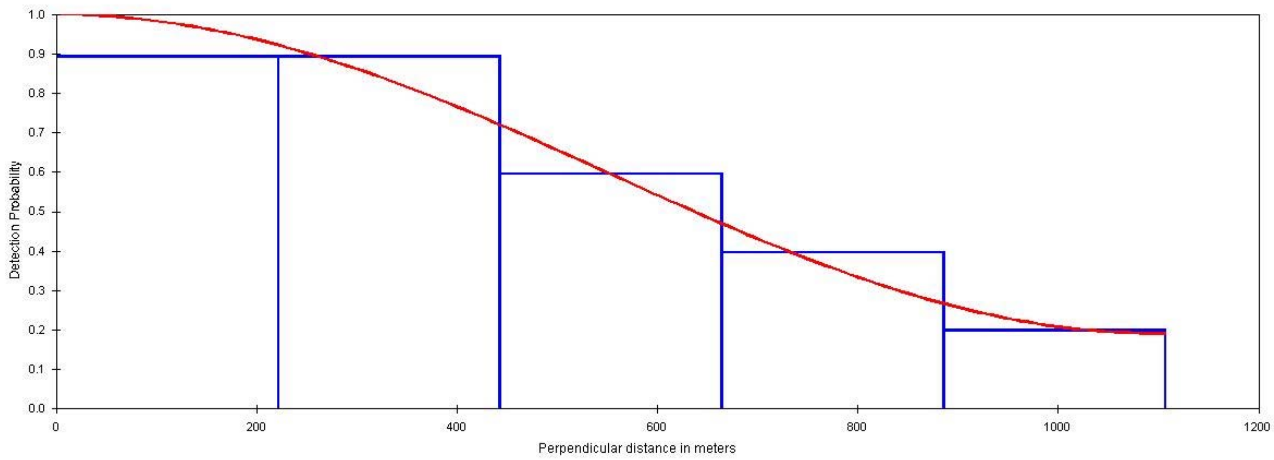



**Figure 34:** Detection probability (continuous line) plot and histogram of perpendicular distances from the transect line for clusters of Peary caribou in the Lougheed Island survey area, April 2007. The g(x) is estimated using a uniform model with cosine adjustment. Bin size is 221.

**Table 17:** Summary of candidate models used in the line-transect analysis for Peary caribou of the Lougheed Island survey area, April 2007. The parameter Delta i AIC refers to the change in AIC between model i and the model with lowest AIC score.

| **Lougheed - Peary caribou** | | | | | **Denisty** | | | |
|---|---|---|---|---|---|---|---|---|
| **Name** | **Par** | **Delta AIC** | **AIC** | **ESW (m)** | **Caribou/km$^2$** | **95% LCI** | **95% UCI** | **CV** |
| Uniform Cosine | 1 | 0.00 | 414.82 | 658.93 | 0.2626 | 0.1451 | 0.4754 | 0.300 |
| Half-normal Hermite Poly | 1 | 0.93 | 415.75 | 679.74 | 0.2616 | 0.1414 | 0.4839 | 0.312 |
| Half-normal Cosine | 1 | 0.93 | 415.75 | 679.74 | 0.2616 | 0.1414 | 0.4839 | 0.312 |
| Uniform Simple Poly | 2 | 1.35 | 416.17 | 643.55 | 0.2698 | 0.1400 | 0.5199 | 0.336 |
| Hazard-rate Simple Poly | 2 | 2.50 | 417.32 | 707.80 | 0.2681 | 0.1374 | 0.5230 | 0.343 |
| Hazard-rate Cosine | 2 | 2.50 | 417.32 | 707.80 | 0.2681 | 0.1374 | 0.5230 | 0.343 |

**Muskoxen**

*Ground Survey*: A ground survey was not carried out in the Lougheed Island Group.

*Aerial Survey:* No muskoxen were observed in the Lougheed Island Group survey area during the 2007 aerial survey (Table 5, Figure 33).

# 4.0 DISCUSSION

## 4.1 OVERVIEW

In 1961, Tener (1963) estimated that there were 25,845 Peary caribou and 7,421 muskoxen across the Queen Elizabeth Islands (QEI). For the QEI that are within Nunavut, Tener's estimates were 6,414 Peary caribou, distributed primarily in the Bathurst Island Complex (BIC; 56%), and 6,421 muskoxen, distributed on Ellesmere Island (62%), the BIC (19%) and Axel Heiberg Island (16%). Prince of Wales and Somerset Island, south of the QEI, were not surveyed until 1974. Results indicated that an additional 1,285 Peary caribou and 564 muskoxen occupied these islands (Fischer and Duncan, 1976). Our study reveals that the abundance and distribution of Peary caribou and muskoxen within the Arctic Archipelago, Nunavut has changed dramatically over the last five decades.

We estimated that there are approximately 4000 Peary caribou (combining estimates and minimum counts) within the 2001-2008 study area; the majority of which occurred within the Axel Heiberg Island Group (2,291 95% CI 1,636-3,208; 55%). For muskoxen, we estimated that the study area hosted approximately 17,500 (combining distance sampling estimates and minimum counts), with the majority in the Ellesmere Island Group, primarily the northern Ellesmere survey area (8115 95% CI 6632-9930; 47%). In contrast to Tener (1963), we found less than 5% of Peary caribou and 1% of muskoxen within the BIC. Trends in abundance by island group are discussed in detail in separate sections below.

Evaluating trends in abundance from 1961-2008 was hampered by differences in survey methods and design, and we discuss these issues in section 5.0 Management Implications. Notably, these challenges are not uncommon (Good 2007) and we present a history of the existing data, recognizing that 1) no other population estimates directly comparable to this study are available; 2) past estimates are generally based on strip sampling; 3) some past estimates are based on few data collected using low coverage.

## 4.2 PEARY CARIBOU

### 4.2.1 Bathurst Island Group
*(Survey Areas - Bathurst Island Complex, Cornwallis Group)*

**Bathurst Island Complex**

Within the QEI, the BIC has likely received the greatest interest and resources in terms of structured research programs, including 15 aerial surveys (including ours) between 1961 and 2001(Tener, 1963; Miller *et al*., 1977a; Fischer and Duncan, 1976; Ferguson, 1991; Miller, 1987a, 1989, 1992, 1993a, 1994, 1995b, 1997a, 1998; Gunn and Dragon, 2002). In part, this is a consequence of Teners' 1961 results, which highlighted the importance of the BIC to Peary caribou (Tener 1963). Interest has also focused on the BIC due to its importance as a caribou hunting area for the community of Resolute Bay (in the 1960s and 1970s, and again starting in the 1990s: Ferguson, 1991; Miller, 1993a, Miller 1995b), due to oil and gas exploration and development such as on Cameron Island (Bent Horn operation 1984-1996) and lead-zinc deposits on

Bathurst and Little Cornwallis (Babb and Bliss, 1974; Miller, 1977; Taylor, 2005), and planning for Tuktusiuqvialuk National Park.

Our results suggest that the Peary caribou population of the BIC has increased from the 1997 estimate of 78 ± 26 1-year-old and older caribou (Gunn and Dragon, 2002). However our estimated number is still small in relation to historical values that estimate a population size as large as 3,565 individuals (including calves) in 1961 and again in 1994 (Tener, 1963; Miller 1998).

Although evaluation of trends in abundance is complicated by differences in survey design and the inclusion or exclusion of calves, overall patterns are discernable. In the past four decades, the Peary caribou population on the BIC has fluctuated with steep declines in 1973-74, and again in 1995-1997. The first two surveys of the BIC were separated by 12 years (1961-1973) and revealed an 83% reduction in this caribou population from 3,565 (including calves; Tener, 1963) to 608 (including calves; Miller *et al*., 1977a). Late winter and summer surveys in 1973 and 1974 identified a further reduction in caribou numbers to 228 (no calves were observed) in August 1974 (Miller *et al*., 1977a). This additional 62% decline was attributed to deep snow cover and icing, which caused widespread mortality and resulted in little or no reproductive success (Miller *et al*., 1977a). Subsequent surveys from 1985 to 1994 indicated a slow increase in population size, and by 1994 Peary caribou were estimated at 3100 on the BIC (Miller, 1998).

Aerial surveys in 1995, 1996, and 1997 revealed a second die-off with an all-time low estimate of 78 caribou in 1997 (Gunn and Dragon, 2002). Based on carcass counts, it was estimated that 85% of the overall decline was directly related to caribou mortality (and not movement) and coincided with exceedingly severe winter and spring conditions (deep snow and icing; Miller and Gunn, 2003a, 2003b).

Our estimate for the BIC survey area suggests that this population of caribou has increased since 1997. The annual rate of population increase ($\lambda$) over the 4 years between these estimates is 24% ($\lambda = 1.24$) although the 1997 and 2001 estimates of abundance may not be directly comparable. However, the finite rate of Increase suggested by this finding is not unexpected for the initial years of growth in a population that is well below carrying capacity and strongly female-biased in composition (Heard, 1990). The recent die-off (1994-97) was biased toward male and younger caribou and the surviving population in 1998 was 75% females (Miller and Gunn 2003b). Notably, the annual finite rate of increase for caribou immediately following the 1973-74 die-off is unknown, as comparable data for the BIC is not available until 1985. Abundance estimates for the period from 1985 to 1993 (Miller 1987a, 1989, 1992, 1993a, 1994, 1995b) indicate average annual rates of increase ($\lambda$) ranging from 1.103 (1975-1988) to 1.399 (1990-1993) (Table B, Appendix 1).

Bergerud (1978), suggested the annual rate of increase of $\lambda = 1.35$ ($r = 0.30$) as the Malthusian rate of increase for caribou (i.e., intrinsic natural rate of population growth in the absence of all density-dependent effects). Based on this, potentially, the

Peary caribou population on the BIC could return to levels experienced in the early 1960s and early 1990s (i.e., roughly 3,000 animals) in the next 10 to 15 years and in the absence of severe weather or other environmental conditions including predation. However, it took roughly 20 years before caribou abundance recovered from lows recorded in 1974. Observations made by the Bathurst Island National Park negotiating team during a reconnaissance flight across northern Bathurst Island in September 2010 (300-350 caribou counted) support an increasing trend (Joadamee Amagoalik, personal communications, Sept. 21, 2011).

The proportion of short yearlings (10-12 months) among caribou seen on transect in May 2001 was 29%. This is in line with historical values and generally supports an increasing trend although mortality rates are unknown. In June-July 1961, Tener (1963) reported that 19.8% of the caribou seen on-transect (on the BIC) were calves, while Miller *et al*. (1977a) observed no caribou calves during an aerial survey in August 1974. Between 1975 and 1993, when there was an overall increase in the BIC caribou population the proportions of calves observed were variable but ranged from 19% to 29% (Ferguson, 1981; Miller 1987a, 1989, 1992, 1993a, 1994, 1995b). Based on this, our 29% observed in the 2001 survey could be a sign of initial recovery

Since the 1950s, Inuit in Resolute Bay have harvested Peary caribou from the BIC and Cornwallis Island. In the early 1970s however, hunters reported animals in very poor condition and starving (Taylor, 2005). Concerned with the low abundance and poor condition of animals, the HTO suspended their harvesting of caribou on Bathurst Island in 1975 (Taylor, 2005). Harvesting was re-initiated in the late 1980s and has continued since that time (Taylor, 2005; Nancy Amarualik, personal communication, Sept 21, 2010). In the mid 1990s, hunters observed many caribou and muskoxen carcasses on Bathurst Island following freezing rain during the winter (Taylor, 2005). As much as 5 cm of ice was observed by local residents during the winter of 1995-96 (Jenkins *et al*., 2010a) and harvesters had to traveled to other islands (i.e., Somerset and Prince of Wales Islands) to support subsistence harvesting (Taylor, 2005). More recently, hunters have resumed harvesting on Bathurst Island, where they are able to successfully locate and harvest enough caribou to meet their needs (Nancy Amarualik, personal communication, Sept. 21, 2010). To date, harvest reporting has not been required and our limited harvest records (voluntary reports of harvest) are not sufficient to assess the potential impact of harvesting on population trends.

We note that our estimate of abundance of Peary caribou on Bathurst Island (187 95% CI 104–330) is low compared to the preliminary estimates of abundance independently calculated (using the same data) previously by McLoughlin *et al*. (2006) (272 95% CI 185–400 caribou), and M. Ferguson (279 with 95% CI 166–503; provided as a personal communication in COSEWIC 2004). This is likely because past analysis were derived with the inclusion of data from B-transects, which biased density estimates upwards. The inclusion of B-transects violated assumptions of random sampling, since B-transects were only flown after caribou were observed on A-transects. Thus, systematically increasing the effort in areas where animals are known to occur (areas of higher animal density) leads to the overestimation of abundance using conventional line transect estimators (Pollard *et al.,* 2002). Notably, both estimates are within our confidence intervals.

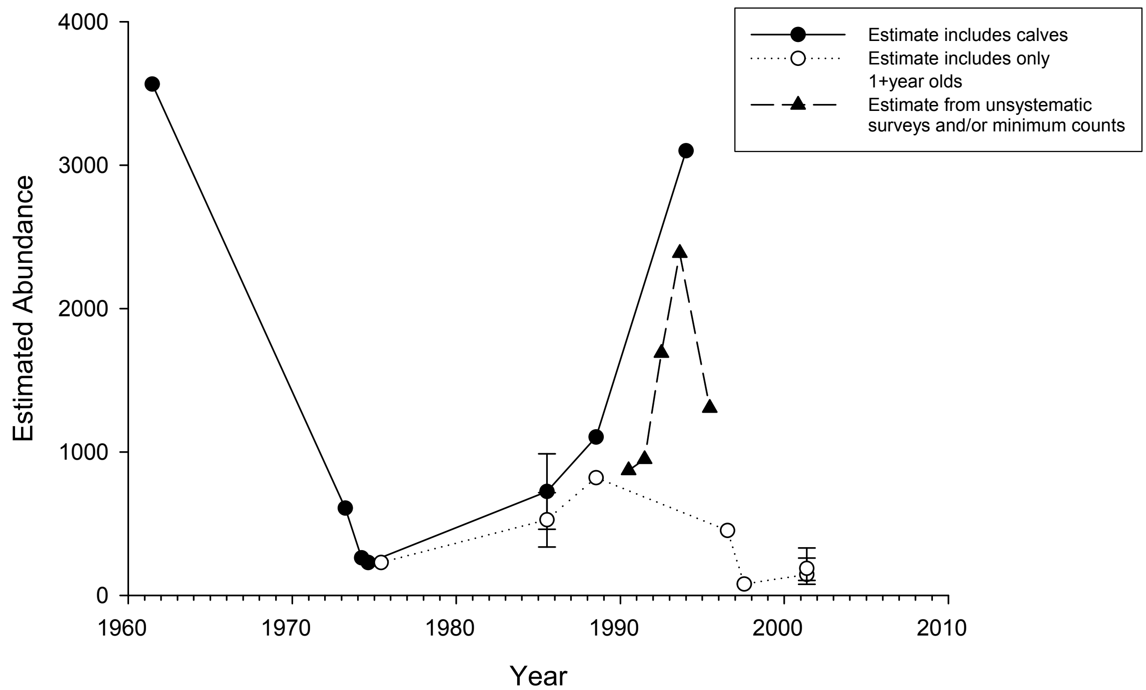



**Figure 35:** Peary caribou abundance for Bathurst Island Complex, 1961-2001. See Table B, Appendix 1 for information regarding survey details.

**Cornwallis Survey Area**

Peary caribou on the Cornwallis Island Group are probably migrants from adjacent Bathurst Island possibly seasonally as well as during severe winters (Miller 1998, Taylor 2005). During May 2001, the only observation of live caribou in the survey area was on northwest Cornwallis Island. Previous estimates that include both Cornwallis Island and Little Cornwallis Island are limited to summer 1961 and 1988, when 43 and 51caribou (with calves) were estimated, respectively; all animals were observed on Cornwallis Island (Tener, 1963; Miller, 1989). Additional surveys of Little

Cornwallis in 1973 and 1974, produced estimates of 8 and 12 caribou, respectively, with no calves observed (Miller *et al*., 1977a).

Although it is possible that higher numbers of caribou were present on Cornwallis Island prior to the settlement of Resolute Bay in 1953, RCMP records suggest that only a few caribou occurred on the island prior to 1950s (DIANA 1947-1950 in Taylor, 2005). By the mid- to late 1960s, Inuit reported that it was difficult to find caribou on this island and that none were observed from 1990 to 2003 (Taylor, 2005). These observations are consistent with our ground and aerial survey results from 2002. Notably, in October 1995, severe weather conditions on Bathurst Island may have forced the movement of approximately 100 caribou from Bathurst to Cornwallis Island near Resolute Bay, where they were harvested (Struzik, 1996; Miller, 1998; Taylor, 2005). Thus, it is likely that Cornwallis and Little Cornwallis Islands have historically provided important range to small numbers of resident caribou, but also to temporary migrants that leave Bathurst Island during unfavourable weather events with poor forage conditions.

### 4.2.2 Devon Island Group

*(Survey areas – Devon Island, Baille Hamilton, Dundas/Margaret, North Kent)*

The number of Peary caribou on Devon Island is extremely low (minimum count of 17 in 2008). The reasons for this are not immediately evident and historical information is limited. Only irregular surveys have been carried out and, to our knowledge, a full island survey has not been completed since 1961 (Tener, 1963). Most previous surveys have focused on muskoxen and the coastal wetland areas that they principally occupy (Freeman, 1971; Hubert, 1977; Pattie, 1990; Case, 1992). Tener (1963) estimated about 150 caribou on Devon Island in 1961. Inuit knowledge indicates that there have been caribou on the northeastern coast of Devon Island, on the Grinnell Peninsula, and that they can reliably be found along the western coast of the island (Taylor, 2005).

Minimum counts for western Devon Island in 2002 suggested that caribou numbers were low. These findings are consistent with our results for Bathurst Island Complex (2001) and Cornwallis Island Group (2002). However, movement patterns for caribou on Devon Island are not well understood and it was possible that there were caribou in other areas of the island at that time (e.g., the Truelove Lowlands; Taylor, 2005). Our extended survey coverage in 2008 yielded a minimum count of 17 caribou, confirming the extremely low abundance of caribou across Devon Island.

#### 4.2.3 Ellesmere Island Group

*(Survey Areas - Southern Ellesmere, Northern Ellesmere Island)*

The Ellesmere Island Group makes up 41% of Nunavut's Peary caribou range (based on our study area). Our results revealed extremely low densities for Peary caribou (8-9 caribou/1000 $km^2$; north and south Ellesmere Island). Historical surveys of Ellesmere Island are infrequent and limited in their spatial coverage. Results from the first aerial survey in 1961 (Tener, 1963) suggested that there were approximately 200 caribou on Ellesmere Island; however, a mathematical estimate was not derived due to the small number of observations and low survey coverage. No island-wide aerial survey was undertaken since 1961.

Surveys in 1973 (Riewe, 1973) and 1989 (Case and Ellsworth, 1991) focused on southern Ellesmere (south from the Svendson Peninsula). The stratified survey in 1989 provided density estimates ranging from 6 caribou/km$^2$ on the Svendsen Peninsula stratum to lows of 2 caribou/1000 km$^2$ on the Bjorne Peninsula, on the area between Vendom Fiord and Makinson Inlet, and on Ellesmere Island south of Baumann Fiord (Case and Ellesworth, 1991). Overall, the estimated abundance was 89 caribou (90% CI 37-141) on southern Ellesmere Island in 1989 (Case and Ellesworth, 1991).

Our estimate for southern Ellesmere (9.2 caribou/1000 km$^2$ or 219 caribou) included Graham Island, which Inuit knowledge (Taylor 2005) and Riewe (1973) identified as Peary caribou range. We observed few caribou clusters which led to a low density estimate with wide confidence intervals (95% CI 4.6-18.6 caribou/1,000 km$^2$). Densities on Graham Island appeared higher than on the mainland, but data were not sufficient to derive local density estimates. In the early 1990s, the emaciated carcasses of one caribou and two muskoxen were observed on the sea ice off the west side of Bjorne Peninsula, and Inuit from Grise Fiord reported seeing caribou on Graham Island in the mid-1990s (Taylor, 2005). In the winter of 2002, additional observations of dead animals were reported after freezing rain that likely limited access to forage. However, by 2003, Inuit believed that numbers of caribou on southern Ellesmere were increasing (Taylor, 2005).

During our survey on southern Ellesmere in 2005, we observed 40 emaciated muskoxen carcasses and at the same time, hunters of Grise Fiord also reported muskoxen in poor condition (Campbell, 2006). No observations of Peary caribou carcasses were recorded by our aerial or ground crews. Weather conditions were identified as a possible causative factor (Jenkins *et al.* 2010b) although some local Inuit do not believe that snow and ice play a significant role in the population dynamics of Peary caribou on southern Ellesmere. Inuit knowledge indicates that muskoxen have difficulties in deep snow conditions and are sometimes found dead or dying of starvation, whereas caribou are rarely found in this condition (Jenkins *et al*., 2010b). Inuit state that the reason for this is that caribou seek refuge in high-elevation areas where precipitation is reduced and vegetation more exposed (Jenkins *et al*., 2010b). Miller *et al*. (2005a) have also postulated that the large rugged land base on Ellesmere and other eastern islands may be of great importance in the persistence of Peary caribou because of the numerous micro niches that are available. Due to the rugged terrain, most of Ellesmere Island experiences different climatic conditions than other arctic islands (Maxwell 1981). This includes reduced influence from cyclonic systems which plague islands such as Bathurst and Cornwallis (Maxwell 1981)

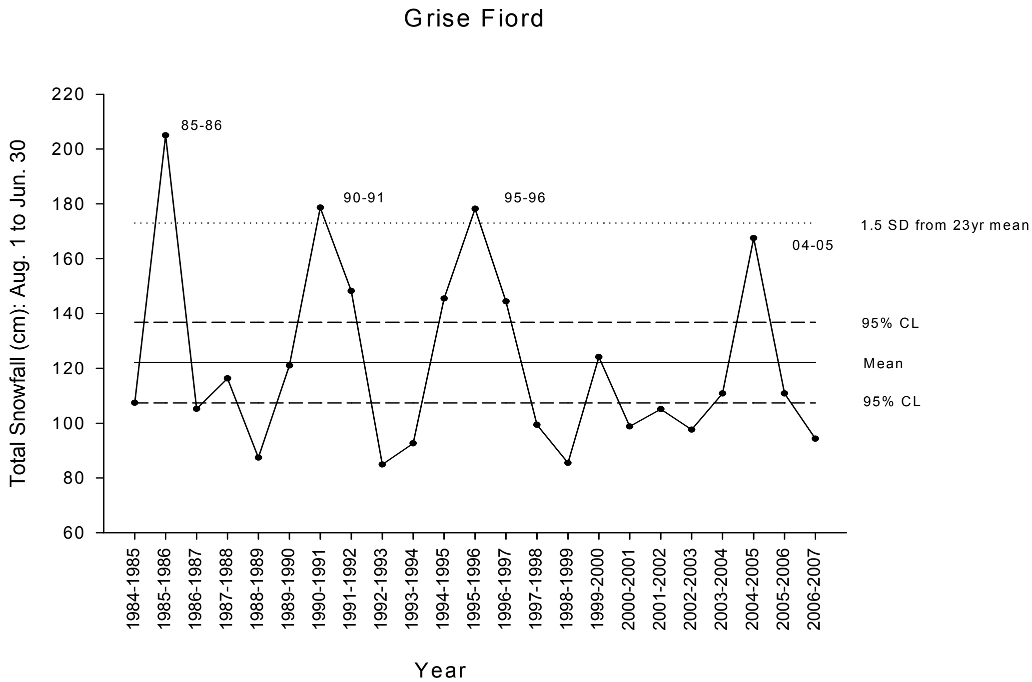
Lack of data limits our ability to drawing conclusions about any trends in abundance on Ellesmere Island. Our combined abundance estimate for the Ellesmere Island Group is approximately 1,000 animals, and this is comparable to the extrapolation presented in COSEWIC (2004). The estimated abundance is higher on northern Ellesmere than in the south, and this is explained in part by the larger area and the larger clusters we observed.

On Ellesmere, calf or short yearling recruitment was low in 2005 (no short yearlings among 57 caribou classified) and in 2006 (no short yearlings among 344 caribou classified). The 2004-2005 winter was marked by high snowfall, which may have reduced survival for the 2004-cohort and may have carried over to influence pregnancy rates and/or calf survival for the 2005 cohort as by early spring 2006, short yearlings were 0% and yearlings were only 7 %. Cow condition, which affects pregnancy rates (especially for young cows) and calf birth weights and hence calf survival, is influenced by food availability (Thomas 1982; Cameron *et al*., 1993). Thomas (1982) found a direct relationship between the fertility of female Peary caribou and fat reserves in late winter. The same author concluded that reproduction in Peary caribou in the western QEI nearly ceased from 1973-1974 to 1975-1976 because of the poor physical condition of female caribou. In barrenground caribou, early calf survival has also been linked to late-term maternal conditions (Cameron *et al*., 1993; Adam, 2003). Adams (1995, 2003) found that fat deposition and skeletal growth of caribou neonates were inversely related to late winter severity and that calves were smaller at birth following severe winters. Additionally, severe winter conditions were associated with reduced calf survival and increased calf susceptibility to predation (Adams, 1995).

In the western QEI, calf production has been proximately related to snow depth, the duration of snow cover from previous winters, and the occurrence of ground-fast ice

(Miller *et al*., 1977; Thomas, 1982; Ferguson, 1991; Miller and Gunn, 2003b). For example, Miller and Gunn (2003b) found that major to near-total calf crop losses in the western QEI were associated with winters that featured significantly greater than average total snowfall (measured between Sept-June). At Grise Fiord and Eureka, total snowfall in 2004-05 was greater than the 24-year mean annual snowfall recorded at each of these locations (Figure 36). Assuming these conditions were widespread on Ellesmere Island, significant snowfall may explain the lack of calf recruitment we observed in late winter 2005 and 2006.

(A)




(B)

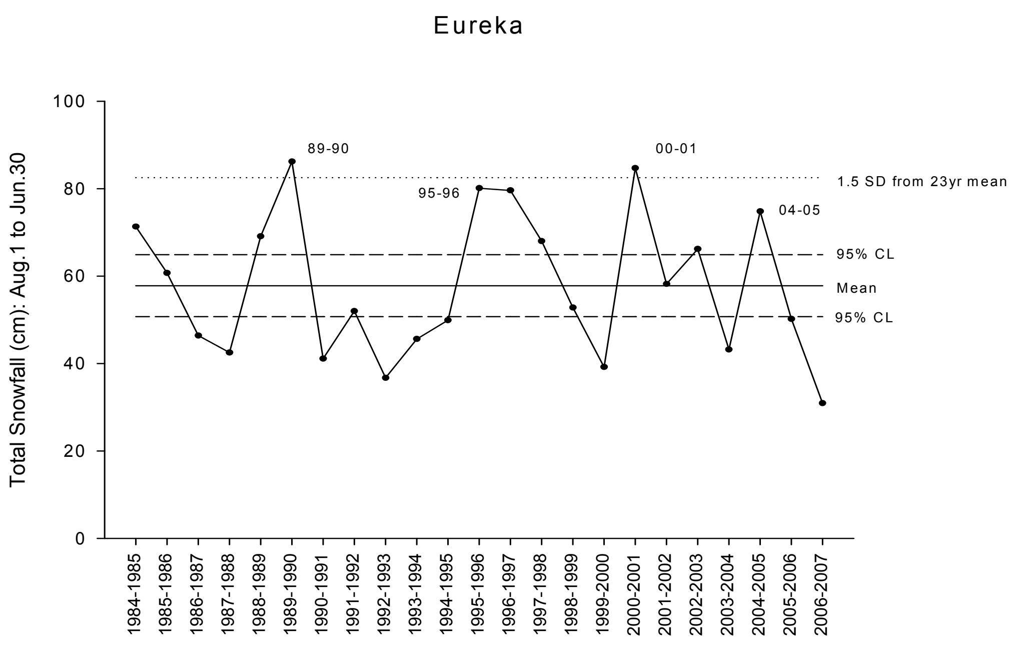



Figure 36: Total snowfall (cm) at Grise Fiord (A) and Eureka (B) from August 1 through June 30 (autumn through spring) by year from 1984 to 2007. Data obtained from Environment Canada (2010).

Historical values of calf production on Ellesmere Island are both variable and few. In 1961, Tener (1963) estimated the proportion of calves at 10.8 % for Ellesmere.Island while the proportion of calves in southern Ellesmere has ranged from 5.5 % in July 1973 (Riewe, 1973) to 22.0% in 1989 (Case and Ellsworth, 1991).

Aerial observations of caribou clusters in the Ellesmere Island Group suggest that population composition may be strongly female-biased in both southern and northern Ellesmere, although the average group size is larger in northern Ellesmere (4.6 (SE 0.37) vs. 3 (SE 0.34) caribou, respectively). The literature suggests that, in populations of *Rangifer* and other cervids, female-biased sex ratios may reflect greater mortality of males from a variety of factors including severe weather (Bergerud, 1971; Miller and Gunn 2003b; Barboza *et al*., 2004). For example, male caribou invest in reproduction at the same time as plant production declines; thus, body reserves may not be sufficient to support rutting activities as well as winter survival (Weladji *et al*., 2002; Barboza *et al*., 2004). Male-skewed harvesting is not a suspected factor, as much of the survey area is beyond the hunting range for Inuit harvesters (NWMB Data 1996-2001; Taylor, 2005).

#### **<u>4.2.4 Prince of Wales – Somerset Island Group</u>**

*(Survey areas - Prince of Wales Island, Somerset Island)*

During the 2004 aerial survey, we observed no Peary caribou on the Prince of Wales/Somerset Islands (POW/SI) Group. These results are consistent with ground surveys of Prince of Wales Island in 2004 and Somerset Island in 2005, in which crews reported only four caribou after traveling a combined distance of 4,831 km.

Peary caribou in the POW/SI Group declined from an estimated 5,682 caribou (one year or older) in 1974 (Fischer and Duncan, 1976) to a minimum count of two in 1996 (Miller, 1997b). Our results indicate that there has been no recovery since 1996.

Based on survey results from 1980 (5,097 caribou one year or older), Gunn and Decker (1984) concluded that this population was likely stable or declining slightly based on low recruitment and relatively high annual harvest (150-250 caribou per year). By the late 1980's and early 1990s, Inuit hunters had observed a decrease in the abundance of caribou and found it difficult to locate caribou for harvesting (Taylor, 2005, Gunn *et al*., 2006). Subsequent surveys in 1995 and 1996 yielded critically low numbers: seven caribou in 1995 (Gunn and Dragon 1998) and two caribou in 1996 (Miller, 1997b). Due to the 15-year delay between aerial survey studies, the causes for the significant decline could not be determined with certainty (Gunn *et al*., 2006).

Several factors likely explain the decline in caribou numbers through the 1980s and 1990s: 1) reduced survival rates for breeding females and calves (in the first year of life); 2) continued harvesting; 3) increased wolf predation (hypothesized as a consequence of increasing muskoxen numbers; Gunn *et al*., 2006). Contributing factors may have changed during the decline. It is possible that the severe winters of 1989-90 and 1994-95 extended to this island group and affected caribou numbers. Unfortunately, weather information for Prince of Wales/Somerset is not available although it is in the same climate region as Bathurst Island Group (Maxwell 1981).

Gunn and Dragon (1998) indicated that information on the abundance of predators, their diet, predation rates, and other parameters was not available for the POW/SI Group. However, the authors suggested that the increasing abundance of muskoxen (1980-1995) could likely support a higher number of wolves in the area.

In addition to predation, the POW/SI Group may have been subject to increased harvest during 1980-1995. As mentioned above (BIC section), Resolute Bay hunters instituted a voluntary hunting ban on Bathurst Island caribou from 1975-1989 and this resulted in a shift of harvesting activities to Prince of Wales and Somerset islands. This harvest pressure may have escalated when a voluntary hunting ban on southern Ellesmere Island caused the community of Grise Fiord to purchase caribou meat from the Resolute Bay Hunters and Trappers Association (Miller, 1990a). During this period, Inuit hunters from Taloyoak (Spence Bay) were also harvesting caribou on Prince of Wales and Somerset Islands (Gunn and Decker, 1984) as well as on the Boothia Peninsula. Based on the fact that an unknown portion of Peary caribou from the POW/SI Group used the Boothia Peninsula as part of their winter range, Miller (1990a) suggested that the high annual caribou harvest at Taloyoak (about 1000) could have impacted the POW/SI Group.

Inuit knowledge indicates that the decline in caribou on the POW/SI Group was associated with natural events, including overabundance in the 1980s (Taylor, 2005) predation, and weather (Gunn *et al.,* 2006). In the early 1980s, caribou were abundant on Prince of Wales, Somerset, and the smaller coastal islands (Taylor 2005). By the mid-1980s, hunters were observing tapeworm cysts (*Taenia krabbei*) in the muscle tissue of caribou from both Prince of Wales and Somerset Islands (Taylor, 2005; Jenkins *et al*., 2010a) and noticed muskoxen in areas previously occupied by caribou. Since wolves are the other host for this tape-worm, it is possible that wolf abundance and hence, predation, had increased in relation to the larger prey base (Gunn and Dragon, 1998; Gunn *et al.,* 2006). Hunters also observed carcasses of caribou and muskoxen on Somerset Island and Prince of Wales in the early 1990's following a period of freezing rain in the fall. Similarly, in 1989 Inuit reported that caribou harvested from Somerset Island were skinny (Taylor 2005) and that 21 dead caribou had been observed on the west coast of Somerset in March and May (Letter from Josh Hunter to M. Ferguson, 1989 in Gunn *et al*., 2006).

Assessment of potential limiting factors for the Prince of Wale/Somerset population is complicated by the fact that some Peary caribou also use or historically used Boothia Peninsula in the winter (Miller *et al.,* 2005b). Additionally, there are also some Peary caribou that are unique to Boothia Peninsula (Zittlau 2004). We know little about the spatial extent of Boothia Peary caribou, their current abundance, or interchange that occurs between this population and the Peary caribou of the POW/SI Group. Gunn and Dragon (1998) estimated 6,658 caribou (SE 1,728) on Boothia in July-

August 1995, but the surveyors did not differentiate between Peary and barrenground caribou that are known to occupy the area (Campbell, 2006 – NEM report on file). Miller (1997b) observed no Peary caribou on the northwest portion of Boothia in 1996 but did not survey the remainder of the Peninsula. During a muskoxen survey on the Boothia Peninsula in 2006, one caribou morphologically similar to Peary caribou was observed (Dumond, unpublished data).

The paucity of monitoring data between 1980 and 1995 make it difficult to evaluate with certainty the cause of the decline within the Prince of Wale/Somerset Group though it is clear that immediate management action will have to be taken if we are to conserve this population into the future.

### 4.2.5 Axel Heiberg Island Group

Our survey results are higher than the only previous description of caribou abundance for Axel Heiberg Island. Having surveyed less than 3% of the ice free area of Axel Heiberg, Tener (1963) estimated about 300 caribou on the island in 1961. No other surveys of the island have occurred since that time. Lack of data and this 50-year gap in monitoring make it impossible to discuss population status or trends for Peary caribou on Axel Heiberg Island.

The relative abundance of both caribou and muskoxen was greatest east of the Princess Margaret Range where snow cover appeared to be less than the western coast during the May 2007 survey. As mentioned previously, much of the central part of the island is permanently covered in ice (Muller Ice Cap and Steacie Ice Cap), and this, in conjunction with the central mountain range may fragment the population. Further research is needed to evaluate this.

The Axel Heiberg Group currently supports the largest population of Peary caribou in Nunavut, with an estimated 2,291 animals (95% CI 1636-3208) based on our 2007 survey results. This population accounts for more than 55% of the total estimated Peary caribou population in our entire study area. This may be a consequence of the local climate (Maxwell, 1981), biomass and diversity of vegetation (Edlund and Alt, 1989), the varied topography, and isolation from human disturbance (Taylor, 2005).

Axel Heiberg Island, particularly the eastern portion, may be a natural refugium for Peary caribou, much like the western coast of Ellesmere Island functions as a refugium for muskoxen (Thomas *et al.,* 1981; Ferguson, 1995). Eastern Axel Heiberg, including the central mountains, is in Climate Region V (Maxwell, 1981). Region V also includes most of Ellesmere Island (except the southeastern and northern coasts), and is distinguished by rugged mountainous terrain. Notably, west central Ellesmere Island and the eastern portion of Axel Heiberg are almost completely surrounded by mountains which provide protection from cyclonic activities and result in a rain shadow effect (Maxwell 1981). Hence, this 'interior' area of Region V is characterized by low precipitation, a wide temperature range (Maxwell, 1981) and is generally snow free by early to mid-June (Edlund and Alt, 1989). Consequently, vegetation is rich along the eastern coast of Axel Heiberg, transitioning from an enriched prostrate shrub zone at low elevations to a lower-diversity herb-shrub transition zone at high elevations (Edlund and Alt, 1989). In combination, the climate, diverse vegetation, and varied topography may be of benefit to Peary caribou, particularly in the face of accelerated climate change.

#### <u>4.2.6 Ringnes Island Group</u>

*(Survey Areas - Ellef Ringnes, Amund Ringnes, King Christian, Cornwall, Meighen, Lougheed Islands)*

Our 2007 survey of the Ringnes Island Group was the first concerted attempt to assess Peary caribou abundance in this region since Tener's work in 1961, and we estimated a total of 654 caribou. It is difficult to track populations in this area due to its remoteness and of these islands, only irregular surveys of Lougheed Island have occurred in the past five decades.

Our combined abundance estimate for Ellef Ringnes, Amund Ringnes, Cornwall, Meighen, and King Christian islands (282 caribou 95%CI 157-505) was much lower than the 1961 estimate of 832 caribou for these islands (Meighen excluded) (Tener, 1963). Our flight effort (i.e., linear distance flown) was double that of the 1961 survey (3,905 km vs. 1,953 km, respectively), and observer effort was also greater than in the 1961 survey (four observers vs. one, respectively). Thus, our systematic sampling design was robust and supported the detection of caribou.

Lougheed Island was surveyed in 1961, 1973, 1974, 1985, and most recently in 1997 (Tener, 1963; Miller *et al*., 1977a; Miller, 1987; Gunn and Dragon, 2002). Results from these investigations suggest that caribou abundance has fluctuated over time, with data indicating an overall reduction from an estimated 1,324 in summer 1961 (Tener, 1963) to 56 in April 1973 (Miller *et al*., 1977a). Only one caribou was observed in April 1974 (Miller *et al*., 1977a), and no caribou were reported by Miller (1987a) during an aerial survey in July 1985. Gunn and Dragon (2002) estimated 101 caribou (one year and older, SE 73) for Lougheed Island in July 1997, compared to our estimate of 372 (95% CI 205-672) in April 2007. Although not directly comparable our estimate suggests that either caribou are increasing on Lougheed Island or that its use is seasonal. From the existing data no patterns of seasonal use are discernable and caribou movement within this Island Group is unknown.

Overall, we caution that it is difficult to interpret population trends within this Island Group as survey information is limited, typical seasonal movement patterns are unknown, and surveys (e.g., Lougheed Island) have occurred at different times of year. Nonetheless, the overall proportion of calves (14%) that we observed is encouraging given the extreme northern latitude and the small calf crops we recorded for other survey areas.

Although Taylor (2005) documented Inuit knowledge on Peary caribou in Nunavut from 16 interviewees (all from Grise Fiord or Resolute Bay), the observations and information did not extend to the Ringnes Island Group. This likely reflects the remoteness of the area, which makes it inaccessible to most Inuit hunters (Taylor, 2005).

## 4.3 MUSKOXEN

### 4.3.1 Bathurst Island Group

*(Survey Areas - Bathurst Island Complex, Cornwallis Group)*

**Bathurst Island Complex**

In 1961, the Bathurst Island Complex had the second largest estimated population of muskoxen in the Queen Elizabeth Islands (1161, including calves). This figure included an estimated 25 muskoxen on the Governor General Islands after observing 3 animals (Tener, 1963).

Since the 1960s, muskox abundance on the BIC has fluctuated in parallel with Peary caribou abundance. There was a 40% decline from 1961 to 1973, followed by a significant die-off (approximately 75%) during the winter of 1973-74 (Miller *et al*., 1977). The number of muskoxen estimated on BIC then increased from 1974 to 1994 reaching levels similar to those recorded in 1961. Between 1995 and 1997, numbers declined by approximately 96% based on minimum counts and systematic surveys (Miller *et al*., 1977a; Ferguson, 1991; Miller, 1987a, 1989, 1995b, 1997a, 1998; Gunn and Dragon, 2002; Table C, Appendix 1).

This study followed the lowest ever estimate of muskoxen abundance for Bathurst Island Complex (124 $\pm$ SE 45, including calves; Gunn and Dragon, 2002), recorded in 1997. Also, aerial surveys in July of 1996 and 1997 suggested complete failure of the muskoxen calf crop on Bathurst Island Complex (Miller, 1998; Gunn and Dragon 2002). Our minimum count of 82 muskoxen (excluding newborn calves) or 103 (with newborn calves) suggests that although the population remains at low numbers, it is likely stable or increasing. We caution that although the sample size was small, the proportion of calves (ca. 20%) was encouraging.

In 2001, we did not observe muskoxen on any of the satellite islands which make up the Bathurst Island Complex (Cameron, Ile Vanier, Massey, Isle Marc, Alexander, Helena, Table 5). Muskoxen use of those islands has varied historically (Appendix 1, Table 3) although no muskoxen have ever been recorded on Ile Marc or Helena and only low counts of muskoxen have periodically been recorded on Vanier, Cameron, Massey, and Alexander (Tener, 1963; Miller, 1987a; 1989).

**Cornwallis Survey Area**

Few studies of muskoxen abundance have incorporated the Cornwallis Island Group. In 1961, Tener (1963) estimated 50 muskoxen on Cornwallis Island and reported no muskoxen on Little Cornwallis. The islands were not surveyed again as a pair until 1988, when estimates were 70 muskoxen on Cornwallis and zero on Little Cornwallis (Miller, 1989). Although our results are not directly comparable, the low number of animals observed during our aerial survey in 2002 (minimum count 18) suggests that this population has not grown.

Aerial surveys of Little Cornwallis Island in 1973 and 1974 demonstrated that small numbers of muskoxen occupied this island in the past. From April 1973 to August 1974, estimated abundance on Little Cornwallis dropped from 40 muskoxen to 12 (Miller *et al*., 1977a).

No regular seasonal large-scale movement of muskoxen to Little Cornwallis Island has been documented although movement between islands must occur for recolonization. The temporal and spatial scales of these movements are unknown. Limited radio telemetry data for muskoxen on Devon, Cornwallis and Bathurst Islands for the period 2003-2006 indicates no movement between these islands and no use of Little Cornwallis Island (Jenkins, in prep). The absence of muskoxen from Little Cornwallis in 1988 and 2001 suggests that either muskoxen have not permanently recolonized the island or that they were simply not present at the time of the survey.

### 4.3.2 Devon Island Group

*(Survey Areas – Devon Island, Baille Hamilton, Dundas/Margaret, North Kent)*

Tener (1963) completed the first aerial survey of Devon Island in 1961 and covered approximately 6% of the habitable portion of the island. After observing no muskoxen on transect and 23 animals off transect, Tener (1963) estimated that no more than 200 animals occupied the island. Since 1961, only infrequent partial surveys have been done. Freeman (1971) estimated 450 muskoxen on the Grinnell Peninsula and northern coast of Devon Island using ground sightings from 1966-1967. The same study yielded an estimate of 230 to 300 muskoxen from the north coast lowlands along the shore of Bear Bay. From 1970 to 1973, Hubert (1977) counted between 116 and 278 muskoxen on the north coast lowlands from Sverdrup Inlet to Sverdrup Glacier. Pattie (1990) investigated the same area roughly a decade later and documented a marked decline in muskoxen over 3 years, with estimates of 188 in 1984 and 76 in 1987.

In 1980, an aerial survey of the lowlands of southern and western Devon Island located 32 muskoxen in the Croker Bay/Dundas area, 14 in the Philpots Island area, and 46 inland from Baring Bay (Decker unpublished, in Case, 1992). Case (1992) surveyed lowland areas along the north, south, and western coasts of Devon Island and observed 366 muskoxen. A minimum estimate of 400 animals was subsequently established for Devon Island at that time (Case, 1992).

Based on our 2008 survey, muskoxen continue to inhabit discrete and highly fragmented low-lying areas of Devon Island. The majority of muskoxen were located along the southeastern coast of Devon Island, including Philpots Island where we counted 142 muskoxen including calves. This contrasts with previous reports that have indicated greatest abundance along the northeastern coast of Devon.

Inuit have consistently observed muskoxen on Devon Island, principally on the coastal lowlands in the northeast (the Truelove Lowlands) but also along the western coast (Baring Bay and Dragleybeck Inlet areas), on eastern Grinnell Peninsula, and along the southeastern coast (Dundas Harbour area)(Taylor, 2005). Our results suggest a decline in muskoxen along the northeast coast and increased muskoxen numbers in the east and southeast portions of the island.

### 4.3.3 Prince of Wales – Somerset Island Group

*(Survey Areas - Prince of Wales Island, Somerset Island)*

**Prince of Wales (incl. Russell Island)**

Our results suggest a significant overall decline in the Prince of Wales Island Group muskoxen population, from an estimated 5,257 (SE 414) in 1995 (Gunn and Dragon, 1998) to our estimate of 2,086 (95% CI 1582-2746) in 2004 (Table 4). This is a drop of approximately 60%.

The cause of this decline is unknown as there is a paucity of biological and abiotic data for this area. Inuit knowledge recorded by Taylor (2005) does not directly refer to a decline of muskoxen on Prince of Wales Island. The possible emigration of muskoxen from Prince of Wales Island to Somerset Island is documented as well as the loss of muskoxen on both Prince of Wales and Somerset in relation to freezing rain in the early 1990s (Taylor 2005). Regardless of these events, Inuit observations suggest that muskoxen numbers continued to rise on both islands in the early 2000s (Taylor, 2005).

The overall decline referred to above is consistent with other recent scientific studies in the western Arctic Archipelago that revealed a rapid drop in muskox abundance between 2001 and 2005 on Northwestern Victoria Island (Nagy *et al*., 2009a) and Banks Island (Nagy *et al*., 2009b). According to Nagy *et al*. (2009a, 2009b), it is likely that the principle cause of these declines was winter icing events.

Unfortunately, we are unable to determine the severity, timing or cause of the decline due to the paucity of survey data; specifically a 9 year gap in monitoring between 1995 and 2004.

**Somerset Island**

Muskox population studies on Somerset Island have been limited. The first aerial surveys in 1974 and 1975 located no muskoxen on Somerset Island (Fischer and Duncan, 1976). In 1980, three groups of muskoxen where counted on the island for a total of 29 animals with no calves (Gunn and Decker, 1984). No population estimate was derived from that assessment. The next aerial survey was not completed until 1995 when the abundance of muskoxen (one year or older) was estimated at 1,140 (SE 260) (Gunn and Dragon, 1998).

The results from our 2004 survey, although not directly comparable to the above, suggest that the population is likely stable with an estimated 1,910 (95% CI 962-3792) muskoxen (one year or older). The newborn calf crop appears low (5%), however, this finding is confounded by the timing of the survey. The survey was conducted in mid-April, which coincides with the beginning of calving. For muskoxen, calving can extend from April into June (Gray, 1987). In comparison, the proportion of yearlings was 13%, which is encouraging.

### 4.3.4 Ellesmere Island Group

(*Survey area - Southern Ellesmere, Northern Ellesmere)*

**Northern Ellesmere Island**

The results from our 2006 survey indicate that Northern Ellesmere Island supports the largest abundance of muskoxen in the entire study area, with 47% of the total estimated muskoxen population. The estimated density for Northern Ellesmere Island (84.0 muskoxen/1000 km$^2$ , 95% CI 68.7-102.8) was second only to the density on Axel Heiberg Island (137.2 muskoxen/1000km$^2$ , 95% CI 109.2 – 172.5). We observed muskoxen across the entire survey area, from the Svendson Peninsula in the south to areas north of Alert. Concentrations of animals were seen on the Lake Hazen-Alert Plateau, Raanes Peninsula, Svendson Peninsula, and along the north and southern coasts of Greely Fiord.

During our survey, the largest concentration of muskoxen was detected on the Fosheim Peninsula, and this is consistent with findings from the first aerial survey of Ellesmere Island in 1961 (Tener, 1963). The Fosheim Peninsula has previously been identified as a Wildlife Area of Special Interest (WASI) because of its special features, high biological diversity, and significance to muskoxen (Ferguson, 1995). During our aerial survey of Northern Ellesmere Island (April 6 to May 22, 2006), 56% of all the muskoxen that we observed on transect were on the Fosheim Peninsula (3,292 muskoxen), and of these 66% of the groups had newborns. Previous assessments on the Fosheim Peninsula in 1960 and 1961 yielded counts of 312 and 227 muskoxen, respectively (Tener, 1963).

The Fosheim Peninsula is considered an arctic refugium (Thomas *et al*., 1981) in the sense that it may support muskoxen even during periods of unfavourable climatic conditions in the Arctic Archipelago. In other words, animals may survive here when environmental conditions elsewhere are unfavourable for survival (Mackey *et al*., 2008). This also means that the muskoxen on the Fosheim Peninsula may be a source of animals that disperse and colonize or reoccupy other areas of less ideal habitat (e.g., areas where unfavourable climatic conditions may have extinguished local populations: Thomas *et al*., 1981).

We report a muskox newborn calf crop of 15% for Northern Ellesmere Island in 2006 however, this is likely a low estimate as the survey commenced in early April, before the expected onset of calving. Tener (1963) estimated the proportion of calves for Ellesmere at 12.4 % in June 1961, while calf crop ranged from 14% and 23% in Sverdrup Pass between 1981-1984 (Henry *et al*., 1986). This is comparable to our results for Southern Ellesmere where the proportion of newborn calves was only 1% in 2005 (May 4-May30: this study).

Tener (1963) reported approximately 4,000 animals for the entire island in 1961, and estimated that approximately 1,000 of these inhabited the Fosheim Peninsula and

Lake Hazen Alert Plateau. Our estimate of 8,115 (95% CI 6,632-9,930) is for Northern Ellesmere Island, which we defined as the area north of Vendom Fiord. Consequently, either Tener (1963) underestimated and or muskoxen in northern Ellesmere Island have increased since 1961.

**Southern Ellesmere Island Group**

Previous surveys of Ellesmere are few and limited in their spatial coverage. (Tener 1963) estimated that in 1961 Ellesmere had more muskoxen than the rest of the Queen Elizabeth Islands in total (ca. 4000 vs. 3421 respectively). Subsequent surveys were mostly limited to southern Ellesmere, where muskox harvesting was important to residents of Grise Fiord. Case and Ellsworth (1991) divided the area into five strata and reported density estimates ranging from a high of 121 muskoxen/1000km$^2$ on the Bjorne Peninsula to a low of 63.0 muskoxen/1000 km$^2$ in the area south and east of Bjorne Peninsula and Baumann Fiord. The resulting overall population estimate for 1989 (in an area comparable to our survey area minus Graham Island) was approximately 1,670 muskoxen (Strata I, lll, IV, and V; Case and Ellsworth, 1991).

Our 2005 estimate for southern Ellesmere, 19.2 muskoxen/1000 km$^2$ or 456 muskoxen (95% CI 312-670) included Graham Island where a total of 8 muskoxen with no calves were observed in 3 groups on-transect. Thus, although not directly comparable, this information suggests that there has been a decline in the muskoxen population of Southern Ellesmere Island since 1989.

In the early 1990s, Inuit observed the emaciated carcasses of two dead muskoxen and a dead caribou on the sea ice off the west side of Bjorne Peninsula (Taylor, 2005). Further, in the winter of 2002, additional local observations of dead animals were reported after freezing rain that apparently limited access to forage (Taylor, 2005). During our aerial survey (2005), 40 emaciated muskoxen were observed across the study area and frequent reports of muskoxen in poor and/or starving condition were described by the hunters of Grise Fiord as well as the aerial survey crew (Campbell, 2006). Weather conditions were identified as a possible factor and local Inuit suggest that muskoxen have difficulties in deep snow conditions and are sometimes found dead or dying due to starvation (Jenkins *et al*., 2010b).

Only two newborn calves were observed across Southern Ellesmere Island in our 2005 aerial survey, which is a concern. On Ellesmere, Tener (1963) estimated 12.4 % muskox calves in 1961, second only to Melville Island at 17.22 %. The percentage of muskox calves on the Bjorne Peninsula in July 1973 was 15% (Riewe, 1973), and across southern Ellesmere was 17.3% in 1989 (Case and Ellsworth, 1991). Although the direct cause of the low calf crop is unknown, severe weather events have been identified as the primary cause of major to near-total calf crop losses in other muskoxen populations (i.e. particularly harsh winters of 1973/74, 1994/95, 1995/96 and 1996/97; Miller *et al*., 1977a; Miller 1997a, 1998; Gunn and Dragon, 2002). Miller and Gunn (2003b) found that all four of these winters were characterized by significantly greater total snowfall (as measured between September and June). This is consistent with snow records for Grise Fiord and Eureka for the winter of 2004-05 (Figure 36).

Deep snow can severely restrict access to forage which impacts survival and reproduction (Miller and Gunn, 2003b; Taylor, 2005). Indeed, snow cover has repeatedly been implicated in significant over-winter mortality of muskoxen (Parker *et al*., 1975; Miller *et al.,* 1977; Parker, 1978; Gunn *et al*., 1989; Miller and Gunn, 2003b). Local hunters on southern Ellesmere report that muskoxen have difficulty in deep snow and they sometimes come across muskoxen that have died of starvation (Taylor, 2005; Jenkins *et al*., 2010b).

Schaefer and Messier (1995) found that muskoxen on Victoria Island exhibited consistent preference for thin or soft snow cover and greater forage abundance when studied across a nested hierarchy of spatial scales from population range to travel routes, to feeding sites, to feeding crates and finally to diet. Rettie and Messier (2000) have suggested that selection patterns are linked to limiting factors. Specifically, limiting factors which are most important to a species will influence selection at coarser spatial scales while those less important will influence fine-scale decisions. Thus, for muskoxen, snow cover and snow hardness appear to be limiting factors, as muskoxen consistently selected for thinner and softer snow across spatial scales (Schaefer and Messier, 1995).

### 4.3.5 Axel Heiberg Island Group

Tener (1963) provided preliminary estimates of 1,000 muskoxen for Axel Heiberg Island in 1961. During an aerial reconnaissance survey in July 1973, 866 muskoxen were counted between Stang Bay and Whitsunday Bay on eastern Axel Heiberg, an area known as Mokka Fiord (Ferguson, 1995). Our 2007 results (4237 95% CI 3371-5325 muskoxen one year or older) indicate that muskoxen have likely increased since the 1961 survey although we caution that coverage in 1961 was low (<3%).

Our estimated proportion of newborn calves (13%) is likely biased low as the 2007 survey was completed in early May, before calving ended (Tener, 1965; Gray, 1987). For the eastern Arctic historical estimates of calf crop are limited. Calf percentages for the Fosheim Peninsula varied between 0 and 14.2 in 1954 and 1960 (Tener, 1965) while reported values for Sverdrup Pass range from 14% in 1984 to 23% in 1983 (Henry *et al*., 1986). At a larger spatial scale, Tener (1963) reported the proportion of calves on Ellesmere and Axel Heiberg in 1961 as 12.4 % and 7.3 % respectively. Overall, our data indicates that Axel Heiberg Island supports a larger population of muskoxen than was previously thought. Current trends are impossible to determine due to the lack of survey data. However, our results show that Axel Heiberg Island supports the highest density of muskoxen in the Arctic Archipelago, Nunavut and next to northern Ellesmere, the largest population. Notably, this muskox population is sympatric with the largest Peary caribou population in Nunavut.

### 4.3.6 Ringnes Island Group

*(Survey area - Ellef Ringnes, Amund Ringnes, King Christian, Cornwall, Meighen, and Lougheed)*

With the exception of Lougheed Island, our survey was the first since 1961 (Tener, 1963) to estimate muskoxen abundance across the Ringnes Island Group. Like Tener (1963), we observed, in 2007, too few muskoxen to derive a population estimate for individual islands. Tener (1963) provided a preliminary estimate of 10 animals for Amund Ringnes Island based on observation of four bull muskoxen. He observed no muskoxen on Ellef Ringnes, Lougheed, King Christian, or Cornwall Islands (Tener, 1963).

Our combined minimum count of 21 animals for the Ringnes Island Group suggests that these islands are still on the periphery of muskoxen range. No muskoxen were observed on Ellef Ringnes, Lougheed, and Meighen Islands. No communities harvest muskoxen from these islands.

# 5.0 IMPLICATIONS FOR MANAGEMENT

## 5.1 SURVEY DESIGN

We designed the surveys to be accurate by using Distance Sampling methodology which allowed us to model the probability of detection. The approach relaxes the assumption that we saw and counted every individual within a certain distance of the transects, which is the case with strip transects (Buckland et al. 2001). Thus, we made the strip very wide (unbounded), expected not to detect all the animals (except for those on or very close to the transect), and recorded all observations regardless of distance from the transect. This approach, particularly suited to populations of animals that are sparsely distributed over large areas (Buckland *et al*., 2001; Buckland *et al*., 2004), can increase the number of detections, resulting in a greater sample size (n) and more precise density estimates (Buckland *et al.,* 2001). We also designed the surveys to be relatively precise by flying enough transects (k) and by ensuring that the transects covered entire non-glaciated island areas so that both caribou and muskoxen had a chance of being seen and counted.

The analysis of abundance and trends in population size is important in wildlife management and our survey is a baseline against which future surveys can be compared. The analysis of trends requires density and abundance estimates with sufficient power to detect change over time. Attention to survey design is important in achieving this objective (Buckland *et. al.,* 2001; Zerbini 2006) and with *a priori* knowledge of encounter rates (e.g. number of caribou per 1,000 km flown), we will be able to estimate the line length (effort) necessary to achieve desired precision and design transect coverage accordingly.

This study demonstrates that for some populations, large scale surveys will be necessary to apply sufficient effort to yield an adequate sample size. Notably if the sample is too small, then precision is poor (Buckland *et. al.,* 2001). Abundance estimates with low and/or variable precision can constrain wildlife management and approaches to improve precision should be evaluated. Thus, future surveys of small populations would also benefit from reconnaissance surveys, to determine when and if encounter rates will support a full scale survey, and what effort is necessary to generate the required precision.

One approach to increasing precision is to use stratification. For example, stratification of Distance Sampling data through *a priori* methods or through post stratification, should be considered. Another promising alternative includes multiple covariate distance sampling (MCDS), which uses multiple covariates in the estimation of detection probability and has the advantage of potentially providing a more precise estimate than stratification (Buckland *et. al*. 2001; Marques *et al*., 2003; Zerbini 2006).

Notably, our shift in methodology from the previously used strip transect to distance sampling has limited our ability to measure population trends as comparative data is not available. However, the benefits of distance sampling, including associated possibilities of increased precision with improved survey design and MCDS, have significant positive implications for wildlife management (Marques *et al*. 2003; Marques *et. al*., 2006; Buckland *et al.* 2004; Zerbini 2006; Aars *et. al.* 2008)

## 5.2 SURVEY SCALE

Until additional information on population boundaries becomes available, future surveys of Peary caribou should continue at the scale of Island Groups. This approach recognizes what we know about inter-island movements and population structure, and increases the likelihood of detecting real changes in caribou and muskoxen numbers (Gunn *et al.* 1997; Zittlau 2004; Miller *et al*., 2005b).

Defining populations requires understanding of genetics, geographic distribution and demography (Wells and Richmond 1995). The collection and analyses of data on genetics and distribution is underway although considerable effort is required to complete the analyses. Currently, population structure is being evaluated using microsatellite DNA from 300 Peary caribou samples collected from six island groups during the recently completed surveys, as well as previous research efforts. This is the first time that many of these areas have been sampled as previous analyses were limited in areas sampled (Zittlau, 2004; Petersen *et al.,* 2010). With 16 to 18 locus genotypes from Peary caribou, the variation within and between island groups is being exposed (Jenkins in prep). Similar research is underway for muskoxen. Movement and space use are also being analyzed for a small sample of radio-collared Peary caribou and muskoxen on Devon Island, Cornwallis Island and the Bathurst Island Complex (Jenkins in prep).

## 5.3 SURVEY FREQUENCY, MONITORING, AND MANAGEMENT PROGRAMS

In the Arctic Archipelago, the lack of routine monitoring is likely the greatest impediment to evaluating trends in abundance. Our study highlights the paucity of monitoring data for most island groups of Peary caribou and muskoxen. Monitoring is particularly important in areas where populations are small, environmental stochasticity is high, and where there is interest in harvesting (Miller and Barry, 2009).

Small populations are of great conservation concern due to the potential risk of inbreeding and genetic drift, and the resulting loss of genetic variability. This may reduce the ability of caribou and muskoxen to respond to future environmental and anthropogenic changes (Caughley and Gunn 1996; Zittlau, 2004).

When caribou and muskoxen population sizes are severely reduced, the risk of extinction is greater due to natural variation or chance (demographic stochasticity, environmental stochasticity, genetic stochasticity; Caughley and Gunn, 1996; Krebs, 2001, Zittlau, 2004). Such populations are also more vulnerable to additional pressures, such as human harvest, industrial activities (mineral and petroleum exploration and development), and climate change (Caughley and Gunn, 1996; Gunn *et al*., 2006; Mackey *et al*., 2008).

Peary caribou and muskoxen are important to local communities and an adequate monitoring program is not in place to inform communities on the status of local populations and determine sustainable harvest levels.  When populations are low, it is important to maintain the maximum number of animals to minimize vulnerability and allow for the fastest possible recovery (Miller and Gunn, 2003a).

Similarly, formal monitoring programs to detect large-scale changes in the abundance and distribution of Peary caribou and muskoxen are lacking as are comprehensive management programs to initiate appropriate conservation measures when / if numbers become unsustainably low. Peary caribou and muskoxen populations are subject to abrupt changes in size, and adaptive and collaborative measures are necessary to detect fluctuations in population size, to monitor population parameters, to establish and communicate sustainable harvest levels, and to evaluate the effects of predation, harvesting, land use activities and other natural and anthropogenic factors (Miller and Gunn, 2003b; Miller and Barry, 2009; Prowse *et al*., 2009). At present, muskox harvesting occurs under a quota system however, a formal harvest management system for Peary caribou has not yet been applied. While some HTAs (Hunter and Trapper Associations) have implemented voluntary harvest restrictions for certain populations in the past, further action should be taken. Given the significant reduction of some Peary caribou populations, and the importance of caribou to local communities and the ecosystem at large, a formal and comprehensive management system should be developed in conjunction with the local HTAs (Jenkins *et al*. 2010a, 2010b).

## 5.4 COMMUNITY-BASED MONITORING

Local harvesters have unique knowledge and skill, and a shared interest in preservation of viable wildlife populations (Ferguson *et al.,* 1997;Taylor, 2005; Brook *et* *al.,* 2009, Curry 2009, Jenkins 2009, Jenkins *et al*., 2010a, 2010b). Local harvesters have on-going contact with caribou and muskoxen and can provide important information on these species and on the ecosystem at large. The implications for management are to ensure that a collaborative program is strengthened and to make certain that Inuit knowledge is integrated into management planning.

A community based monitoring program will address some of the unique challenges of conducting northern research (i.e. information exchange, remote location), while engaging community members, wildlife managers, and scientists in a collaborative effort that combines resources and knowledge (Meier *et al.*, 2006; Brook *et al.,* 2009; Jenkins 2009; Merkel 2010). Communities in the Arctic Islands want input into scientific studies and to participate and develop research programs that address their needs and concerns (Jenkins *et al.,* 2010a, 2010b). This study was built on the shared understanding that population monitoring is critical to wildlife management and conservation. Members of the Resolute Bay and Grise Fiord Hunting and Trapping Associations were strong proponents for the ground surveys which were valuable. Their information (i.e. observations of caribou and muskoxen, group composition, wildlife sign) was used to assess the aerial survey results and led to the collection of non-invasive samples for DNA and diet analyses.

Environmental conditions, particularly, unfavourable snow and ice conditions, have been identified as a principle limiting factor of Peary caribou (Miller and Gunn, 2003a, 2003b; Miller and Barry 2009). Thus, ecological monitoring should be a priority and can be based on observations collected by Inuit hunters. A program to systematically collect those observations is an essential component of a Peary caribou conservation program.

## 5.5 LAND-USE PLANNING

Conservation and management planning for caribou will be ineffective without consideration for their range (McCarthy *et al.,* 1998; Miller and Gunn, 2003a, Hummel and Ray, 2008; Jenkins *et al.,* 2010b). Peary caribou are at low numbers; they experience stochastic fluctuations in their environment and they exhibit significant fluctuations in population size due to these events (Miller and Barry 2009). Thus, additional stressors that negatively impact habitat quality and/or quantity are of concern. Scientists and Inuit agree that conservation of habitat, including sea ice, is important (Miller and Gunn 2003a; Jenkins *et al*. 2010b). Inuit knowledge is that the overall range of Peary caribou must be considered given that intact habitat is necessary at all times of the caribou life cycle and that life requirements change throughout the year (Japettee Akeeagok, in Jenkins *et al.,* 2010b). Miller and Gunn (2003a) explain that *'the protection of the caribou range during the stressful part of the year will be of little value if the caribou cannot subsequently make back their body condition, make new growth and build up their body reserves during the favourable time of the year. Thus, caribou need to have sufficient amounts of forage and space available during all seasons of the year to foster their year-round long term survival.*'

The management implications are to ensure that Peary caribou ecology and conservation are integrated into land-use planning.  This has started with an assessment of Peary caribou distribution and habitat use based on the data from the aerial surveys.

## 5.6  CLIMATE CHANGE

Climate change may act as a significant factor in population dynamics and numerous studies have highlighted the sensitivity of Peary caribou and muskoxen to climate.  Historical data shows that Peary caribou and muskoxen in the High Arctic have experienced significant declines due to unfavourable weather conditions (Miller *et. al.,* 1977a; Miller, 1995b, Miller and Gunn, 2003b; Miller and Barry, 2009; Tews, 2007a) and climate warming may exacerbate these events (Tews *et al*., 2007b; Barber *et al*., 2008; Vors and Boyce, 2009).

Tews *et al*., (2007b) found that some populations of Peary caribou will be at a greater risk of extinction if the frequency and intensity of poor winter conditions increases. Populations such as those on Axel Heiberg and Ellesmere Island may be less vulnerable given the complexity of niches afforded by topographic relief (Miller *et al.,* 2005b; Jenkins *et al*., 2010b).

Some Peary caribou depend on perennial ice to access portions of their annual range, or to expand their range when they are displaced by severe winter events (Miller, 1990b, Miller *et al*., 2005a). Recent trends suggest a reduction in sea-ice over most of the Arctic Basin and a marked basin-wide thinning in sea-ice (Barber *et al.,* 2008). Scientists have already identified a tendency for fast ice areas to melt earlier and freeze up later (Barber *et al.,* 2008). Miller *et al*. (2005a) has suggested that increases in the ice-free period could critically modify the timing and even the opportunity for seasonal migrations between islands.

Another potential impact of thinning ice, and a shorter ice season, is an extension in the shipping season. There is increasing interest in shipping lanes through Arctic waters due to thinning ice and the decreasing extent of sea ice (Kubat *et al.,* 2007, Somanathan *et al*., 2009, Ho 2010). Ships are constructed that can manage ice year round and the feasibility of shipping in Canada's Arctic is under consideration (Ho 2010).

Ship traffic through the ice covered channels could influence or interrupt caribou movement (i.e. regular seasonal movements, desperation movements) and/or increase the risks for caribou crossing the ice (of injury or death to caribou), as well as affect the timing, pattern and structure of sea ice formation and breakup (Miller, 1990a, 1990b; Miller *et al.,* 2005a; Poole *et al.,* 2010). .

The potential consequences of climate change for caribou and muskoxen are extensive and are driven by changes in temperature, precipitation, land/water use, sea ice, vegetation, atmospheric carbon dioxide concentrations, invasive species, insects, disease and ecosystem dynamics to name a few (Sala *et al.,* 2000; Mackey *et al.,* 2008). Positive responses to climate change are possible (Nemanin *et al.,* 2003) which would include higher levels of plant biomass and a longer snow-free season. However; most trends suggest that stress will increase for many species and ecosystems (Mackey *et al*., 2008).

The management implications are to develop research and monitoring programs to help us understand and measure the impacts of climate change on caribou and muskoxen ecology, population dynamics, space use and movement. Another implication is to integrate the uncertainty of climate change and potential environmental impacts into land use planning and wildlife management.

# 6.0 ISLAND-GROUP MANAGEMENT RECOMMENDATIONS

Management and monitoring programs for caribou and muskoxen in the Arctic Islands should be developed in consultation with local communities (Jenkins *et al.* 2010a, 2010b). The following information is offered for consideration in this process.

## 6.1 PEARY CARIBOU

### 6.1.1 Bathurst Island Group

The Bathurst Island Complex and Cornwallis Island are a frequently used hunting area for residents of Resolute Bay. Our survey results suggest that the Peary caribou abundance was low in 2001 although the survey and subsequent sightings appear to indicate some recovery. Regular surveys of the Bathurst Island Complex, including Cornwallis Island should be undertaken to update this estimate and allow for the monitoring of population trends and harvest to be managed for long term sustainable use. Reports of unusual movements or carcasses should be investigated and treated as a trigger for island-wide surveys. Support for continuing the process for a national park on the Governor General Islands and northern Bathurst Island will protect ranges including wintering and calving areas for Peary caribou. The proposed national park also has to be part of a framework to provide a resilient landscape for Peary caribou throughout their seasonal cycle. The marine component (i.e. sea ice) of Peary caribou habitat should be recognized in these designations.

### 6.1.2 Devon Island Group

Harvesting of caribou on Devon Island continues (Jenkins *et al*., 2010b) and limited harvest reports suggest that, for the period of 1996-2001, harvest efforts focused on the north coast of Devon (Grise Fiord, NWMB data 1996-2001), with some effort by Resolute Bay harvesters on the western coast (Resolute Bay, NWMB data 1996-2001).

We have no evidence that Devon Island receives migrants from adjacent caribou populations (e.g., Somerset, Cornwallis, or Ellesmere Island; Taylor, 2005) and at extremely low numbers, risks increase through demographic, genetic, and environmental stochasticity (Caughley and Gunn, 1996; Krebs 2001). Given our results of low abundance and unknown trend, caribou on Devon Island will require careful monitoring and management to support recovery and determine trends.

### 6.1.3 Ellesmere Island Group

Since the mid-1990s, Inuit from Grise Fiord have annually harvested between 20 and 66 Peary caribou on southern Ellesmere Island (DoE Unpublished Data, Priest and Usher, 2004). Harvest information since the mid-1990s has been provided voluntarily. As such, it is not complete and may underestimate the actual harvest requirements.

Population trends suggest that the reported harvest level may not be sustainable over the long term. To maintain a harvestable population on southern Ellesmere, management initiatives are required to reduce losses and compensate for low calf recruitment. Management initiatives should be developed in consultation with the local community and be linked to routine monitoring of the Island Group (Jenkins *et al.,* 2010 a, 2010b).

### 6.1.4 Prince of Wales/Somerset Island Group

Peary caribou numbers continue to be extremely low suggesting that recovery is uncertain and immediate measures to conserve caribou on Prince of Wales/Somerset group are necessary. Because some Peary caribou on POW/SI are known to use Boothia Peninsula in the winter, these measures should also include the Peninsula. The conservation of this inter-island population must involve the full spatial extent of caribou range and all communities that harvest Peary caribou within the geographic area. Further work is needed to evaluate the population of Peary caribou on Boothia and to understand the interchange that occurs between Boothia Peary caribou and POW/SI Complex. All future caribou surveys of Prince of Wales and Somerset Island should include the Boothia Peninsula and, during these surveys, efforts should be made to distinguish between Peary and Barrenground caribou.

### 6.1.5 Axel Heiberg Island Group

Axel Heiberg Island is the largest remaining population of Peary caribou in Nunavut (and the NWT). Interest in the conservation of unique features and ecosystems on Axel Heiberg have been identified previously (Zoltai *et al.,* 1981; Ferguson, 1995) and portions of the island have been listed for consideration as a World Heritage Site (DoE 2006). Given the diverse vegetation, varied topography, and protection from cyclonic activity (primarily, in the east; Maxwell, 1981; Alt and Edlund,1983), Axel

Heiberg Island is of national interest in the conservation and recovery of Peary caribou, particularly in the face of accelerated climate change. Given that a fundamental goal of wildlife management is the maintenance of wildlife habitat, the designation of Axel Heiberg Island for wildlife conservation is recommended. The benefits include provision of sites for environmental monitoring (Ferguson, 1995) and ecological research where anthropogenic influences on wildlife and their habitat are limited.

#### 6.1.6 Ringnes Island Group

Although this Island Group forms part of the northern extent of Peary caribou range, the area supports the third largest abundance of caribou. Miller et al., 2005 identify the area as a low density reserve that can benefit the recovery and long-term persistence of Peary caribou. This study highlights the importance of Lougheed Island, and that further research is necessary to understand habitat characteristics, and caribou space use and movement.

## 6.2 MUSKOXEN

#### 6.2.1 Bathurst Island Group

*Bathurst Island Complex* Survey Area - The BIC is currently identified as Muskoxen Management Unit MX-01 and the current harvest quota is 40 animals per season. Typically, less than half that quota is used annually (DoE data, 1990-2009) but the current quota will impede any recovery in muskox abundance and consultations are needed to collaborate on the harvest level. This is important as human activities are increasing in the High Arctic and this could intensify interest in the harvesting of muskoxen.

*Cornwallis Survey Area* - The Cornwallis Island Group is not within the boundaries of any of Nunavut's current Muskoxen Management Units. Nonetheless, DoE harvesting records indicate that muskoxen have been harvested on Cornwallis Island, primarily for sport hunts out of Resolute Bay. Our results provide no evidence that the nearest harvest management unit should be expanded to include the Cornwallis Island Group.

### 6.2.2 Devon Island Group

The Devon Island Group is part of Muskoxen Management Unit 5 (MX-05) and three communities harvest muskoxen in this region: Grise Fiord, Resolute Bay, and Arctic Bay. Based on our findings, we believe that the current quota of 15 muskoxen for MX-05 is sustainable.

### 6.2.3 Ellesmere Island Group

*Northern Ellesmere Survey Area* - During our survey, the largest concentration of muskoxen was detected on the Fosheim Peninsula, and this is consistent with findings from the first aerial survey of Ellesmere Island in 1961 (Tener, 1963). The Fosheim Peninsula has previously been identified as a Wildlife Area of Special Interest (WASI) because of its special features, high biological diversity, and significance to muskoxen

(Ferguson, 1995). The results of our study support this designation and emphasize the critical value of this habitat to muskoxen and their young.

*Southern Ellesmere Island* - The people of Grise Fiord (including sport hunters) harvest muskoxen across southern Ellesmere Island, primarily south of Baumann Fiord (in what is currently MX-02), but also in areas west and east of the community (i.e. MX-03 and MX-04, respectively). In combination, the combined annual quota of 74 muskoxen has been identified for these areas. Our results demonstrate that the majority of muskoxen were distributed north of the designated muskoxen management units, with low densities and numbers across southern Ellesmere Island. Additionally, animals unable to stand or run were observed frequently in 2005 and over 40 emaciated recently dead carcasses were observed throughout the survey area (Campbell 2006). Thus, the current quota, non-quota limitations and management units should be reviewed with the local HTA. Efforts to redirect harvesting pressure to areas in Northern Ellesmere should be considered.

### 6.2.4 Prince of Wales - Somerest Island Group

*Prince of Wales Survey Area* - The population of muskoxen on the Prince of Wales Group is harvested primarily by hunters from Resolute Bay. The quota for Prince of Wales Group is currently combined with Somerset Islands at 20 animals. An independent quota should be established for the Prince of Wales Island Group given that muskoxen are likely a separate population based on sea and ice conditions and their effects as an obstacle to regular movements (Gunn and Jenkins, 2006). That is, muskoxen can swim but rarely do (Tener 1965, Gunn and Adamczewski, 2003) and seasonal movements of muskoxen between Prince of Wales Island Group and Somerset Island have not been documented (Miller *et al*., 1977b; Taylor, 2005). Limited information from marked or radio-collared muskoxen in other areas of the high Arctic revealed no seasonal inter-island movements and there are few observations of muskoxen crossing sea ice (Miller *et al.,* 1977a; Taylor, 2005; Gunn and Jenkins, 2006; Jenkins in prep). The decline measured on Prince of Wales Island is a concern and regular monitoring is necessary to direct management action.

*Somerset Island Survey Area* **-** Muskoxen on Somerset Island have mainly been harvested by hunters from Resolute Bay and occasionally by hunters from Arctic Bay. As noted above, the current quota of 20 is for both the Prince of Wales and Somerset Island. An independent quota should be established for Somerset Island muskoxen given that this is likely a separate population based on the sea and ice conditions and its impacts on movement. Muskoxen on Somerset Island are not known to make seasonal inter-island movements (Taylor, 2005). Although muskoxen must have crossed the sea ice on occasion to colonize or recolonize islands in the Arctic Archipelago, the spatial and temporal scale of these movements is likely beyond the time frame that harvest management actions must target.

### 6.2.5 Axel Heiberg

No communities are known to harvest muskoxen from Axel Heiberg Island. Axel Heiberg Island has the second largest muskoxen population in the Arctic Archipelago, Nunavut. Interest in the conservation of unique features and ecosystems on Axel Heiberg have been identified previously (Zoltai *et al.,* 1981; Ferguson, 1995) and portions of the island have been listed for consideration as a World Heritage Site (DoE 2006). Concentrations of muskoxen east of the Princess Margaret Islands have been highlighted as a Wildlife Areas of Special Interest (Ferguson, 1995). Given the diverse vegetation, varied topography, and protection from cyclonic activity, primarily in the east; (Maxwell, 1981; Alt and Edlund,1983), Axel Heiberg Island may be of national interest in the conservation of biological diversity in the Arctic Archipelago, particularly in the face of accelerated climate change.

### 6.2.6 Ringnes Island Group

Muskoxen are at extremely low numbers and absent from a number of these islands. This, in combination with the high northern latitude and sparse vegetation, Edlund and Alt (1989) suggest that the area may be unable to sustain large numbers of muskoxen year round.

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## APPENDIX 1

**Table A:** Survey Area Calculations

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Bathurst Island Group** | | | | | | | |
| **Bathurst Island Survey Area** | | | | | | | |
| Bathurst Is.(survey area only) | 2001 | 11693 | 0 | 11693 | | | |
| Cameron | 2001 | 1066 | 0 | 1066 | | CM101W; LoO76N | WGS1984 |
| Vanier | 2001 | 1136 | 0 | 1136 | | | |
| Massey | 2001 | 436 | 0 | 436 | | | |
| Isle Marc | 2001 | 57 | 0 | 57 | | | |
| Alexander | 2001 | 484 | 0 | 484 | | | |
| Helena | 2001 | 328 | 0 | 328 | | | |
| Unnamed Bracebridge Inlet | 2001 | 88 | 0 | 88 | | | |
| Loney | 2001 | 19 | 0 | 19 | | | |
| Bathurst Is. Complex Survey | | 15307 | | 15307 | | | |
| | | | | | | | |
| Bathurst Island (all) | 2001 | 16030 | 0 | 16030 | | CM101W; LoO76N | WGS1984 |
| Cameron | 2001 | 1066 | 0 | 1066 | | | |
| Vanier | 2001 | 1136 | 0 | 1136 | | | |
| Massey | 2001 | 436 | 0 | 436 | | | |
| Isle Marc | 2001 | 57 | 0 | 57 | | | |
| Alexander | 2001 | 484 | 0 | 484 | | | |
| Helena | 2001 | 328 | 0 | 328 | | | |
| Unnamed Bracebridge Inlet | 2001 | 88 | 0 | 88 | | | |
| Loney | 2001 | 19 | 0 | 19 | | | |
| Bathurst Island Complex (all) | Adjusted | 19644 | | 19644 | 19644 | | |

**Table A: Con't.**

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Bathurst Island Group Con't.** | | | | | | | |
| **Cornwallis Survey Area** | | | | | | | |
| Cornwallis Survey Area | 2002 | 2949 | 0 | 2949 | | CM90W; LoO75N | WGS1984 |
| Little Cornwallis | 2002 | 381 | 0 | 381 | | | |
| Milne | 2002 | 25 | 0 | 25 | | | |
| Crozier | 2002 | 35 | 0 | 35 | | | |
| Baring | 2002 | 21 | 0 | 21 | | | |
| Cornwallis Survey Area | | 3411 | | 3411 | | | |
| | | | | | | | |
| Cornwallis (All) | 2002 | 7012 | 0 | 7012 | | CM90W; LoO75N | WGS1984 |
| Little Cornwallis | 2002 | 381 | 0 | 381 | | | |
| Milne | 2002 | 25 | 0 | 25 | | | |
| Crozier | 2002 | 35 | 0 | 35 | | | |
| Baring | 2002 | 21 | 0 | 21 | | | |
| Cornwallis Group (All) | Adjusted | 7474 | | 7474 | 7474 | CM90W; LoO75N | WGS1984 |

**Table A: Con't.**

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Devon Island Group** | | | | | | | |
| **Western Devon Survey Area** | | | | | | | |
| West Devon | 2002 | 12316 | | 12316 | | | |
| | | | | | | | |
| **Devon Island Survey Area** | | | | | | | |
| Devon (includes Philpots Is.) | 2002 | 55534 | 15993 | 39541 | | CM88W; LoO76N | WGS1984 |
| Table&Ekins | 2002 | 68 | 0 | 68 | | | |
| Crescent | 2002 | | | | | | |
| Pioneer | 2002 | | | | | | |
| Spit | 2002 | | | | | | |
| Herbert | 2002 | | | | | | |
| John Barrow | 2002 | | | | | | |
| Kerr | 2002 | | | | | | |
| Fairholme | 2002 | | | | | | |
| Isle of Mists | 2002 | | | | | | |
| Hyde Parker | 2002 | | | | | | |
| Dyer | 2002 | | | | | | |
| Princess Royal Island | 2002 | | | | | | |
| 3 unnamed Islands | 2002 | | | | | | |
| Total Small Islands | 2002 | 122 | 0 | 122 | | | |
| Survey Area Total | 2008 | 55724 | | 39731 | 39731 | | |
| | | | | | | | |
| North Kent | 2008 | 594 | 154 | 440 | 440 | CM88W; LoO76N | WGS1984 |
| Baillie Hamilton | 2008 | 290 | 0 | 290 | 290 | CM88W; LoO76N | WGS1984 |
| Dundas | 2008 | 51 | 0 | 51 | 51 | CM88W; LoO76N | WGS1984 |
| Margaret | 2008 | 10 | 0 | 10 | 10 | CM88W; LoO76N | WGS1984 |

**Table A: Con't.**

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Prince of Wales - Somerset Island Group** | | | | | | | |
| **Prince of Wales Survey Area** | | | | | | | |
| Prince of Wales | 2004 | 33274 | 0 | 33274 | | CM96W; LoO73N | WGS1984 |
| Russell | 2004 | 937 | 0 | 937 | | | |
| Prescott Island | 2004 | 412 | 0 | 412 | | | |
| Pandora Island | 2004 | 142 | 0 | 142 | | | |
| Survey Area Total | | 34765 | | 34765 | 34765 | | |
| | | | | | | | |
| **Somerset Island Survey Area** | | | | | | | |
| Somerset | 2004 | 24549 | 0 | 24549 | 24549 | CM96W; LoO73N | WGS1984 |
| **Ellesmere Island Group** | | | | | | | |
| **North Ellesmere Survey Area** | | | | | | | |
| N Ellesmere | 2006 | 165649 | 69399 | 96250 | | CM80W; LoO80N | WGS1984 |
| Hoved Island | 2006 | 115 | 0 | 115 | | | |
| Pim Island | 2006 | 84 | 0 | 84 | | | |
| Krueger Island | 2006 | 30 | 0 | 30 | | | |
| Bromley Island | 2006 | 26 | 0 | 26 | | | |
| Marvin Islands | 2006 | 9 | 2 | 7 | | | |
| Miller Island | 2006 | 19 | 0 | 19 | | | |
| Bellot | 2006 | 16 | 0 | 16 | | | |
| (Small unnamed) | 2006 | 20 | 0 | 20 | | | |
| (Total small islands only) | 2006 | | | 317 | | | |
| Survey Area Total | | 165968 | | 96567 | 96567 | | |

**Table A: Con't.**

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Ellesmere Island Group Con't.** | | | | | | | |
| **South Ellesmere Survey Area** | | | | | | | |
| South Ellesmere | 2005 | 31929 | 9723 | 22206 | | CM80W; LoO80N | WGS1984 |
| Landslip Island | 2005 | 36 | 0 | 36 | | | |
| Graham | 2005 | 1388 | 0 | 1388 | | | |
| Buckingham | 2005 | 137 | 0 | 137 | | | |
| Survey Area Total | | 33490 | | 23767 | 23767 | | |
| **Axel Heiberg Island Group** | | | | | | | |
| **Axel Heiberg Survey Area** | | | | | | | |
| Axel Heiberg | 2007 | 42319 | 11974 | 30344 | | CM91W; LoO80N | WGS1984 |
| Stor Island | 2007 | 315 | 0 | 315 | | | |
| Bjarnason | 2007 | 128 | 0 | 128 | | | |
| Ulvingen | 2007 | 84 | 0 | 84 | | | |
| Small Unnamed | 2007 | 5 | 0 | 5 | | | |
| Survey Area Total | | 42851 | | 30877 | 30877 | | |
| **Ringnes Island Group** | | | | | | | |
| **Ellef Ringnes Survey Area** | | | | | | | |
| Ellef Ringnes | 2007 | 11428 | 0 | 11428 | | CM100W; LoO79N | WGS1984 |
| Thor | 2007 | 121 | 0 | 121 | | | |
| Survey Area Total | | 11549 | | 11549 | 11549 | | |
| | | | | | | | |
| **Amund Ringnes Survey Area** | | | | | | | |
| Amund Ringnes | 2007 | 5300 | 0 | 5299 | | CM100W; LoO79N | WGS1984 |
| Haig Thomas | 2007 | 65 | 0 | 65 | | | |
| Survey AreaTotal | | 5364 | | 5364 | 5364 | | |

**Table A: Con’t.**

| Island (Group) | Year Surveyed | Area (km sq.) | Glaciated Area | Habitat (Survey Area) | Totals Only | Projection Specifics | Datum |
|---|---|---|---|---|---|---|---|
| **Ringnes Island Group Con't.** | | | | | | | |
| **Cornwall Survey Area** | | | | | | | |
| Cornwall | 2007 | 2273 | 0 | 2273 | 2273 | CM100W; LoO79N | WGS1984 |
| | | | | | | | |
| **King Christian Survey Area** | | | | | | | |
| King Christian | 2007 | 647 | 0 | 647 | 647 | CM100W; LoO79N | WGS1984 |
| | | | | | | | |
| **Meighen Survey Area** | | | | | | | |
| Meighen | 2007 | 933 | 93 | 840 | | CM100W; LoO79N | WGS1984 |
| Perley | 2007 | 9 | 0 | 9 | | | |
| Survey Area Total | | 943 | | 849 | 849 | | |
| | | | | | | | |
| **Lougheed Island Survey Area** | | | | | | | |
| Lougheed | 2007 | 1319 | 0 | 1319 | | CM105W; LoO77N | WGS1984 |
| Edmund Walker | 2007 | 82 | 0 | 82 | | | WGS1984 |
| Grosvenor | 2007 | 7 | 0 | 7 | | | WGS1984 |
| Patterson | 2007 | 5 | 0 | 5 | | | WGS1984 |
| Stupart | 2007 | 2 | 0 | 2 | | | |
| Survey Area Total | | 1415 | | 1415 | 1415 | | |
| | | | | | | | |
| Total Ringnes Islands Group Survey Area | | | | 20682 | | | |
| | | | | | | | |
| **Arctic Island Study Area** | | **407600** | | | **300261** | **CM84W; LoO73N** | **WGS1984** |

*Note: All calculations conducted in the North Pole Lambert Azmimuthal Equal Area Projection; Datum 1984. The Projection was centered on each island or island group to increase precision.*

**APPENDIX 1: Table B:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | |
| **Bathurst Island** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun -7 Jul | 2723 | | | | | | unk | | | | | | | | Tener 1963 |
| 1973 | 29 Mar-3 Apr | 527 | 79 | | | | | N | | -0.137 | 0.872 | | | | | Miller et al. 1977 |
| 1974 | 25-31 Mar | 226 | 59 | | | | | N | | -0.847 | 0.429 | -0.191 | 0.826 | | | Miller et al. 1977 |
| 1974 | 25-26 Aug | | | | 231 | 130 | | 0 | | | | | | | | Miller et al. 1977 |
| 1981 | 10-13 Aug | 289 | 93 | | 234 | | | 19 | | 0.002 | 1.002 | | | | | Ferguson 1991 |
| 1985 | 10-25 Jul | 495 | | 253-737 | 352 | | 184-521 | 26 | | 0.102 | 1.107 | | | | | Miller 1987a |
| 1988 | 15-21 Jul | 821 | 138 | | 611 | 99 | | 28 | | 0.184 | 1.202 | 0.069 | 1.072 | | | Miller 1989 |
| 1990 | 6-10 Jul | | | | | | | 20 | 655 | | | | | | 920min. Search effort | Miller 1992 |
| 1991 | 27-30 Jun | | | | | | | 24 | 584 | -0.115 | 0.892 | | | | 547min. Search effort | Miller 1993 |
| 1992 | 5, 7, 8 Jul | | | | | | | 29 | 1428 | 0.894 | 2.445 | | | | 1025min. Search effort | Miller 1994 |
| 1993 | 17-21 Aug | | | | | | | 28 | 2273 | 0.465 | 1.592 | 0.415 | 1.514 | | 1765min. Serach effort | Miller 1995 |
| 1995 | 7-11 Jul | | | | | | | 11 | 1084 | -0.370 | 0.691 | | | 48 | 1107min. Search effort | Miller 1997a |
| 1996 | 21-25 Jul | | | | 443 | 108 | | 0 | | | | | | (287+/-68) | | Miller 1998 |
| 1997 | 21-24 Jul | | | | 74 | 25 | | 0 | | -1.790 | 0.167 | | | (82+/-18) | | Gunn and Dragon 2002 |
| **Ile Vanier** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun -7 Jul | 396 | | | | | | unk | | | | | | | | Tener 1963 |
| 1973 | 4-Apr | 20 | | | | | | N | | -0.249 | 0.780 | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 15 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 67 | | 0-153 | 60 | | 0-133 | 25 | | | | | | | | Miller 1987a |
| 1988 | 13-Jul | 85 | | 29-140 | 63 | | 25-101 | 25 | | | | | | | | Miller 1989 |
| 1989 | 22-Jul | 72 | 34 | | 55 | 23 | | 21 | | | | -0.061 | 0.941 | | | Miller 1991 |
| 1990 | 10-Jul | | | | | | | 7 | 43 | | | | | | 160min. Search effort | Miller 1992 |
| 1991 | 4-Jul | | | | | | | 11 | 28 | | | | | | 121min. Search effort | Miller 1993 |
| 1992 | 6-Jul | | | | | | | 17 | 18 | | | | | | 89min. Search effort | Miller 1994 |
| 1995 | 24-Jun | | | | | | | 6 | 34 | | | | | 0 | 78min. Search effort | Miller 1997 |
| 1996 | 26-Jul | | | | 9 | 6 | | 0 | | | | | | (224+/-54) | | Miller 1998 |
| 1997 | 21-Jul | | | | 0 | | | 0 | | | | -0.501 | 0.606 | (95+/-26) | | Gunn and Dragon 2002 |
| **Cameron** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun -7 Jul | 235 | | | | | | unk | | | | | | | | Tener 1963 |
| 1973 | 3-Apr | 8 | | | | | | N | | -0.282 | 0.755 | | | | | Miller et al. 1977 |
| 1974 | 4-Apr | 20 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 51 | | 0-131 | 47 | | 0-122 | 7 | | | | | | | | Miller 1987a |
| 1988 | 13-Jul | 9 | | 0-19 | 9 | | 0-19 | 0 | | | | | | | | Miller 1989 |
| 1989 | 22-Jul | 7 | 5 | | 7 | 5 | | 0 | | | | -0.125 | 0.882 | | | Miller 1991 |
| 1990 | 17-Jun | | | | | | | 0 | 13 | | | | | | 50min. Search effort | Miller 1992 |
| 1991 | 5-Jul | | | | | | | 0 | 2 | | | | | | 182min. Search effort | Miller 1993 |
| 1992 | 21-Jun | | | | | | | 0 | 5 | | | | | | 151min. Search effort | Miller 1994 |
| 1995 | 24-Jun | | | | | | | 0 | 0 | | | | | 7 | | Miller 1997 |
| 1996 | 26-Jul | | | | 0 | | | 0 | 0 | | | | | (606+/-139) | | Miller 1998 |
| 1997 | 21-22 Jul | | | | 0 | | | 0 | | | | -0.243 | 0.784 | (188+/-30) | | Gunn and Dragon 2002 |

**Table B. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | |
| **Massey** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun -7 Jul | 13 | | | | | | unk | | | | | | | | Tener 1963 |
| 1973 | 4-Apr | 44 | | | | | | N | | 0.102 | 1.107 | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 76 | | 26-126 | 43 | | 18-69 | 35 | | | | | | | | Miller 1987a |
| 1988 | 14-Jul | 84 | | 39-131 | 55 | | 23-87 | 36 | | | | | | | | Miller 1989 |
| 1989 | 22-Jul | 108 | 27 | | 68 | 17.4 | | 39 | | | | 0.076 | 1.079 | | | Miller 1991 |
| 1990 | 7-Jul | | | | | | | 27 | 56 | | | | | | 91min. Search effort | Miller 1992 |
| 1991 | 4-Jul | | | | | | | 33 | 123 | | | | | | 91min. Search effort | Miller 1993 |
| 1992 | 6-Jul | | | | | | | 33 | 101 | | | | | | 82min. Search effort | Miller 1994 |
| 1993 | 16-Aug | | | | | | | 43 | 28 | | | | | | 65min. Search effort | Miller 1995 |
| 1995 | 24-Jun | | | | | | | 41 | 49 | | | | | 0 | 61min. Search effort | Miller 1997 |
| 1996 | 26-Jul | | | | 0 | | | 0 | 0 | | | | | (27+/-14) | | Miller 1998 |
| 1997 | 21-Jul | | | | 4 | | | 0 | | | | -0.354 | 0.702 | (13+/-11) | | Gunn and Dragon 2002 |
| **Alexander** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun -7 Jul | 198 | | | | | | unk | | | | | | | | Tener 1963 |
| 1973 | 4-Apr | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 38 | | 0-136 | 27 | | 0-95 | 21 | | | | | | | | Miller 1987a |
| 1988 | 14-Jul | 31 | | 2.4-60 | 26 | | 0.4-51 | 11 | | | | | | | | Miller 1989 |
| 1989 | 22-Jul | 31 | 9.4 | | 26 | 7.5 | | 31 | | | | -0.066 | 0.936 | | | Miller 1991 |
| 1990 | 8-Jul | | | | | | | 14 | 113 | | | | | | 107min. Search effort | Miller 1992 |
| 1991 | 4-Jul | | | | | | | 15 | 82 | | | | | | 106min. Search effort | Miller 1993 |
| 1992 | 6-Jul | | | | | | | 26 | 92 | | | | | | 98min. Search effort | Miller 1994 |
| 1993 | 16-Aug | | | | | | | 22 | 63 | | | | | | 65min. Search effort | Miller 1995 |
| 1995 | 24-Jun | | | | | | | 11 | 84 | | | | | 0 | 87min. Search effort | Miller 1997 |
| 1996 | 13-Jul | | | | | | | 0 | 4 | | | | | 2 | | Miller 1998 |
| 1997 | 21-Jul | | | | 0 | | | 0 | | | | -0.407 | 0.665 | (5+/-5) | | Gunn and Dragon 2002 |
| **Ile Marc** | | | | | | | | | | | | | | | | |
| 1961 | | | | | | | | | | | | | | | Not mentioned in report | Tener 1963 |
| 1973 | 4-Apr | 9 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | NA | | | | | | 25 | 4 | | | | | | | Miller 1987a |
| 1988 | 14-Jul | 4 | | 0-10 | 4 | | 0-10 | 0 | | | | | | | | Miller 1989 |
| 1989 | 22-Jul | 8 | 5.5 | | 8 | 5.5 | | 0 | | | | | | | | Miller 1991 |
| 1990 | 15-Jun | | | | | | | 0 | 15 | | | | | | 16min. Search effort | Miller 1992 |
| 1991 | 7-Jul | | | | | | | 20 | 5 | | | | | | 16min. Search effort | Miller 1993 |
| 1992 | 6-Jul | | | | | | | 11 | 5 | | | | | | 8min. Search effort | Miller 1994 |
| 1993 | 16-Aug | | | | | | | 17 | 23 | | | | | | 22min. Search effort | Miller 1995 |
| 1995 | 24-Jun | | | | | | | 14 | 7 | | | | | 0 | 28min. Search effort | Miller 1997 |
| 1996 | 26-Jul | | | | | | | 0 | 0 | | | | | 2 | | Miller 1998 |
| 1997 | 21-Jul | | | | 0 | | | 0 | | | | | | (25+/-29) | | Gunn and Dragon 2002 |

**Table B. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | |
| **Helena** | | | | | | | | | | | | | | | | |
| 1961 | | | | | | | | | | | | | | | included in Bathurst | Tener 1963 |
| 1973 | 03-Apr | 0 | | | 0 | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 31-Mar | 4 | | | 4 | | | N | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | 0 | | | | | | | | Miller 1987a |
| 1988 | 20-Jul | 17 | | 0-42 | 12 | | 0-28 | 25 | | | | | | | | Miller 1989 |
| 1990 | 24-Jun | | | | | | | 9 | 23 | | | | | | | Miller 1992 |
| 1991 | 07-Jun | | | | | | | 27 | 22 | | | | | | 50min. Search effort | Miller 1993 |
| 1992 | 27 Jun-5 Jul | | | | | | | 28 | 46 | | | | | | 66min. Search effort | Miller 1994 |
| 1995 | 18-Jun | | | | | | | 2 | 49 | | | | | 0 | 72min. Search effort | Miller 1997 |
| 1997 | 22-Jul | | | | 0 | | | 0 | | | | | | 0 | | Gunn and Dragon 2002 |
| **Bathurst Island Complex (Bathurst, Vanier, Cameron Alexander, Massey, and Marc)** | | | | | | | | | | | | | | | | |
| 1961 | 19 Jun-7 Jul | 3565 | | | | | | 20 | | | | | | | | Tener 1963 |
| 1973 | 29 Mar-4 Apr | 608 | | | | | | N | | -0.147 | 0.863 | | | | | Miller et al. 1977 |
| 1974 | 25 Mar-4 Apr | 261 | | | | | | N | | -0.846 | 0.429 | | | | | Miller et al. 1977 |
| 1974 | 18-25 Aug | 228 | | | | | | unk | | | | -0.212 | 0.809 | | | Miller et al. 1977 |
| 1975 | Jun | | | | 228 | | | | | | | | | | | Fischer and Duncan 1976 in Ferguson 1991 |
| 1985 | 10-25 Jul | 724 | | 460-987 | 526 | | 337-716 | 24 | | 0.084 | 1.087 | | | | | Miller 1987a |
| 1988 | 11-21 Jul | 1103 | 146 | | 820 | 105 | | 27 | | 0.148 | 1.160 | 0.098 | 1.103 | | Includes Cornwallis Island | Miller 1989 |
| 1990 | 6-10 July | | | | | | | 19 | 871 | | | | | | | Miller 1992 |
| 1991 | 27 Jun-5 Jul | | | | | | | 22 | 949 | 0.086 | 1.090 | | | | 1478min. Search effort | Miller 1993 |
| 1992 | 5-8 Jul | | | | | | | 29 | 1690 | 0.577 | 1.781 | | | | 1368min. Search effort | Miller 1994 |
| 1993 | 16-24 Aug | | | | | | | 28 | 2387 | 0.345 | 1.412 | 0.336 | 1.399 | | Not including Cameron, Vanier, 1943min. Search effort | Miller 1995 |
| 1994 | | 3100 | | | | | | | | | | | | | Unsystematic estimate, increased by 100 to allow for possible numbers on Cornwallis Is. | Miller 1998 (Table 24) |
| 1995 | 17 Jun-11 Jul | | | | | | | 12 | 1307 | -0.301 | 0.740 | | | 55 | 1433min. Search effort | Miller 1997a |
| 1996 | 13-26 Jul | | | | 452 | | | N | | | | | | (1143+/-164) | | Miller 1998 |
| 1997 | 21-24 Jul | | | | 78 | | | 0 | | -1.757 | 0.173 | | | (408+/-53) | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | | | | 145 | | 77-260 | | | | | 0.155 | 1.168 | | | Jenkins et al. 2011 |
| 2001 | 15-31 May | | | | 187 | | 104-330 | | | | | estimate | 1.24 | | Extrapolated to unsurveyed | Jenkins et al. 2011 |

**Table B. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Bathurst Island Group** | | | | | | | | | | | | | | | | |
| **Cornwallis** | | | | | | | | | | | | | | | | |
| 1961 | 14-16 Jun | 43 | | | | | | unk | | | | | | | | Tener 1963 |
| 1988 | 11, 12 Jul | 51 | | 0-107 | 40 | | 0-88 | 23 | | 0.006 | 1.006 | | | | | Miller 1989 |
| 2002 | 10-11 May | 1 | | | | | | 0 | | -0.281 | 0.755 | | | | | Jenkins et al. 2011 |
| **Little Cornwallis** | | | | | | | | | | | | | | | | |
| 1961 | 16-Jun | 0 | | | | | | 0 | | | | | | | | Tener 1963 |
| 1973 | 1-Apr | 8 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 23-Mar | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 25-Aug | 12 | | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1988 | 12-Jul | 0 | | | | | | 0 | | | | | | | | Miller 1989 |
| 2002 | 10-11 May | 0 | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |
| **Devon Island Group** | | | | | | | | | | | | | | | | |
| **Devon Island** | | | | | | | | | | | | | | | | |
| 1961 | 10-17 Jun | 150 | | | | | | 0 | | | | | | | Extrapolation | Tener 1963 |
| 1990 | 3-7 Aug | 0 | | | | | | | | | | | | | Coastal lowlands | Case 1992 |
| 2002 | 8-30 May | | | | | | | | 35 | | | | | | West Devon | Jenkins et al. 2011 |
| 2008 | 22 Apr-10 May | | | | | | | | 17 | | | | | | All of Devon | Jenkins et al. 2011 |
| **Prince of Wales - Somerset Island Group** | | | | | | | | | | | | | | | | |
| **Prince of Wales** | | | | | | | | | | | | | | | | |
| 1974 | 18-Jun | 1040 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1974 | 29-30 Jul | 5437 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | 13-16 Apr | 2360 | | | | | | | | | | | | | | C. Elliott (CWS) in Gunn and Decker 1984 |
| 1975 | 4-14 Apr | 581 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | Jun | 3768 | | | | | | | | | | -0.367 | 0.693 | | | Fischer and Duncan 1976 |
| 1980 | 12-22 Jul | | | | 3952 | 474 | | 16 | | 0.010 | 1.010 | | | | | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | | | | NA | | | | 5 | | | | | | | Gunn and Dragon 1998 |
| 1996 | 28 Apr-3 May | | | | NA | | | | 0 | | | -0.518 | 0.596 | | | Miller 1997b |
| 2004 | 10-18 Apr | | | | 0 | | | | 0 | | | | | | Systematic | Jenkins et al. 2011 |
| **Somerset** | | | | | | | | | | | | | | | | |
| 1974 | 3-9 Jun | 245 | | | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 18-30 Mar | 645 | | | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 23-24 Jun | 903 | | | | | | | | | | 1.304 | 3.686 | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1980 | 12-22 Jul | | | | 561 | 146 | | 14 | | -0.095 | 0.909 | | | | | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | | | | NA | | | | 2 | | | | | | | Gunn and Dragon 1998 |
| 1996 | 28 Apr-3 May | | | | NA | | | | 2 | | | -0.352 | 0.703 | | | Miller 1997b |
| 2004 | 20-25 Apr | | | | 0 | | | | 0 | | | | | | Systematic | Jenkins et al. 2011 |

**Table B. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Prince of Wales - Somerset Island Group** | | | | | | | | | | | | | | | | |
| **Russell** | | | | | | | | | | | | | | | | |
| 1975 | 4-14 Apr | | | | 0 | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | Jun | | | | 159 | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | Jul | | | | 89 | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1980 | 12-22 Jul | | | | 584 | 90 | | 11 | | 0.376 | 1.457 | | | | | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | | | | 0 | | | | | -0.425 | 0.654 | | | | | Gunn and Dragon 1998 |
| 1996 | 28 Apr-3 May | | | | NA | | | | 0 | | | | | | | Miller 1997b |
| 2004 | 10-18 Apr | | | | 0 | | | | 0 | | | | | | Systematic | Jenkins et al. 2011 |
| **Boothia** | | | | | | | | | | | | | | | | |
| **Boothia (some surveys refer to combined estimates for Peary caribou and barrenground caribou)** | | | | | | | | | | | | | | | | |
| 1974 | 18 May-20 Jun | 626 | | | | | | | | | | | | | Estimate from 3 strata combined, surveyed over time period | Fischer and Duncan 1976 |
| 1974 | 1-3 Aug | 561 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | 18-25 Mar | 1109 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | 5-12 Jun | 1739 | | | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1985 | | | | | 4831 | 543 | | | | | | | | | | Gunn and Ashevak 1990 in Gunn and Dragon 1998 |
| 1995 | 21 Jul-3 Aug | | | | 6658 | 1728 | | | | | | | | | | Gunn and Dragon 1998 |
| 1996 | | | | | | | | | 0 | | | | | | Unsystematic (northwest) | Miller 1997 |
| **Ellesmere Island Group** | | | | | | | | | | | | | | | | |
| **Ellesmere** | | | | | | | | | | | | | | | | |
| Entire Ellesmere Is. | | | | | | | | | | | | | | | | |
| 1961 | 30 Jul-11 Aug | 200 | | | | | | 11 | | | | | | | Extrapolation | Tener 1963 |
| | | | | | | | | | | | | | | | | |
| Southern Ellesmere | | | | | | | | | | | | | | | | |
| 1973 | | | | | | | | | 150 | | | | | | Southeast unsystematic | Riewe 1973 |
| 1989 | 17-23 Jul | 89 | 31 | | | | | 22 | | | | -0.029 | 0.971 | | Southern Ellesmere | Case and Ellsworth 1991 |
| 2005 | 4-30 May | | | | 219 | | 109-442 | | | 0.064 | 1.066 | | | | Includes Graham Island | Jenkins et al. 2011 |
| | | | | | | | | | | | | | | | | |
| Northern Ellesmere | | | | | | | | | | | | | | | | |
| 2006 | 6 Apr-22 May | | | | 802 | | 531-1207 | | | | | | | | | Jenkins et al. 2011 |
| **Graham** | | | | | | | | | | | | | | | | |
| 2005 | 4-30 May | See Southern Ellesmere Is. | | | | | | | | | | | | | | Jenkins et al. 2011 |
| **Axel Heiberg Island Group** | | | | | | | | | | | | | | | | |
| **Axel Heiberg** | | | | | | | | | | | | | | | | |
| 1961 | 2-3 Aug | 300 | | | | | | 14 | | | | | | | Extrapolation | Tener 1963 |

**Table B. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Ringnes Island Group** | | | | | | | | | | | | | | | | |
| **Ellef Ringnes** | | | | | | | | | | | | | | | | |
| 1961 | 14-Aug | 114 | | | | | | Y | | | | | | | | Tener 1963 |
| 2007 | 6-15 Apr | See below | | | | | | | | | | | | | | Jenkins et al. 2011 |
| **Amund Ringnes** | | | | | | | | | | | | | | | | |
| 1961 | 15-Aug | 452 | | | | | | Y | | | | | | | | Tener 1963 |
| 2007 | 15-17 Apr | See below | | | | | | | | | | | | | | Jenkins et al. 2011 |
| **Cornwall** | | | | | | | | | | | | | | | | |
| 1961 | 15-Aug | 266 | | | | | | 25 | | | | | | | | Tener 1963 |
| 2007 | 19 Apr | See below | | | | | | | | | | | | | | Jenkins et al. 2011 |
| **King Christian** | | | | | | | | | | | | | | | | |
| 1961 | 15-Aug | too few | | | | | | | 3 | | | | | | | Tener 1963 |
| 2007 | 14 Apr | See below | | | | | | | | | | | | | | Jenkins et al. 2011 |
| **Meighen** | | | | | | | | | | | | | | | | |
| 2007 | 22 Apr | 0 | | | | | | | 0 | | | | | | | Jenkins et al. 2011 |
| **Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands** | | | | | | | | | | | | | | | | |
| 2007 | 6-22 Apr | | | | 282 | | 157-505 | | | | | | | | None on Meighen | Jenkins et al. 2011 |
| **Lougheed** | | | | | | | | | | | | | | | | |
| 1961 | 18-Aug | 1324 | | | | | | 22 | | | | | | | | Tener 1963 |
| 1973 | 03-Apr | 56 | | | | | | | | -0.264 | 0.768 | | | | | Miller et al. 1977 |
| 1974 | 04-Apr | 0 | | | | | | | 1 | -4.025 | 0.018 | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | 2 | | | | | | 1 cow-calf pair | Miller 1987a |
| 1997 | 21-Jul | | | | 101 | 73 | | | | 0.385 | 1.469 | | | (28+/-29) | | Gunn and Dragon 2002 |
| 2007 | 13 Apr | | | | 372 | | 205-672 | | | 0.130 | 1.139 | | | | | Jenkins et al. 2011 |
| **Prime Minister Island Group (Northwest Territories)** | | | | | | | | | | | | | | | | |
| **Mackenzie King** | | | | | | | | | | | | | | | | |
| 1961 | 17-Aug | 2192 | | | (1710) | | | 22 | | | | | | | | Tener 1963 |
| 1973 | 15-Apr | NA | | | | | | N | 3 | | | | | | | Miller et al. 1977 |
| 1974 | 11-Apr | 60 | | | | | | N | | | | -0.277 | 0.758 | | | Miller et al. 1977 |
| 1997 | 18-Jul | | | | 36 | 22 | | 25 | | | | | | (24+/-14) | 1 cow-calf pair | Gunn and Dragon 2002 |
| **Brock** | | | | | | | | | | | | | | | | |
| 1961 | 17-Aug | 190 | | | | | | unk | | | | | | | Partial survey fog - | Tener 1963 |
| 1973 | 15-Apr | 24 | | | | | | N | | -0.172 | 0.842 | | | | | Miller et al. 1977 |
| 1997 | 18-Jul | 0 | | | | | | 0 | | | | | | 0 | | Gunn and Dragon 2002 |
| **Borden** | | | | | | | | | | | | | | | | |
| 1961 | 17-Aug | 1630 | | | (1271) | | | 22 | | | | | | | | Tener 1963 |
| 1973 | 14-15 Apr | 16 | | | | | | N | | -0.385 | 0.680 | | | | | Miller et al. 1977 |

**Table 2. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Melville Island Group (Northwest Territories)** | | | | | | | | | | | | | | | | |
| **Melville** | | | | | | | | | | | | | | | | |
| 1961 | 8-22 Jul | 12799 | | | | | | 19 | | | | | | | | Tener 1963 |
| 1972 | 20 Mar-6 Apr | 705 | 159 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1972 | 13-24 Aug | 2551 | 724 | | | | | 0 | | -0.147 | 0.864 | | | | Only strata I-VI | Miller et al. 1977 |
| 1973 | 19 Mar-7 Apr | 1648 | 181 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1973 | 5 Jul-2 Aug | 3425 | 618 | | | | | 12 | | 0.295 | 1.343 | | | | | Miller et al. 1977 |
| 1974 | 4-21 Aug | 1679 | NA | | | | | 1 | | -0.713 | 0.490 | | | | Extrapolated for 3 missed strata | Miller et al. 1977 |
| 1987 | 1-22 Jul | 943 | 126 | | 729 | 104 | | 19 | | -0.044 | 0.957 | | | | | Miller 1988 |
| 1997 | 2-20 Jul | 787 | 97 | | | | | 0 | | -0.018 | 0.982 | -0.077 | 0.925 | (150+/-48) | | Gunn and Dragon 2002 |
| **Byam Martin** | | | | | | | | | | | | | | | | |
| 1972 | 22-23 Mar | 4 | 3 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1972 | 7-Aug | 86 | 65 | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1973 | 27-Mar | 34 | 13 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1973 | 15-Jul | 43 | 36 | | | | | 11 | | | | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 6 | 2 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 20-Aug | 6 | 4 | | | | | 0 | | | | -1.331 | 0.264 | | | Miller et al. 1977 |
| 1987 | 8-Jul | 98 | 37 | | 70 | 26 | | 19 | | 0.215 | 1.240 | | | | | Miller 1988 |
| 1997 | 20-Jul | 0 | | | | | | 0 | | -0.425 | 0.654 | | | (26+/-11) | | Gunn and Dragon 2002 |
| **Prince Patrick** | | | | | | | | | | | | | | | | |
| 1961 | 23-24 Jul | 2254 | | | | | | 20 | | | | | | | | Tener 1963 |
| 1973 | 8-15 Apr | 1381 | 269 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1973 | 28 Jul-21 Aug | 807 | 259 | | | | | 11 | | -0.086 | 0.918 | | | | | Miller et al. 1977 |
| 1974 | 10-16 Apr | 1049 | 212 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 18-25 Jul | 621 | 177 | | | | | 7 | | -0.262 | 0.770 | | | | | Miller et al. 1977 |
| 1986 | 4-13 Jul | 151 | | 12-182 | 106 | | 11-114 | 30 | | -0.118 | 0.889 | | | | | Miller 1987b |
| 1997 | 29 Jun-1 Jul | 84 | 34 | | | | | 0 | | -0.053 | 0.948 | -0.091 | 0.913 | (178+/-37) | | Gunn and Dragon 2002 |
| **Eglinton** | | | | | | | | | | | | | | | | |
| 1961 | 24-Jul | 204 | | | | | | *31* | | | | | | | 4 calves observed | Tener 1963 |
| 1972 | 4-Apr | 574 | 122 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1972 | 10-Aug | 83 | 59 | | | | | 0 | | -0.082 | 0.921 | | | | | Miller et al. 1977 |
| 1973 | 8-Apr | 90 | 15 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1973 | 8-Aug | 12 | 9 | | | | | 0 | | -1.934 | 0.145 | | | | | Miller et al. 1977 |
| 1974 | Apr | 301 | 60 | | | | | N | | | | | | | | Miller et al. 1977 |
| 1974 | 25-Jul | 18 | 10 | | | | | 4 | | 0.405 | 1.500 | | | | 1 calf observed | Miller et al. 1977 |
| 1986 | 4-Jul | 79 | | 0-229 | 65 | | 0-183 | 18 | | 0.123 | 1.131 | | | | | Miller 1987b |
| 1997 | 2-Jul | 0 | | | | | | 0 | | -0.397 | 0.672 | -0.148 | 0.863 | 0 | | Gunn and Dragon 2002 |
| **Emerald** | | | | | | | | | | | | | | | | |
| 1961 | 24-Jul | 161 | | | | | | 3 | | | | | | | | Tener 1963 |
| 1973 | 15-Apr | 0 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1973 | 30-Jul | 39 | | | | | | N | | -0.118 | 0.889 | | | | | Miller et al. 1977 |
| 1974 | 17-Apr | 12 | | | | | | N | | | | | | | | Miller et al. 1977 |
| 1986 | 4-Jul | 14 | | 0-49 | 11 | | 0-37 | 25 | | -0.079 | 0.924 | | | | | Miller 1987b |
| 1997 | 19-Jul | 0 | | | | | | 0 | | -0.240 | 0.787 | -0.141 | 0.868 | (17+/-16) | | Gunn and Dragon 2002 |

**Table 2. Con't.:** Historical Peary caribou surveys and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Minimum total counts; unsystematic surveys | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Banks Island (Northwest Territories)** | | | | | | | | | | | | | | | | |
| **Banks** | | | | | | | | | | | | | | | | |
| 1970 | 23-28 Jun | 5300 | | | | | | | | | | | | | Northern Banks | Kevan 1974 |
| 1972 | Sep | 12098 | | | | | | 17 | | 0.413 | 1.511 | | | | | Urquhart 1973 |
| 1979-80 | | | | | 8000-9000 | | | | | -0.032 | 0.968 | | | | | Vincent and Gunn 1981 |
| 1982 | 4-10 Jul | | | | 7233 | 998 | | | | | | | | | Calves not recorded | Latour 1985 |
| 1982 | 4-10 Jul | | | | 9036 | | 6110-11370 | | | 0.031 | 1.031 | | | | Retrospective | Nagy et al. 2009a |
| 1985 | 6-14 Jul | | | | 5000 | 910 | | 15 | | -0.197 | 0.821 | | | | Calves likely minimum est. | McLean et al. 1986 |
| 1987 | 27-30 Jun | | | | 4500 | 660 | | 23 | | -0.053 | 0.949 | | | | | McLean 1992 |
| 1989 | 22-28 Jun | | | | 2600 | 340 | | 26 | | -0.274 | 0.760 | | | (300) | 29 carcasses observed | McLean and Fraser 1992 |
| 1990 | 14-19 Sep | | | | 526 | 302 | | 11 | | - | - | | | | | McLean et al. 1992 |
| 1991 | 27 Jun-3 Jul | | | | 888 | 151 | | 5 | | -0.537 | 0.584 | | | (60) | 6 carcasses observed | Fraser at al. 1992 |
| 1992 | 21-30 Aug | | | | 1018 | 133 | 748-1288 | 29 | | 0.137 | 1.146 | -0.218 | 0.804 | 2 | | Nagy et al. 2009b |
| 1994 | Jul | | | | 742 | 132 | | 8 | | -0.158 | 0.854 | | | 7 | | Nagy et al. 2006a |
| 1998 | Jul | | | | 451 | 60 | | 19 | | -0.124 | 0.883 | | | 0 | | Nagy et al. 2006b |
| 2001 | 7-15 Jul | | | | 1142 | 155 | 818-1466 | 26 | | 0.304 | 1.355 | | | 0 | | Nagy et al. 2006 |
| 2005 | 24 Jul-1 Aug | | | | 929 | 143 | 640-1218 | 19 | | -0.052 | 0.950 | | | 0 | | Nagy et al. 2009c |
| 2010 | 17-26 Jul | | | | 1097 | | 754-1440 | 25 | | 0.033 | 1.034 | | | | | Davison et al. in prep. |
| **Victoria Island (Northwest Territories)** | | | | | | | | | | | | | | | | |
| **NW Victoria** | | | | | | | | | | | | | | | | |
| 1980 | 5-20 Aug | 4512 | 988 | | | | | | | | | | | | St A NW Victoria | Jakimchuk and Carruthers 1980 |
| 1987 | Jun | 3500 | | | 2600 | | Extrapolation | 27 | | | | | | | Extrapolation | Gunn 2005 |
| 1987 | Jun | | | | (643) | (172) | On CG only | | | | | | | | | Gunn and Fournier 2000 |
| 1992 | 24-26 Mar | | | | 170 | 54 | 116-224 | | | | 0.766 | | | | | Heard 1992 |
| 1993 | 18-20 Mar | | | | 144 | 22 | | | | | | | | | | Gunn 2005 |
| 1993 | 13-15 Jun | | | | 20 | - | | 5 | | -2.140 | 0.118 | | | | Total observed; 1 calf | Gunn 2005 |
| 1994 | 5-17 June | | | | 39 | 28 | | | | 0.668 | 1.950 | -0.400 | 0.670 | | St IV of western Victoria | Nishi and Buckland 2000 |
| 1998 | early Jul | | | | 95 | 29 | 35-155 | 12 | | 0.223 | 1.249 | | | 0 | | Nagy et al. 2009d |
| 2001 | 16-21 Jul | | | | 204 | 50 | 101-307 | 24 | | 0.255 | 1.290 | | | 0 | | Nagy et al. 2009e |
| 2005 | 6-8 Jul | | | | 66 | 30 | 5-127 | 28 | | -0.282 | 0.754 | | | 0 | | Nagy et al. 2009f |
| 2010 | 28 Jul-15 Aug | | | | 150 | | 46-254 | 12 | | 0.093 | 1.097 | | | | | Davison et al. in prep. |

**APPENDIX 1: Table C:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| Bathurst Island Group | | | | | | | | | | | | | | | | | |
| Bathurst Island | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 1136 | | | | | | 9 | | | | | | | | | Tener 1963 |
| 1973 | 29 Mar-3 Apr | 672 | 194 | | | | | N | | | -0.046 | 0.955 | | | | | Miller et al. 1977 |
| 1974 | 25-26 Aug | 164 | 70 | | | | | 0 | | | | | | | | | Miller et al. 1977 |
| 1981 | 10-13 Aug | 208 | | | | | | 16 | | | 0.034 | 1.035 | -0.086 | 0.918 | | | Ferguson 1991 |
| 1985 | 10-25 Jul | 521 | | 230-812 | 418 | | 191-645 | 17 | | | 0.230 | 1.258 | | | | | Miller 1987a |
| 1988 | 18-21 Jul | 503 | 108 | | 423 | 83 | | 12 | | | -0.012 | 0.988 | | | | | Miller 1989 |
| 1993 | 17-20 Aug | | | | | | | 18 | (888) | | | | | | | Min. count | Miller 1995 App. 7 |
| 1995 | 17 Jun-12 Jul | | | | | | | 4 | (760) | 14 | | | | | 45 | Min. count | Miller 1997 App 3 |
| 1996 | 13-20 Jul | 425 | | | 425 | 136 | | 0 | | | | | | | (625+/-215) | | Miller 1998 |
| 1997 | 21-24 Jul | 124 | | | 124 | 45 | | 0 | (36) | -96 | -1.232 | 0.292 | | | 21 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | | | | | | | 20 | (82) | | | | | | | Calves based on 8 ca 32 ad | Jenkins et al. 2011 |
| Ile Vanier | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 4-Apr | NA | | | | | | N | 6 | | | | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | NA | | | | | | N | 5 | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | 1 | | | | | | | | Miller 1987a |
| 1988 | 13-Jul | 6 | | 0-12 | 6 | | 0-12 | 0 | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | NA | | | | | | 0 | 11 | | | | | | 0 | | Miller 1997 |
| 1996 | 26-Jul | 0 | | | | | | | | | | | | | 0 | | Miller 1998 |
| 1997 | 21-Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | NA | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |
| Cameron | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 25 | | | | | | 0 | | | | | | | | included Alexander | Tener 1963 |
| 1973 | 3 Apr | 0 | | | | | | N | (5) | | | | | | | | Miller et al. 1977 |
| 1974 | 4 Apr | 0 | | | | | | N | (2) | | | | | | 3 | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | 2 | | | | | | | | Miller 1987a |
| 1988 | 13-Jul | 7 | | 0-15 | 7 | | 0-15 | 0 | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | NA | | | | | | 0 | 14 | | | | | | 1 | | Miller 1997 |
| 1996 | 26-Jul | 0 | | | | | | | | | | | | | (17+/-13) | | Miller 1998 |
| 1997 | 21-22 Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | 0 | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| Bathurst Island Group | | | | | | | | | | | | | | | | | |
| Massey | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 4 Apr | 0 | | | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1974 | 1 Apr | 0 | | | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | | | | | | | | | Miller 1987a |
| 1988 | 14-Jul | 0 | | | | | | | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | NA | | | | | | 10 | 10 | | | | | | 0 | | Miller 1997 |
| 1996 | 26-Jul | 0 | | | | | | | | | | | | | 0 | | Miller 1998 |
| 1997 | 21-Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | 0 | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |
| Alexander | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | 0 | | | | | | | | Included with Cameron | Tener 1963 |
| 1973 | 4 Apr | 0 | | | | | | N | 9 | | | | | | | | Miller et al. 1977 |
| 1974 | 1 Apr | 0 | | | | | | N | 2 | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 27 | | 0-86 | 27 | | 0-86 | 21 | | | | | | | | | Miller 1987a |
| 1988 | 14-Jul | 6 | | 0-14 | 6 | | 0-14 | 0 | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | NA | | | | | | 0 | 46 | | | | | | 4 | | Miller 1997 |
| 1996 | 26-Jul | 0 | | | | | | | 6 | | | | | | 0 | | Miller 1998 |
| 1997 | 21-Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | 0 | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |
| Ile Marc | | | | | | | | | | | | | | | | | |
| 1961 | 18 Jun-7 Jul | NA | | | | | | | | | | | | | | Not mentioned in report | Tener 1963 |
| 1973 | 4 Apr | 0 | | | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1974 | 1 Apr | 0 | | | | | | | 0 | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | | | | | | | | | Miller 1987a |
| 1988 | 14 Jul | 0 | | | | | | | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | 0 | | | | | | | | | | | | | 0 | | Miller 1997 |
| 1997 | 21 Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | 0 | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |
| Helena | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | NA | | | | | | | | | | | | | | | |
| 1973 | 3-Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1974 | 31-Mar | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | | | | | | | | | Miller 1987a |
| 1988 | 20-Jul | 0 | | | | | | | | | | | | | | | Miller 1989 |
| 1995 | 17 Jun-12 Jul | 0 | | | | | | | | | | | | | 0 | | Miller 1997 |
| 1997 | 22-Jul | 0 | | | | | | | | | | | | | 0 | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | 0 | | | | | | | 0 | | | | | | | | Jenkins et al. 2011 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| Survey Year | Season | Estimate incl. calves: Estimate incl. calves | Estimate incl. calves: SE | Estimate incl. calves: 95% CI | Estimate 1+ year: Estimate 1+ year | Estimate 1+ year: SE | Estimate 1+ year: 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Consecutive surveys: Exponential rate of change | Consecutive surveys: Lambda | Range of surveys: Exponential rate of change | Range of surveys: Lambda | Carcass counts (estimates) | Survey Comments | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bathurst Island Group** | | | | | | | | | | | | | | | | | |
| **Bathurst Island Complex** | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 1161 | | | | | | 9 | | | | | | | | Includes GG Islands | Tener 1963 |
| 1973 | 29 Mar-3 Apr | 672 | 194 | | | | | N | | | -0.046 | 0.955 | | | | | Miller et al. 1977 in Miller 1998 |
| 1974 | 25-26 Aug | 164 | 70 | | | | | 0 | | | | | | | | includes 20 secondary satellite islands; excludes Cornwallis Island | Miller et al. 1977 in Miller 1998 |
| 1981 | 10-13 Aug | | | | | | | | | | | | | | | | |
| 1985 | 10-25 Jul | 545 | | 259-830 | | | | 17 | | | | | | | | estimate for nine-island survey area | Miller 1987a in Miller 1998 |
| 1988 | 18-21 Jul | 592 | 108 | | 423 | 83 | | 12 | | | -0.012 | 0.988 | | | | | Miller 1989 in Miller 1998 |
| 1993 | 17-20 Aug | 1200 | | | | | | 18 | | | | | | | | | Miller 1995 in Miller 1998 |
| 1995 | 17 Jun-12 Jul | 980 | | | | | | | | | | | | | | With or Without calves?? | Miller 1998 |
| 1996 | 13-20 Jul | | | | 500 | | | | | | | | | | (625+/-215) | guestimate | Miller 1998 |
| 1997 | 21-24 Jul | | | | 124 | 45 | | 0 | | | | | | | | | Gunn and Dragon 2002 |
| 2001 | 15-31 May | | | | | | | 20 | (82) | | | | | | | | Jenkins et al. 2011 |
| **Cornwallis** | | | | | | | | | | | | | | | | | |
| 1961 | 14-16 Jun | 50 | | | | | | 0 | | | | | | | | Extrapolation | Tener 1963 |
| 1988 | 11, 12 Jul | 70 | 34 | | | | | 19 | | | 0.012 | 1.013 | | | | | Miller 1989 |
| 2002 | 10-11 May | | | | | | | 0 | (18) | | | | | | | | Jenkins et al. 2011 |
| **Little Cornwallis** | | | | | | | | | | | | | | | | | |
| 1961 | 16-Jun | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 01-Apr | 40 | | | | | | N | | | 0.307 | 1.360 | | | | | Miller et al. 1977 |
| 1974 | 23-Mar | 20 | | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1974 | 25-Aug | 12 | | | | | | 0 | | | | | | | | | Miller et al. 1977 |
| 1988 | 12-Jul | 0 | | | | | | | | | | | -0.246 | 0.782 | | | Miller 1989 |
| 2002 | 10-11 May | 0 | | | | | | 0 | 0 | | | | | | | | Jenkins et al. 2011 |
| **Devon Island Group** | | | | | | | | | | | | | | | | | |
| **Devon Island** | | | | | | | | | | | | | | | | | |
| 1961 | 10, 12, 17 Jun | | | | | | | | (200) | | | | | | | Extrapolation | Tener 1963 |
| 1967 | | | | | | | | | (450) | | | | | | | North Devon Is. | Freeman 1971 |
| 1980 | | | | | | | | | (400) | | | | 0.036 | 1.037 | | unsystematic | Decker unpubl in Urquhart 1982 |
| 1990 | 3-7 Aug | 400 | | | | | | 13 | | | | | | | | Coastal lowlands | Case 1992 |
| 2008 | 22 Apr-10 May | | | | 513 | | 302-864 | 14 | | | | | | | | Systematic | Jenkins et al. 2011 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Prince of Wales - Somerset Island Group** | | | | | | | | | | | | | | | | | |
| **Prince of Wales** | | | | | | | | | | | | | | | | | |
| 1974 | 18-Jun | | | | 564 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1974 | 29-30 Jul | | | | 872 | | | 7-14 | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 4-14 Apr | | | | 2381 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 13-16 Apr | | | | 907 | | | 15 | | | | | | | | | C. Elliott in Gunn and Decker 1984 |
| 1975 | Jun | | | | 313 | | | 11-15 | | | -0.589 | 0.555 | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1980 | 12-22 Jul | | | | 1126 | 276 | | 10-12 | | | 0.256 | 1.292 | | | | | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | 5157 | 414 | | | | | N | | | | | | | | Includes 68 on Pandora | Gunn and Dragon 1998 |
| 2004 | 10-18 Apr | | | | 2086 | | 1582-2746 | | | | | | 0.026 | 1.026 | | Includes Russell and Pandora | Jenkins et al. 2011 |
| **Somerset** | | | | | | | | | | | | | | | | | |
| 1974 | 3-9 Jun | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 18-30 Mar | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 23-24 Jun | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1980 | 12-22 Jul | | | | NA | | | 0 | | | | | | | | 29 MX seen; no estimate | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | | | | 1140 | 260 | | | | | | | 0.352 | 1.422 | | | Gunn and Dragon 1998 |
| 2004 | 20-25 Apr | | | | 1910 | | 962-3792 | | | | 0.057 | 1.059 | | | | | Jenkins et al. 2011 |
| **Russell** | | | | | | | | | | | | | | | | | |
| 1975 | 4-14 Apr | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | 13-16 Apr | | | | | | | | | | | | | | | | C. Elliott in Gunn and Decker 1984 |
| 1975 | Jun | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 in Gunn and Decker 1984 |
| 1975 | Jul | | | | 0 | | | | | | | | | | | | In Gunn and Decker 1980 |
| 1980 | 12-22 Jul | | | | 0 | | | 0 | | | | | | | | | Gunn and Decker 1984 |
| 1995 | 21 Jul-3 Aug | | | | 102 | 54 | | | | | 0.308 | 1.361 | | | | | Gunn and Dragon 1998 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Boothia** | | | | | | | | | | | | | | | | | |
| **Boothia** | | | | | | | | | | | | | | | | | |
| 1974 | 18 May-20 Jun | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1974 | 1-3 Aug | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | 18-25 Mar | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1975 | 5-12 Jun | | | | 0 | | | | | | | | | | | | Fischer and Duncan 1976 |
| 1985 | 31 May-3 Jun | | | | 0 | | | | | | | | | | | | Gunn and Ashevak 1990 |
| **Ellesmere Island Group** | | | | | | | | | | | | | | | | | |
| **Ellesmere** | | | | | | | | | | | | | | | | | |
| Whole island | | | | | | | | | | | | | | | | | |
| 1961 | 30 Jul-7 Aug | | | | | | | 12 | (4000) | | | | | | | Extrapolation | Tener 1963 |
| S. Ellesmere | | | | | | | | | | | | | | | | | |
| 1967 | | | | | | | | | (470) | | -0.357 | 0.700 | | | | | Freeman 1971 |
| 1973 | Jul | 1060 | | | | | | | | | | | | | | southeast unsystematic | Riewe 1973 |
| 1989 | 17-23 Jul | 2020 | 285 | | | | | 17 | | | 0.040 | 1.041 | | | | Southern Ellesmere | Case and Ellsworth 1991 |
| 2005 | 4-30 May | | | | 456 | | 312-670 | | | | | | | | 20 | Syst. incl Graham | Jenkins et al. 2011 |
| | | | | | | | | | | | | | | | | | |
| N. Ellesmere | | | | | | | | | | | | | | | | | |
| 2006 | 6 Apr-22 May | | | | 8115 | | 6632-9930 | 18 | | | | | | | | Systematic | Jenkins et al. 2011 |
| **Graham** | | | | | | | | | | | | | | | | | |
| 1967 | | | | | | | | | (50) | | | | | | | | Freeman 1971 |
| **Axel Heiberg Island Group** | | | | | | | | | | | | | | | | | |
| **Axel Heiberg** | | | | | | | | | | | | | | | | | |
| 1961 | 2-3 Aug | | | | | | | 7 | (1000) | | | | | | | Extrapolation | Tener 1963 |
| 2007 | 19 Apr-3 May | | | | 4237 | | 3371-5323 | | | | | | | | | | Jenkins et al. 2011 |
| **Ringnes Island Group** | | | | | | | | | | | | | | | | | |
| **Ellef Ringnes** | | | | | | | | | | | | | | | | | |
| 1961 | 14-Aug | 0 | | | | | | | | | | | | | | | Tener 1963 |
| **Amund Ringnes** | | | | | | | | | | | | | | | | | |
| 1961 | 15-Aug | 4 | | | | | | 0 | | | | | | | | | Tener 1963 |
| **Cornwall** | | | | | | | | | | | | | | | | | |
| 1961 | 15-Aug | 0 | | | | | | | | | | | | | | | Tener 1963 |
| **Ellef Ringnes, Amund Ringnes, Cornwall, King Christian, and Meighen Islands** | | | | | | | | | | | | | | | | | |
| 2007 | 6-22 Apr | | | | | | | | (21) | | | | | | | | Jenkins et al. 2011 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| Ringnes Island Group | | | | | | | | | | | | | | | | | |
| Lougheed | | | | | | | | | | | | | | | | | |
| 1961 | 18-Aug | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 3 Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1974 | 4 Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1985 | 10-25 Jul | 0 | | | | | | | | | | | | | | | Miller 1987a |
| 1997 | 21 Jul | 0 | | | | | | | | | | | | | | | Gunn and Dragon 2002 |
| 2007 | 13 Apr | 0 | | | | | | | | | | | | | | | Jenkins et al. 2011 |
| Prime Minister Island Group (Northwest Territories) | | | | | | | | | | | | | | | | | |
| Mackenzie King | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 15-Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1974 | 11-Apr | 0 | | | | | | | 6 | | | | | | | | Miller et al. 1977 |
| 1997 | 18-Jul | 0 | | | | | | | | | | | | | | | Gunn and Dragon 2002 |
| Brock | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | | | | | | | | | partial survey fog - | Tener 1963 |
| 1973 | 15-Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| 1997 | 18-Jul | 0 | | | | | | | | | | | | | | | Gunn and Dragon 2002 |
| Borden | | | | | | | | | | | | | | | | | |
| 1961 | 18Jun-7 Jul | 0 | | | | | | | | | | | | | | | Tener 1963 |
| 1973 | 14-15 Apr | 0 | | | | | | | | | | | | | | | Miller et al. 1977 |
| Melville Island Group (Northwest Territories) | | | | | | | | | | | | | | | | | |
| Melville | | | | | | | | | | | | | | | | | |
| 1961 | 8-22 Jul | 1000 | | | | | | 17 | | | | | | | | Extrapolation | Tener 1963 |
| 1972 | 20 Mar-6 Apr | 3394 | 478 | | | | | N | | | 0.111 | 1.117 | | | | | Miller et al. 1977 |
| 1972 | 13-24 Aug | NA | | | | | | 10 | | | | | | | | 986+/-264 only strata I-VI | Miller et al. 1977 |
| 1973 | 19 Mar-7 Apr | 3025 | 455 | | | | | N | | | -0.115 | 0.891 | | | | | Miller et al. 1977 |
| 1973 | 5 Jul-2 Aug | 3171 | 627 | | | | | 19 | | | | | | | | | Miller et al. 1977 |
| 1974 | 4-21 Aug | 2390 | 412 | | | | | 10 | | | -0.283 | 0.754 | | | | extrapolated for 3 missed strata | Miller et al. 1977 |
| 1987 | 1-22 Jul | 5652 | 464 | | 4761 | 373 | | 15 | | | 0.066 | 1.068 | 0.067 | 1.069 | | | Miller 1988 |
| 1997 | 2-20 Jul | | | | 2258 | 268 | | 0 | | | -0.075 | 0.928 | | | 32 | | Gunn and Dragon 2002 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Melville Island Group (Northwest Territories)** | | | | | | | | | | | | | | | | | |
| **Byam Martin** | | | | | | | | | | | | | | | | | |
| 1972 | 22-23 Mar | 151 | 132 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1972 | 7-Aug | 61 | 61 | | | | | 2 | | | | | | | | | Miller et al. 1977 |
| 1973 | 27-Mar | 8 | 6 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1973 | 15-Jul | 117 | 84 | | | | | 24 | | | 0.651 | 1.918 | | | | | Miller et al. 1977 |
| 1974 | 1-Apr | 28 | 8 | | | | | N | | | | | | | 8 | | Miller et al. 1977 |
| 1974 | 20-Aug | NA | | | | | | 0 | 8 | | | | | | | | Miller et al. 1977 |
| 1987 | 8-Jul | 100 | 61 | | 96 | 59 | | 3 | | | | | -0.027 | 0.973 | | | Miller 1988 |
| 1997 | 20-Jul | | | | 0 | | | 0 | | | -0.461 | 0.631 | | | 1 | | Gunn and Dragon 2002 |
| **Prince Patrick** | | | | | | | | | | | | | | | | | |
| 1961 | 23-24 Jul | 0 | | | | | | 0 | | | | | | | | | Tener 1963 |
| 1973 | 8-15 Apr | 86 | 43 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1973 | 28 Jul-21 Aug | 152 | 101 | | | | | 16 | | | 0.419 | 1.520 | | | | | Miller et al. 1977 |
| 1974 | 10-16 Apr | 91 | 57 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1974 | 18-25 Jul | 114 | 63 | | | | | 6 | | | -0.288 | 0.750 | | | | | Miller et al. 1977 |
| 1986 | 4-13 Jul | 62 | | 7-154 | 62 | | 7-154 | 0 | | | -0.051 | 0.951 | 0.165 | 1.179 | 6 | | Miller 1987b |
| 1997 | 29 Jun-1 Jul | | | | 96 | 42 | | 0 | | | 0.040 | 1.041 | | | 3 | | Gunn and Dragon 2002 |
| **Eglinton** | | | | | | | | | | | | | | | | | |
| 1961 | 24-Jul | 0 | | | | | | *0* | | | | | | | | | Tener 1963 |
| 1972 | 4-Apr | 12 | 10 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1972 | 10-Aug | 4 | 4 | | | | | 7 | | | 0.126 | 1.134 | | | | | Miller et al. 1977 |
| 1973 | 8-Apr | 22 | 14 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1973 | 8-Aug | 26 | 18 | | | | | 14 | | | 1.872 | 6.500 | | | | | Miller et al. 1977 |
| 1974 | Apr | 44 | 18 | | | | | N | | | | | | | | | Miller et al. 1977 |
| 1974 | 25-Jul | 16 | 11 | | | | | 19 | | | -0.486 | 0.615 | | | | | Miller et al. 1977 |
| 1986 | 4-Jul | 101 | | 7-195 | 94 | | 6-181 | 7 | | | 0.154 | 1.166 | 0.185 | 1.203 | | | Miller 1987b |
| 1997 | 2-Jul | | | | 37 | 21 | | 0 | | | -0.085 | 0.919 | | | | | Gunn and Dragon 2002 |
| **Emerald** | | | | | | | | | | | | | | | | | |
| 1961 | 24-Jul | 0 | | | | | | 0 | | | | | | | | | Tener 1963 |
| 1973 | 15-Apr | 0 | | | | | | 0 | | | | | | | | | Miller et al. 1977 |
| 1973 | 30-Jul | 0 | | | | | | 0 | | | | | | | | | Miller et al. 1977 |
| 1974 | 17-Apr | 0 | | | | | | 0 | | | | | | | | | Miller et al. 1977 |
| 1986 | 4-Jul | 0 | | | | | | 0 | | | | | | | | | Miller 1987b |
| 1997 | 19-Jul | 0 | | | | | | 0 | | | | | | | | | Gunn and Dragon 2002 |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Banks Island (Northwest Territories)** | | | | | | | | | | | | | | | | | |
| **Banks** | | | | | | | | | | | | | | | | | |
| 1970 | 23-28 Jun | | | | 1567 | | | | | | | | | | | Northern Banks | Kevan 1974 |
| 1972 | | | | | 3800 | | | | | | 0.443 | 1.557 | | | | | Urquhart 1973 |
| 1980 | Mar 1979-80 | 18328 | 4132 | | N | | | | | | | | | | | Over 2 years | Vincent and Gunn 1981 |
| 1982 | 4-10 Jul | | | | 9393 | 1054 | | | | | | | | | 30 | | Latour 1985 |
| 1982 | 4-10 Jul | | | | 12481 | | 9433-14913 | | | | 0.119 | 1.126 | | | | Retrospective | Nagy et al. 2009a |
| 1985 | 6-14 Jul | | | | 25700 | 2050 | | 12 | | | 0.241 | 1.272 | | | 20 | | McLean et al. 1986 |
| 1989 | 22-28 Jun | | | | 34270 | 2360 | | 13 | | | 0.072 | 1.075 | | | 120 (685) | | McLean and Fraser 1992 |
| 1991 | 27 Jun-3 Jul | | | | 47670 | 3971 | | 15 | | | 0.165 | 1.179 | | | (80) | | Fraser at al. 1992 |
| 1992 | 21-30 Aug | | | | 53526 | 1968 | 49494-57558 | 17 | | | 0.116 | 1.123 | | | 35 | | Nagy et al. 2009b |
| 1994 | | | | | 64680 | 2009 | | | | | 0.095 | 1.099 | | | | | Fig. 6 in Nagy et al. 2006 |
| 1998 | | | | | ~46000 | | | | | | -0.085 | 0.918 | | | | | Fig. 6 in Nagy et al. 2006 |
| 2001 | 7-15 Jul | | | | 68585 | 3452 | 65133-72037 | 15 | | | 0.133 | 1.142 | 0.122 | 1.130 | 31 | | Nagy et al. 2006 |
| 2005 | 24 Jul-1 Aug | | | | 47209 | 1978 | 43212-51206 | 10 | | | -0.093 | 0.911 | | | Not counted | 2004 icing event | Nagy et al. 2009c |
| 2010 | 17-26 Jul | | | | 36676 | | 32645-40707 | 10 | | | -0.050 | 0.951 | -0.07 | 0.933 | | | Davison et al. in prep |
| **Victoria Island (Northwest Territories)** | | | | | | | | | | | | | | | | | |
| **NW Victoria (survey areas didn't always match)** | | | | | | | | | | | | | | | | | |
| 1980 | | | | | 9540 | | | 27 | | | | | | | | | Jakimchuk and Carruthers 1980 |
| 1983 | 8-17 Aug | | | | 6430 | 498 | | 16 | | | -0.132 | 0.877 | | | | | Jingfors 1985 |
| 1989 | 19-31 Aug | | | | 12850 | 1260 | | 10 | | | 0.115 | 1.122 | | | | | Gunn unpubl in Fournier and Gunn 1998 |
| 1992 | 24-26 Mar | 8900 | 820 | | N | | | | | | | | | | | Minto Inlet area north | Heard 1992 |
| 1994 | 5-16 Jun | | | | 19989 | 3786 | | -- | | | 0.088 | 1.092 | 0.053 | 1.054 | | From Fournier and Gunn 1998 | Nishi in Fournier and Gunn 1998 |
| 1998 | early Jul | | | | 18795 | 1393 | 402-20188 | 18 | | | -0.015 | 0.985 | | | 4 | | Nagy et al. 2009d |
| 2001 | 16-21 Jul | | | | 19282 | 1607 | 061-22503 | 11 | | | 0.009 | 1.009 | | | 0 | | Nagy et al. 2009e |
| 2005 | 6-8 Jul | | | | 12062 | 1051 | 906-14218 | 15 | | | -0.117 | 0.889 | | | 0 | | Nagy et al. 2009f |
| 2010 | 28 Jun-15 Aug | | | | 11442 | | 9805-13079 | 1 | | | -0.011 | 0.990 | -0.035 | 0.966 | | 31 calves/2273 adults | Davison et al. in prep |

**Table C. Con't.:** Historical Muskox survey and abundance estimates.

| | | Estimate incl. calves | | | Estimate 1+ year | | | | | | Consecutive surveys | | Range of surveys | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Year | Season | Estimate incl. calves | SE | 95% CI | Estimate 1+ year | SE | 95% CI | % Calves or Not Observed | Off transect sightings or (minimal count) | % Change | Exponential rate of change | Lambda | Exponential rate of change | Lambda | Carcass counts (estimates) | Survey Comments | Reference |
| **Victoria Island (Northwest Territories)** | | | | | | | | | | | | | | | | | |
| **SW Victoria (survey areas didn't always match)** | | | | | | | | | | | | | | | | | |
| 1980 | | | | | 896 | 387 | | | | | | | | | | From Fournier and Gunn 1998 | Jakimchuk and Carruthers 1980 |
| 1983 | | | | | 135 | 51 | | | | | -0.631 | 0.532 | | | | From Fournier and Gunn 1998 | Poole 1985 |
| 1988 | Mar | 1072 | 129 | | | | | | | | | | | | | From Fournier and Gunn 1998 | Gunn in prep |
| 1993 | Mar | 2008 | 356 | | | | | | | | 0.126 | 1.134 | | | | From Fournier and Gunn 1998 | Gunn in prep |
| 1994 | 10-17 Jun | | | | 3934 | 1225 | | | | | | | 0.106 | 1.111 | | From Fournier and Gunn 1998 | Nishi in prep |
| **SE Victoria** | | | | | | | | | | | | | | | | | |
| 1980 | | | | | 1760 | | | 27 | | | | | | | | From Fournier and Gunn 1998 | Jakimchuk and Carruthers 1980 |
| 1983 | 13-19 Mar | 3300 | 345 | | | | | 16 | | | | | | | | | Jingfors 1984 |
| 1988 | 21 Mar-3 Apr | 13031 | 1121 | | | | | N | | | 0.275 | 1.316 | | | | Repeated Jingfors survey area | Gunn and Patterson in prep |
| 1993 | 6-10 Mar | 12563 | 1254 | | | | | N | | | -0.007 | 0.993 | | | | Repeated Jingfors survey area | Gunn and Patterson in prep |
| 1999 | 12-20 Mar | 18290 | 1100 | | | | | N | | | 0.063 | 1.065 | 0.107 | 1.113 | | Repeated Jingfors survey area | Gunn and Patterson in prep |
| **NE Victoria** | | | | | | | | | | | | | | | | | |
| 1990 | 10-17 Aug | | | | 5451 | 521 | | 11 | | | | | | | | | Gunn and Lee 2000 |

## APPENDIX 2:

**Participants in the Peary Caribou & Muskoxen Ground Surveys, 2001-2006**

**Bathurst Island 2001**

Resolute Bay HTA
Norman Idlout
Samson Simeonie
Micheal Pudluk
Ross Pudluk
Steven Nungaq
Clyde Kalluk
Ely Allakarialuk

Department of Sustainable Development
Tabitha Mullin
Seeglook Akeeagok

**Cornwallis Island 2002**

Resolute Bay HTA
Norman Idlout
Hans Aronsen
Ross Pudluk
Saroomie Manik
Enookie Idlout
Joadamee Iqaluk

Department of Sustainable Development
Tabitha Mullin
Seeglook Akeeagok

**West Devon Island 2002**

Resolute Bay HTA
Norman Idlout
Samson Simeonie
Hans Aronsen
Steven Akeeagok (Iviq HTO, Grise Fiord)
Joadamee Iqaluk
Enookie Idlout
Ross Pudluk
Katsak Manik (Replaced Enookie Idlout)
Terrance Nungaq (Replaced Hans Aronsen)

Department of Sustainable Development
Tabitha Mullin
Seeglook Akeeagok

**Prince of Wales Island 2004**

Resolute Bay HTA
Norman Idlout
Sam Idlout
Clyde Kalluk
Steven Nungaq
Jeff Amarualik
Peter Jr Amarualik
Stevie Amarualik
Joadamee Iqaluk

Department of Sustainable Development
Tabitha Mullin

**Participants in the Peary Caribou & Muskoxen Ground Surveys, 2001-2006 Cont'd**

**Somerset Island 2005**

| Resolute Bay HTA | Department of Environment |
|---|---|
| Norman Idlout | Tabitha Mullin |
| Samson Simeonie | |
| Stevie Amarualik | |
| Peter Jr. Amarualik | |

**Southern Ellesmere Island 2005**

| Iviq HTO, Grise Fiord | Department of Environment |
|---|---|
| Aron Qaunaq | Jeffrey Qaunaq |
| David Watsko | |
| Steven Akeeagok | |
| Pauloosie Killiktee | |
| Randy Pijamini | |
| Mosha Kiguktak | |

**Southern Ellesmere Island 2006**

| Iviq HTO, Grise Fiord | Department of Environment |
|---|---|
| Pauloosie Killiktee | Seeglook Akeeagok |
| Benjamin Akeeagok | |
| Randy Pijamini | |
| Jimmy Nungaq | |
| Patrick Audlaluk | |

**Participants in the Peary Caribou & Muskoxen Aerial Surveys, 2001-2008**

**Bathurst Island 2001**

| Resolute Bay HTA | Department of Sustainable Development |
|---|---|
| Matthew Manik | Mike Ferguson |
| Babah Kalluk | Grigor Hope |
| Samson Idlout | |

**Cornwallis Island 2002**

| Resolute Bay HTA | Department of Sustainable Development |
|---|---|
| Joadamee Amagoalik | Mike Ferguson |
| | Grigor Hope |

**West Devon Island 2002**

| Resolute Bay HTA | Department of Sustainable Development |
|---|---|
| Joadamee Amagoalik | Mike Ferguson |
| | Grigor Hope |

**Prince of Wales Island & Somerset Island 2004**

| Resolute Bay HTA | Department of Sustainable Development |
|---|---|
| Martha Allakariallak | Mike Ferguson |
| Mark Amaraulik | Grigor Hope |

**Southern Ellesmere Island 2005**

| Iviq HTO, Grise Fiord | Department of Environment | RCMP |
|---|---|---|
| Lymieky Pijamini | Mitch Campbell | Louis Jenvenne |
| Mosha Kiguktak | Grigor Hope | |
| Jaypeetee Akeeagok | Mike Ferguson | |
| Tom Kiguktak | Seeglook Akeeagok | |
| | Jeffrey Qaunaq | |

**Ellesmere Island 2006**

| Iviq HTO, Grise Fiord | Department of Environment | Parks Canada |
|---|---|---|
| Aron Qaunaq | Mitch Campbell | Gary Mouland |
| | Grigor Hope | Jason Hudson |
| | | Doug Stern |

**Ellef & Amund Ringnes, Lougheed, King Christian, Cornwall & Axel Heiberg Islands 2007**

| Iviq HTO, Grise Fiord | Department of Environment |
|---|---|
| Tom Kiguktak | Debbie Jenkins |
| | Grigor Hope |
| | Mitch Campbell |

**Devon Island 2008**

| Resolute Bay HTA | Department of Environment | Iviq HTO, Grise Fiord |
|---|---|---|
| Jeffrey Amaraulik | Debbie Jenkins | Tom Kiguktak |
| Peter Jr. Amaraulik | Grigor Hope | |
| Tom Kiguktak | | |

**Submission to the Nunavut Wildlife Management Board**

**<u>FOR DECISION</u>**

**Issue**: Request for approval of the proposed final *Management Plan for the Dolphin and Union Caribou in Canada*

**Background:**

- To develop the management plan, Environment and Climate Change Canada (ECCC), Government of the Northwest Territories (GNWT) and Government of Nunavut (GN) held a co-management partners joint meeting in Kugluktuk in March 2015 (Appendix I), and in Cambridge Bay in January 2016 (Appendix II). Additional meetings were held via teleconference in 2015 and 2016 to draft and review specific parts of the plan and to receive additional input on the threats calculator portion of the document.
- ECCC does not have jurisdiction for managing the harvest of Dolphin and Union caribou. Therefore, ECCC will adopt the joint management plan, with the exception of the harvest management portion which will be left to the GN and GNWT for implementation in their respective jurisdiction.
- Community consultations on the draft management plan were conducted in April 2016; it was presented to the Ekaluktutiak and Kugluktuk Hunters and Trappers Organizations (HTOs) and the communities. ECCC, GNWT and GN amalgamated the feedback into a comment table (Appendix III), and reviewed and/or incorporated comments into the draft management plan.
- ECCC emailed the comment table to HTOs on June 6, 2016 to ensure the comments captured in the meetings were correct. ECCC followed up with phone calls HTOs about table comments, but did not receive responses from the HTOs. ECCC, GNWT and GN updated the table to show how comments were reviewed and/or incorporated into the document and send the table back to HTOs.
- The first jurisdictional technical review of the draft recovery document was conducted from June 3 to July 8, 2016. ECCC sent the document to the NWMB on June 3, 2016, while the GN sent the document to the HTOs. ECCC did not receive any responses about the draft, but the GN received comments from the Ekaluktutiak HTO. ECCC,

GNWT and GN worked together to review comments received from other jurisdictions and incorporated them into the recovery document if necessary.

- The second jurisdictional technical review of the proposed management plan was conducted from September 2 to October 7, 2016. ECCC sent the document to the NWMB on September 2, while the GN sent the document to HTOs. ECCC, GNWT and GN worked together to review comments received during this process and incorporated them into the recovery document.
- ECCC posted the proposed document from March 30 to May 29, 2017, on the Species at Risk Public Registry for a 60-day public comment period. ECCC sent the document to the HTOs, NTI and NWMB.
- ECCC sent a questionnaire asking for approval of the proposed document to the Kugluktuk and Ekaluktutiak HTOs, and neither raised objections.
- ECCC, GNWT and GN considered the minor comments received during the 60-day public comment period and revised the document in June and July 2017.

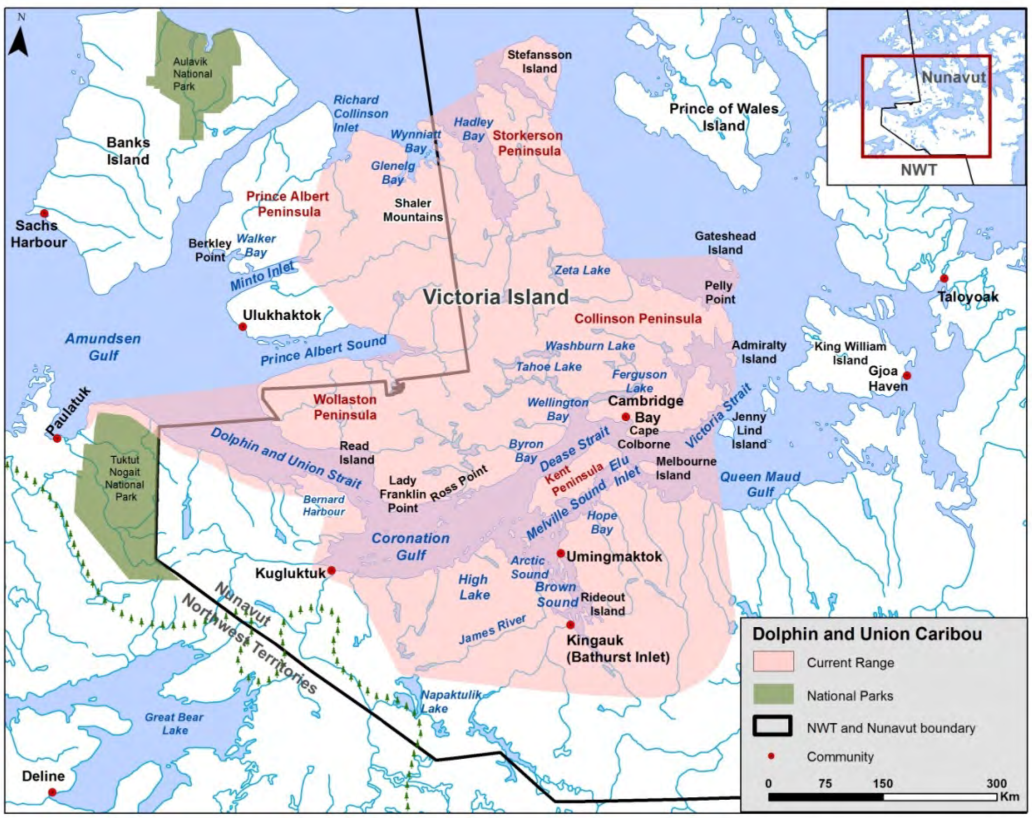


Figure 1. Current range of Dolphin and Union Caribou in NU and NT.

**Next Steps:**

- This briefing is the notification of the results of the consultations and accommodation based on consultation record on the recovery document in Nunavut.
- ECCC is now prepared to post the recovery document on the Species at Risk Public Registry as final.
- ECCC and the GN are providing the recovery document to the NWMB for final approval decision as per the NLCA s. 5.2.34

**Recommendation:**

- That the NWMB considers whether or not they approve the proposed final Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut under the federal Species at Risk Act as per the NLCA s. 5.2.34.


Prepared by:
Dawn Andrews, Species at Risk Biologist
Canadian Wildlife Service
Environment and Climate Change Canada
Yellowknife, NT
Phone: 867-669-4767
June 30, 2017

**SUBMISSION TO THE**

**NUNAVUT WILDLIFE MANAGEMENT BOARD**

**FOR**

**Information:** **Decision: X**

**Issue: Request a decision to approve or not the Dolphin and Union Management Plan titled "Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut".**

## Background

- The Dolphin and Union herd was assessed as a Species of Special Concern by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2004, up-listed under part 4 of Schedule 1 of the federal *Species at Risk Act* in 2011 (SARA) and on the Northwest Territories List of Species at Risk as a species of "special concern" in 2014.
- With the recent assessment by COSEWIC, threats facing Dolphin and Union classified them as high-very high (based on- IUCN-CMP unified threats classifications system), which put a strong emphasis to increase the monitoring effort on the Dolphin and Union herd and the much needed development of a management plan for the herd.
- Dumond and Lee (2007) estimated the extrapolated population of Dolphin and Union caribou at 27,787 ± 7,537 (95% CI), and the same analysis was applied to the 1997 estimates resulting in a revised extrapolated estimate of 34,558 ± 6,801 (95% CI) caribou.
- The 2015 extrapolated population of Dolphin and Union Caribou was estimated at 18,413 ± 6,795 caribou (95% CI). This estimate shows signs of decline relative to the 2007 survey estimates (z-test, Z=-2.19, p=0.036).There has been an overall decline of 33.8%, or 5% annually since 1997.
- Environment and Climate Change Canada (ECCC) must produce a federal management plan for the Dolphin and Union caribou under the federal Species At Risk Act.
- The Government of Northwest Territories (GNWT) is also required to develop a management plan under its Territorial Species at Risk Act.
- Since 2015, the Government of Nunavut, Department of Environment (GN-DOE), has committed to taking part in the development of the Dolphin and Union Management Plan. GN-DOE has participated actively and provided technical information and expertise into the management plan development process.

- The Dolphin and Union Management Plan was drafted based on the input received from the co-management partners (HTOs, NTI, KRWB) during the first and second joint meetings, draft consultation, and two jurisdictions reviews to accommodate their comments.
- The Dolphin and Union Management Plan was developed upon a community-based management approach in consultation with all the communities that harvest from this caribou herds. There were two rounds of community and public engagements, consultations at different phase of the management plan development to assure active community participation and accommodation.

## Current Status

- The Government of Nunavut's Department of Environment (DOE) has been working with communities, HTOs, KRWO, NTI and interjurisdictional co-management partners (Environment Canada, and Government of Northwest Territories) to develop a joint management plan for Dolphin and Union caribou herd. The first engagement teleconference call happened on February 18, 2015
- ECCC does not have jurisdiction for managing the harvest of Dolphin and Union caribou in Nunavut. Therefore, the Government of Nunavut and the Government of NWT were responsible to develop the harvest management portion of the Dolphin and Union management plan and its submission to NWMB for approval.
- The harvest management recommendations are based on the population size (high, increasing, declining, and low), as well as taking in consideration other indicators such as recruitment, pregnancy rate, sex ratio.
- This harvest management is based on the population cycle, which recognized the Dolphin and Union herd being a small herd with an historic high agreed at 40,000 animals and where Inuit harvest restrictions might be considered when the herd falls to 20% of the high, below 8,000 animals.
- The Kugluktuk and Cambridge Bay HTO has already imposed voluntary management actions following discussion happen during the Management Plan consultation process:
    - Kugluktuk has a motion to suspend all caribou commercial and sport hunts.
    - Cambridge Bay HTO is reducing the number of tag allocating to sport hunt.
    - There is no commercial harvest of Dolphin and Union caribou herd in Nunavut.
    - Increase in educational and public awareness on the Dolphin and Union programs (HTOs and GN).
- The Department has engaged with and continues to work closely with the affected communities and respective co-management partners (NTI, HTOs, KRWB) and GNWT on management actions needed and to monitor the Dolphin and Union caribou herd.

**Consultations:**

Face-to-face:

- February 18, 2015: Introductory meeting in Yellowknife and phone. Participants: Kugluktuk HTO, Umingmaktok HTO, Ekaluktutiak HTO, Gjoa Haven HTO, KRWB, NTI, ECCC and GN.
- March 25-27, 2015: First Joint Meeting in Kugluktuk (NU). Participants: Kugluktuk HTO, Ekaluktutiak HTO, KRWB, NTI, KIA, ECCC, and GN. (See Appendix I)
- October 26, 2015: Framework Review Teleconference. Participants: Burnside HTO, Ekaluktutiak HTO, KRWB, NTI, KIA, NWMB, ECCC, and GN
- January 11-13, 2016: Second Joint Meeting in Cambridge Bay (NU). Participants: Kugluktuk HTO, Burnside HTO, Ekaluktutiak HTO, KRWB, NTI, ECCC, and GN. (See Appendix II)
- February 8, 2016: Threat Calculator Exercise Teleconference. Participants: Ekaluktutiak HTO, KRWB, ECCC and GN.
- April 19, 2016: Draft Consultation with the Ekaluktutiak HTO and Community of Cambridge Bay. Participants: Ekaluktutiak HTO, Burnside HTO, ECCC and GN.
- April 28, 2016: Draft Consultation with the Kugluktuk HTO and Community of Kugluktuk. Participants: Kugluktuk HTO, ECCC and GN.

Written:

- June 3, 2016: First jurisdictional technical review. Send the management plan to all HTOs
- September 2, 2016: Second jurisdictional technical review. Send the management plan to all HTOs.
- March 30 to May 29, 2017: 60-day public comment period. Send the management plan to all HTOs, NTI, NWMB.

**Accommodations:**

- After each round of consultation on the draft management plan, a comment table was developed in a transparent approach to highlight how each comment from the co-management partners was addressed and the following responses in the management plan.

## Recommendation

- GN-DOE request decision to support or not the Dolphin and Union management plan and its recommendations for the Dolphin and Union caribou herds.

# Proposed final Management Plan for Dolphin and Union Caribou

"Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut".


Government of Northwest Territories

0780

ᓄᓇᕗᑦ Nunavut

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

September 2017

# Dolphin and Union Caribou Management – A Shared Responsibility

- Many groups share responsibilities to manage Dolphin and Union caribou
  - Nunavut Land Claim Agreement & Inuvialuit Final Agreement
  - Inuit and Inuvialuit organizations
  - Governments of Nunavut, NWT & Canada
  - Species at risk legislation – federal and NWT

**Joint management planning**

- A common vision & approach to managing this shared population
- Reinforce management similarity between groups
- Increase coordination & cooperation
- Avoid duplication of effort


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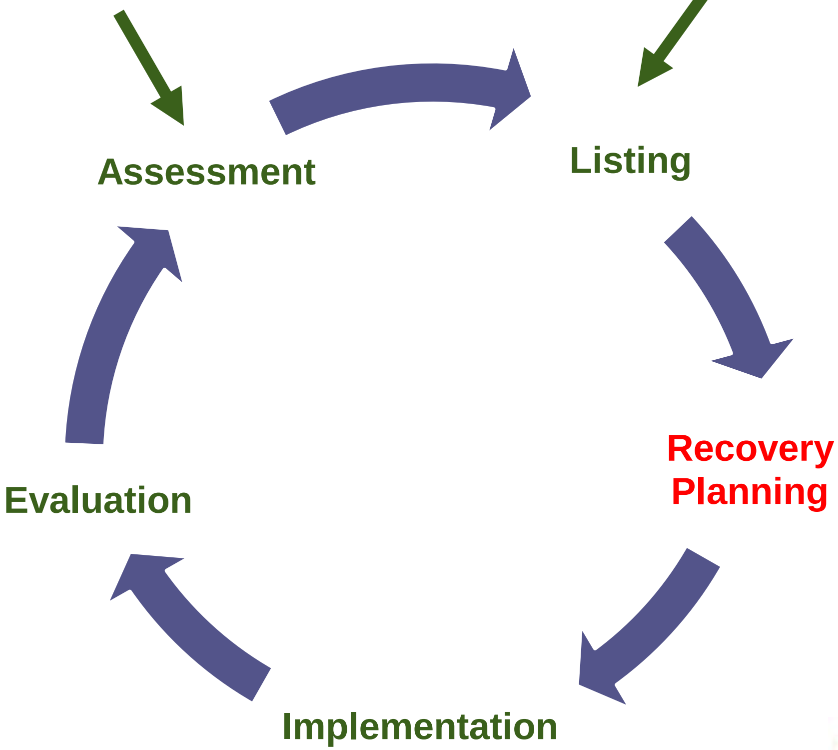
# Species at Risk Processes for Canada – Dolphin and Union Caribou

*COSEWIC assessed as Special Concern (2004)*

*Listed as Special Concern under SARA (2011)*




<u>Species of special concern</u> is a wildlife species that could become threatened or endangered because of a combination of biological characteristics and identified threats.

# Requirements for Dolphin and Union Caribou Management Plan in different Jurisdictions

- Environment and Climate Change Canada (ECCC) must produce a management plan under the federal Species At Risk Act.
- In cooperation with the Government of Nunavut and the Government of Northwest Territories, all three jurisdictions worked together towards creating a management plan for Dolphin and Union caribou
- ECCC does not have jurisdiction for managing the harvest of Dolphin and Union caribou. Therefore, ECCC will adopt the joint management plan, with the exception of the harvest management portion (section 6) which will be left to the Governments of Nunavut and NWT for implementation.
- Government of the NWT and the Wildlife Management Advisory Council (NWT) will develop an agreement on accepting the plan
- NWMB should review the management plan for decision to approve or not the management plan.

# Dolphin & Union Caribou – Description

- Best identified using a combination of characteristics
    - Short muzzles with short, wide hooves, but slightly narrower than Peary caribou
    - Characteristic pelage of Peary caribou, but slightly darker
    - Larger and thicker antlers than Peary caribou
    - Grey antler velvet
- Migrate in the fall and spring between Victoria Island and the mainland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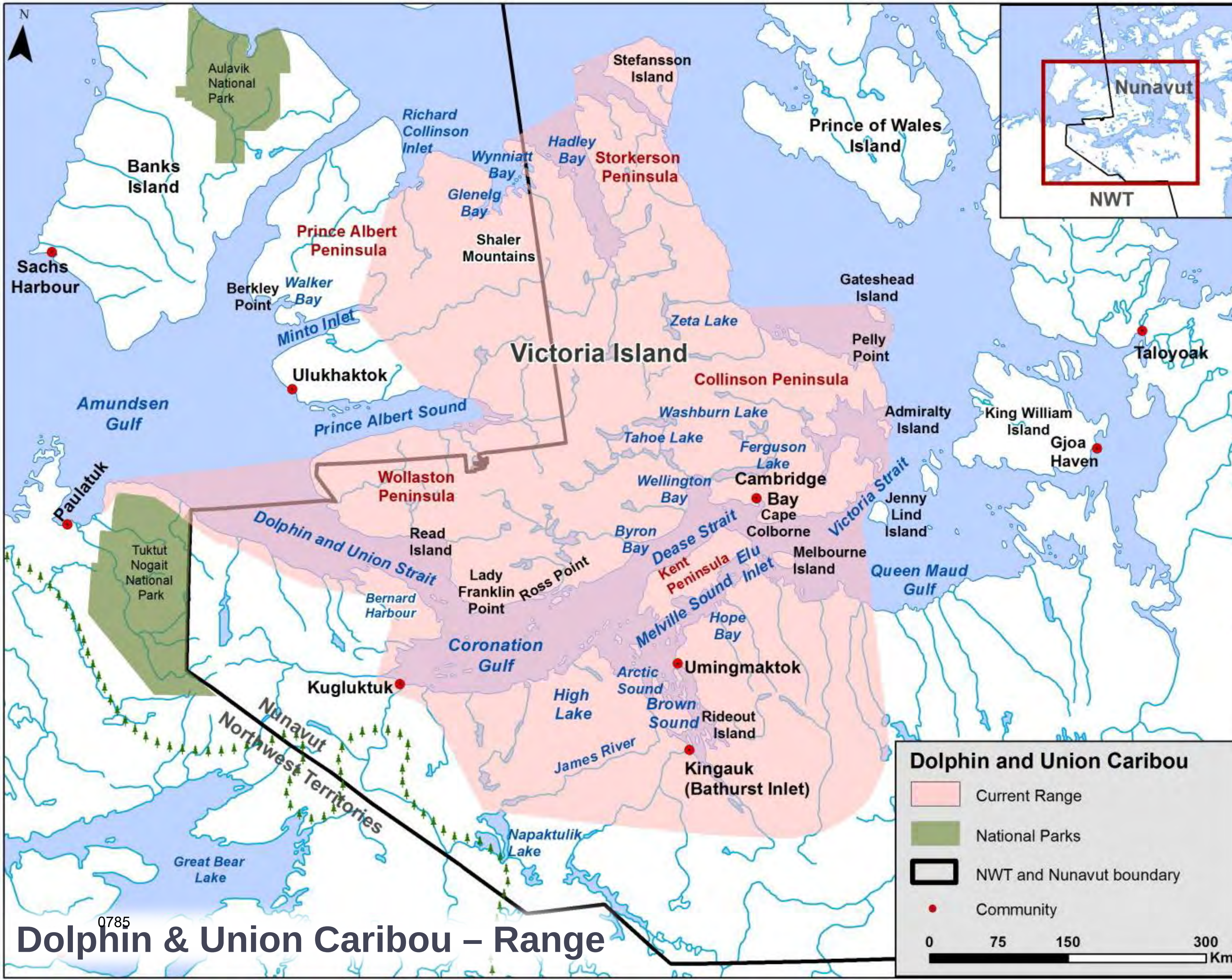


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# Dolphin & Union Caribou – Range

# Population Sizes and Trends

- Some community members need to travel farther now to harvest caribou, and recent research indicates a decline in the population
- First population estimate in 1997 of 34,558 ± 6,801 caribou, and the second estimate in 2007 of 27,787 ± 7,537 caribou.
- 2015 assessment: estimate of 18,413 ± 6,795 caribou, which inform of a declining trend in the population.

# Dolphin and Union Caribou – Threats in Canada

- Overall threat impact for Dolphin and Union caribou is **Very High – High**

| THREAT | IMPACT |
|---|---|
| **Marine traffic** | **High** |
| Competition and Predation | High - Low |
| Harvest | Medium - Low |
| Parasites, Diseases & Insect harassment | Medium - Low |
| Climate Change | Medium - Low |
| Resource extraction | Low |
| Roads and Railroads; Flight Paths | Low |
| *Human Disturbance; Residential and Commercial Development; Utility and Service Lines* | *Negligible* |
| *Interbreeding* | *Unknown* |
| *Oil and Gas Drilling; War, Civil Unrest and Military Exercises; Garbage and Solid Waste* | *Impact not calculated* |

0787

# Threats in Canada

- <u>Year-round marine traffic</u> could prevent spring and fall migrations, delay crossings, or increase the risk of drowning

- <u>Climate change</u>
  - Sea ice loss can cause caribou drowning or dying soon after emerging from water, increase staging time, or prevent movement across ice.
  - Vegetation may change, and icing events may increase.

- <u>Predation and competition</u>
  - Wolves are the main predator.  Grizzly bears may have a limited impact on caribou.
  - Either avoid or share habitat with muskoxen depending on the area.
  - Overabundant geese could destroy caribou habitat.

- <u>Harvesting</u> is occurring; however the levels are currently unknown and reporting is not mandatory but on a voluntary basis.

# Threats in Canada

- Diseases could be spread through contact with muskoxen and other caribou, while climate change is causing new/more insects/parasites in the Arctic and increased insect harassment to caribou

- Scheduled flights could disturb caribou and Extraction projects and Roads could impact migration routes and winter feeding grounds

- Timing and flight height of unscheduled flights are a concern, particularly over calving grounds

- Unclear what impact interbreeding with other caribou species will have on Dolphin and Union caribou

0789

# Management Goal

Recognizing the ecological, cultural and economic importance of Dolphin and Union Caribou, the goal of this management plan is to maintain the long term persistence of a healthy and viable Dolphin and Union Caribou population that moves freely across its current range and provides sustainable harvest opportunities for current and future generations.


0790

# Management Objectives & Approaches

There are five management objectives:

1. Adaptively co-manage Dolphin and Union (DU) Caribou using a community-based approach.
2. Communicate and exchange information on an ongoing basis between parties to ensure a collaborative and coordinated approach.
3. Collect information to fill knowledge gaps on DU Caribou using IQ and TK, community monitoring, and scientific methods.
4. Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.
5. Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.

0791

# *Section 6.6 Managing Based on Population Level*

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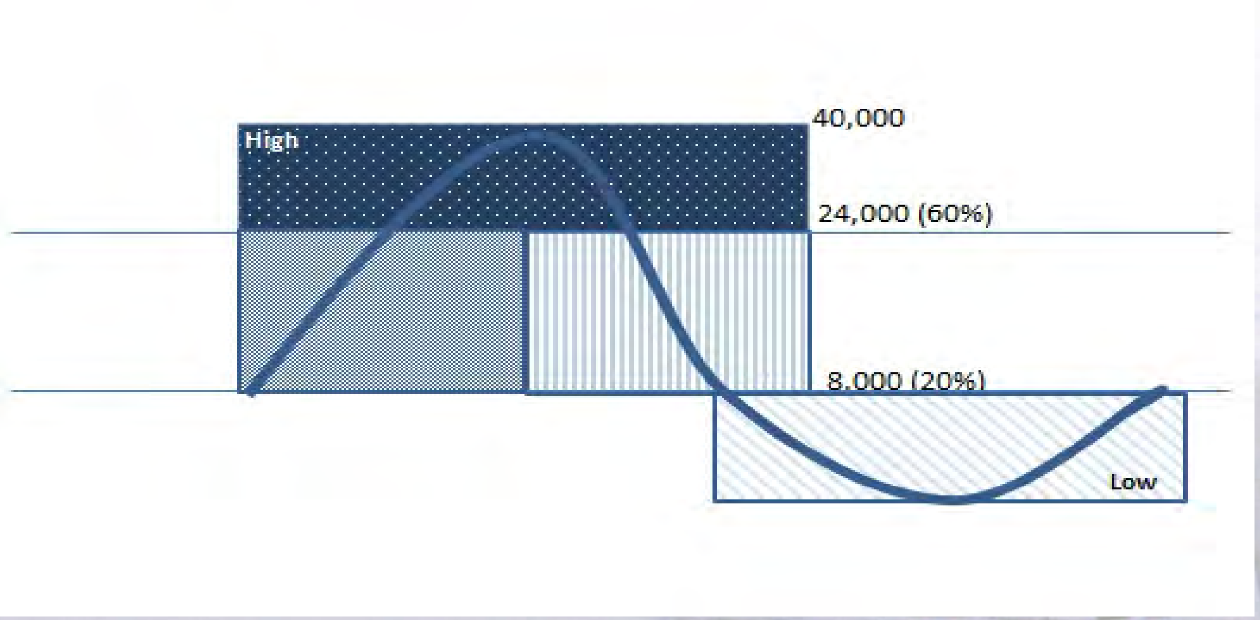
# Management Actions Based on Population Level

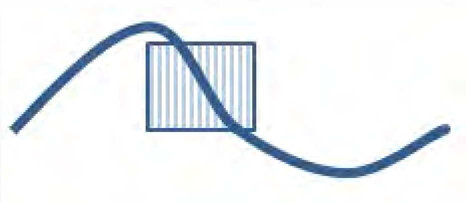
- For each phase of the Dolphin-Union caribou population cycle, the management plan recommends certain actions, including harvest management, to reflect the conservation issues.

**Population Size**




- Other indicators such as climate change, recruitment, and changes to distribution, will also be considered

# Management Action Examples

| | |
|---|---|
| High  | • Educate harvesters and youth on how to harvest respectfully.<br>• No harvest restrictions on beneficiaries.<br>• Support reporting of harvest and community-based monitoring programs.<br>• Working group of stakeholders meets. |
| Decreasing  | • Educate and integrate information into the school system (ex. importance of using the whole caribou).<br>• Increase research and monitoring; have sample kits to monitor harvest.<br>• The working group of stakeholders should meet more frequently. |
| Low  | • Educate people on the new restriction and management in place.<br>• Consider establishing effective mandatory mechanisms to reduce overall harvest.<br>• Support reporting of harvest and community-based monitoring program. |
| Increasing  | • Easing of harvest restrictions and consider implementing non-quota limitation.<br>• Encourage research on predators and ease management of predators.<br>• Maintain industry restrictions.<br>• Working group of stakeholders meets. |

# Consultation Process

| Date | | Meeting<br>*Meeting Lead Organization* | Attendance by Nunavut Organizations |
|---|---|---|---|
| 2014 | December 8 | **Threat Calculator Exercise - Teleconference**<br>*ECCC* | **Kugluktuk HTA, KRWB, GN**<br>*(also invited: Ekaluktutiak HTA, Burnside HTA, NTI, NWMB)* |
| 2015 | February 18 | **Introductory Meeting – Yellowknife, NT and Phone**<br>*ECCC* | **Kugluktuk HTA, Umingmaktok HTA, Ekaluktutiak HTA, Gjoa Haven HTA, KRWB, NTI, GN** |
| | March 25-27 | **First Joint Meeting – Kugluktuk, NU**<br>*GN, GNWT, ECCC* | **Kugluktuk HTA, Ekaluktutiak HTA, KRWB, NTI, KIA, GN**<br>*(also invited: NWMB)* |
| | October 26 | **Framework Review – Teleconference**<br>*GN, GNWT* | **Burnside HTA, Ekaluktutiak HTA, KRWB, NTI, KIA, NWMB, GN** |

0795

# Consultation Process

| | Date | Meeting<br>*Meeting Lead Organization* | Attendance by Nunavut Organizations |
|---|---|---|---|
| **2016** | January 11-13 | **Second Joint Meeting – Cambridge Bay, NU**<br>*GN, GNWT, ECCC* | **Kugluktuk HTA, Burnside HTA, Ekaluktutiak HTA, NTI, KRWB, GN**<br>*(also invited: Omingmaktok HTA, NWMB)* |
| | February 8 | **Threat Calculator Exercise – Teleconference**<br>*ECCC* | **Ekaluktutiak HTA, KRWB, GN**<br>*(also invited: Kugluktuk HTA, Omingmaktok HTA, Burnside HTA, NTI, KIA, NWMB)* |
| | April 19 | **Draft Consultation with the Ekaluktutiak HTA and Community of Cambridge Bay, NU**<br>*GN, ECCC* | **Ekaluktutiak HTA, Burnside HTA, GN** |
| | April 28 | **Draft Consultation with the Kugluktuk HTA and Community of Kugluktuk, NU**<br>*GN, ECCC* | **Kugluktuk HTA, GN** |

0796

# Consultation Process/Results

- Community consultations were conducted in April 2016
  - Incorporated feedback into draft management plan
  - The meeting comment table (Appendix III) was updated to show how comments were reviewed and/or incorporated into the document and returned to the HTOs.

- ECCC sent the draft document to the NWMB on **June 3, 2016** for the first jurisdictional technical review. GN sent the document to the HTOs.

- ECCC sent the proposed document to the NWMB on **September 2, 2016** for the second jurisdictional technical review. GN sent the document to the HTOs.

- ECCC posted the proposed document from **March 30 to May 29, 2017**, on the public registry for a 60-day public comment period. ECCC sent the document to the HTOs, NTI and NWMB.

- ECCC sent a questionnaire asking for approval of the proposed document to the Kugluktuk and Ekaluktutiak HTOs, and neither raised objections.

0797

# Changes to the Management Plan

- Many comments received from the reviews were minor edits and suggestions to re-organize information within the plan
- Some of the major changes to the plan include:
  - Information about the 2015 population estimate was added.
  - An additional knowledge gap was added: Potential impact of future development on Dolphin and Union caribou. The Knowledge gaps were prioritized.
  - A ‘Threats and/or knowledge gaps addressed’ column was added on the ‘Approaches to Management’ table to link back to the initial reason for concern and how concerns are addressing.
  - A new section was added, ‘Measuring Progress’, to define and measure progress toward achieving the management goal.
- A summary of the changes to each section of the plan was provided to NWMB in a separate document

# The Government of Nunavut and ECCC request of the Board

GN-DoE and ECCC request decision to approve or not the proposed final Dolphin and Union Caribou Management Plan
(as per the Nunavut Land Claims Agreement s.5.2.34)

Government of Canada    Gouvernement du Canada

# Management Plan for the Barren-ground Caribou (Rangifer tarandus groenlandicus), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (Rangifer tarandus groenlandicus x pearyi) in the Northwest Territories and Nunavut.

Environment and Climate Change Canada (ECCC) does not have jurisdiction for managing the harvest of Dolphin and Union Caribou. Therefore, ECCC will adopt the joint management plan, with the exception of the harvest management portion (section 6.6), which will be left to the Governments of Nunavut and NWT for implementation.

The Government of Nunavut, the Department of Environment, will adopt this joint management plan in totality and seek additional approval for the implementation of the harvest management portion of the plan (section 6.6), in the Territory of Nunavut.

Government of Canada Gouvernement du Canada

# PROPOSED FINAL MANAGEMENT PLAN FOR DOLPHIN AND UNION CARIBOU


## Summary

This is a summary of the information provided in the recovery document Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut. The common name used in the management plan is Dolphin and Union Caribou. Under the federal *Species at Risk Act*, Dolphin and Union Caribou was listed as Special Concern in 2011.


*© Kim Poole*

The management plan is a document that sets the goals and objectives for maintaining sustainable population levels for Dolphin and Union Caribou. This plan is intended to provide guidance and direction to the co-management partners to help them with their decision-making for Dolphin and Union Caribou management.

This summary is based on the information in the full English version of the Dolphin and Union Caribou management plan. The original English copy of the management plan has been provided for reference.

## Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Assessment and Species Status Information

These pages provide the COSEWIC assessment table which is included here. It describes why COSEWIC has assessed Dolphin and Union Caribou.

**Date of Assessment:** May 2004

**Common Name (population):** Barren-ground caribou (Dolphin and Union population)

**Scientific Name:** *Rangifer tarandus groenlandicus*

**COSEWIC Status:** Special Concern

**Reason for Designation:** This population of caribou is endemic to Canada. Once thought to be extinct, numbers have recovered to perhaps a quarter of the population historic size. They have not been censused since 1997 and are subject to a high rate of harvest, whose sustainability is questioned by some. They migrate between the mainland and Victoria Island and climate warming or increased shipping may make the ice crossing more dangerous. The population, however, increased substantially over the last three generations and was estimated at about 28000 in 1997.

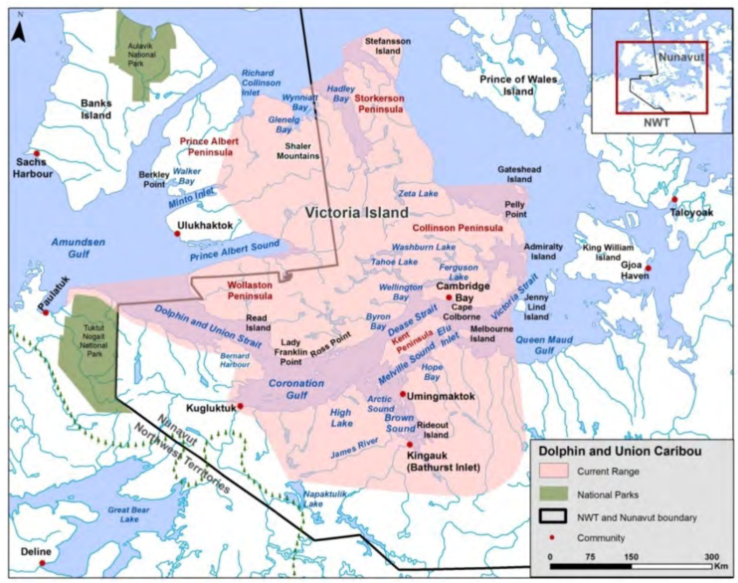
**Occurrence:** Northwest Territories, Nunavut

**COSEWIC Status History:** The original designation considered a single unit that included Peary Caribou, *Rangifer tarandus pearyi*, and what is now known as the Dolphin and Union Caribou, *Rangifer tarandus groenlandicus*. It was assigned a status of Threatened in April 1979. Split to allow designation of three separate populations in 1991: Banks Island (Endangered), High Arctic (Endangered) and Low Arctic (Threatened) populations. In May 2004 all three population designations were de-activated, and the Peary Caribou, *Rangifer tarandus pearyi*, was assessed separately from the Dolphin and Union Caribou, *Rangifer tarandus groenlandicus*. The Dolphin and Union Caribou is comprised of a portion of the former "Low Arctic population", and it was designated Special Concern in May 2004.

This section also provides information on the status of the species throughout Canada, how it is protected in the Provinces and Territories and what rank of protection it has, and other types of protection that are provided to the species.

## Information about Dolphin and Union Caribou

This section of the draft recovery document for Dolphin and Union Caribou provides some information such as what they look like, where they live, and what they need to survive.




This is Figure 4 from the draft recovery document. It shows the current range of Dolphin and Union Caribou in NU and NT. They migrate in the fall and spring between the mainland and Victoria Island. These migrations make seasonal connectivity of sea ice a key habitat requirement.

- Dolphin and Union Caribou look and behave differently from other Barren-ground Caribou populations and from Peary Caribou.
- Dolphin and Union Caribou have short muzzles and short, wide hooves that are slightly

narrower than Peary Caribou. Their coat pattern is similar to Peary Caribou but slightly darker, and their antlers are larger and thicker than Peary Caribou.

- This species play an essential role in the lives of the Inuit and Inuvialuit people. They are highly valued from a spiritual, economic, cultural and subsistence harvest perspective.
- Dolphin and Union Caribou are harvested by the communities of Kugluktuk, Umingmaktok, Bathurst Inlet and Paulatuk during the winter, Ulukhaktok in the summer/fall, and Cambridge Bay in both seasons.
- In spring, this species begin moving northward to the coast for their migration to Victoria Island and ancillary islands.
- In summer, Dolphin and Union Caribou spread out across the island to give birth alone or in small groups. They do not gather in large groups to calve or use distinct calving grounds as is common in other Barren-ground Caribou.
- In fall, they migrate to the southern part of Victoria Island to cross the sea ice to their winter range on the mainland.
- In 2015, population estimate was 18,413 ± 6,795. The population trend is not certain due to lack of information and monitoring.
- *Inuit Qaujimajatuqangit* and local knowledge collected in the community of Ikaluktutiak (Cambridge Bay) on Victoria Island, NU, reported a Dolphin and Union Caribou decline in their area.

## Threats to Dolphin and Union Caribou

This section of the draft recovery document describes the things that might cause the Dolphin and Union Caribou population to drop. The primary threat to Dolphin and Union Caribou is a reduction in sea ice connectivity that results both from shipping or ice-breaking activities, and from sea ice loss due to climate change. A decrease in sea ice connectivity limits their range access, in particular access to migratory routes. It also increases the risk of caribou drowning. The main threats are:

- **Shipping Lanes** – Marine traffic & Ice breaking. An increase in shipping traffic when sea ice is forming or during the ice season poses a grave threat to Dolphin and Union Caribou by preventing or delaying crossings, or increasing the risk of drowning. The threat is aggravate by an extended shipping season (due to a shorter sea ice season) that allows more access through the straits for marine traffic (*e.g.* Northwest Passage).
- **Sea ice loss due to climate change** – Thinner and/or unstable ice cannot support the weight of caribou during their migration. Warming temperatures in the Arctic are causing ice freeze-up to take place later in the fall, and spring thaw to take place earlier in the season. Although caribou can swim, they are unlikely to cross distances longer than a few kilometers and sometimes cannot pull themselves out of the water or die soon after emerging from water.

- **Cumulative impacts of changes to sea ice** – Given their migration patterns, seasonal connectivity of the sea ice between Victoria Island and the mainland is essential to Dolphin and Union Caribou. The combination of marine traffic and climate change can affect ice formation to the point where this species may not be able to migrate.
- **Predation and Competition** – Increased number of wolves and grizzly bears are a threat to Dolphin and Union Caribou. Interactions with muskoxen and overabundant geese may also be a threat.
- **Harvest** – Levels are currently unknown and reporting is not mandatory for subsistence harvest. Harvest can have a greater impact on the population trend when it is declining.
- **Parasites, diseases and insect harassment** – Diseases could be spread through contact with muskoxen and other caribou, while climate change is causing new/more insects/parasites in the Arctic and increased insect harassment to caribou.
- **Other impacts of climate change** – Climate change may cause vegetation changes. Also, events such as freeze-thaw, freezing rain, snowfall may increase and reduce access to forage.

Climate change is an underlying driver of many of these threats. Mining, roads and flights also present threats to Dolphin and Union Caribou.

## Management Goal and Objectives

The goal of this management plan is to maintain the long term persistence of a healthy and viable Dolphin and Union Caribou population that moves freely across its current range and provides sustainable harvest opportunities for current and future generations.

Achieving the management goal would allow for a population level sufficient to sustain traditional Indigenous harvesting activities, and one that is consistent with land claim agreements and existing treaty rights of the Indigenous Peoples of Canada.

In order to attain this goal, five objectives were established:

**Objective 1** – Adaptively co-manage Dolphin and Union Caribou using a community-based approach.

**Objective 2** – Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.

**Objective 3** – Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.

**Objective 4** – Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.

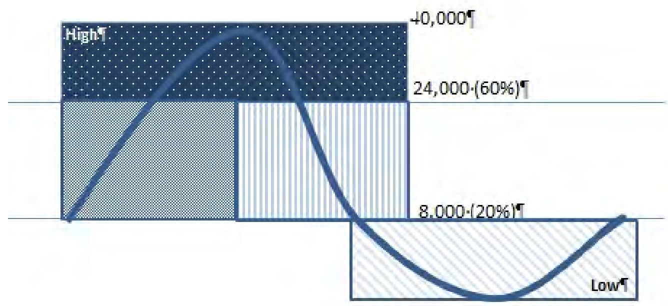
**Objective 5** – Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.

These objectives and their corresponding approaches apply broadly across the population's range in both Northwest Territories and Nunavut. More details can be found in the recovery document.

## Managing Based on Population Level

This management plan also recommends a framework describing how management actions should be adapted at different phases in the Dolphin and Union Caribou cycle, according to when the population is increasing, high, decreasing or low. For each population level, the management actions recommended was based on intensive round of consultation with the communities and co-management partners.

Population Level:




Dolphin and Union Caribou cycles: Determining the location of the Dolphin and Union Caribou population within its cycle.

Such management examples include:

| | |
|---|---|
| High  | • Educate harvesters and youth on how to harvest respectfully.<br>• No harvest restrictions on beneficiaries.<br>• Support reporting of harvest and community-based monitoring programs.<br>• Working group of stakeholders meets. |
| Decreasing  | • Educate and integrate information into the school system (ex. importance of using the whole caribou).<br>• Increase research and monitoring; have sample kits to monitor harvest.<br>• The working group of stakeholders should meet more frequently. |
| Low  | • Educate people on the new restriction and management in place.<br>• Consider establishing effective mandatory mechanisms to reduce overall harvest.<br>• Support reporting of harvest and community-based monitoring program. |
| Increasing  | • Easing of harvest restrictions and consider implementing non-quota limitation.<br>• Encourage research on predators and ease management of predators.<br>• Maintain industry restrictions.<br>• Working group of stakeholders meets. |

PROPOSED FINAL

***Species at Risk Act***
Management Plan Series
Adopted under Section 69 of SARA

# Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada:

## Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut

Barren-ground Caribou, Dolphin and Union population

2017

Government of Canada Gouvernement du Canada

0806

Canada

**Recommended citation:**

| |
|---|
| Environment and Climate Change Canada. 2017. Management Plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, in Canada: Adoption of the Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut [Proposed Final]. *Species at Risk Act* Management Plan Series. Environment and Climate Change Canada, Ottawa. 2 parts, 3 pp. + 102 pp. |

For copies of the management plan or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

**Cover photo:** © Kim Poole

Également disponible en français sous le titre
«Plan de gestion du caribou de la toundra (*Rangifer tarandus groenlandicus*) population Dolphin-et-Union au Canada : adoption du plan de gestion du caribou de Dolphin-et-Union (*Rangifer tarandus groenlandicus x pearyi*) dans les Territoires du Nord-Ouest et au Nunavut [Version finale proposée] »


ISBN
Catalogue no.

[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

# MANAGEMENT PLAN FOR THE BARREN-GROUND CARIBOU (*Rangifer tarandus groenlandicus*), DOLPHIN AND UNION POPULATION, IN CANADA

2017

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut* was prepared jointly by the Government of Nunavut and the Government of the Northwest Territories, in cooperation with the Government of Canada and co-management partners. The Government of Canada adopts this management plan (Part 2) under section 69 of the *Species at Risk Act* (SARA)*.* Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for a management plan.

The federal management plan for the Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population[2], in Canada consists of two parts:

Part 1 – Federal Addition to the *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut***,** prepared by Environment and Climate Change Canada.

Part 2 – *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut [Proposed Final Management Plan for Approval]***,** prepared by the Government of the Northwest Territories – Department of Environment and Natural Resources and the Government of Nunavut – Department of Environment, in cooperation with the Government of Canada – Environment and Climate Change Canada.

[2] At the time of document publication, the species is listed on Schedule 1 of the *Species at Risk Act* as Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population. It is currently referred to as the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus*) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011) and is referred to as the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) by the Northwest Territories. All three names refer to the same population.

# Table of Contents

# Part 1 – Federal Addition to the *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut*, prepared by Environment and Climate Change Canada

# Preface

The federal, provincial, and territorial government signatories under the National Accord for the Protection of Species at Risk (1996)[3] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Barren-ground Caribou, Dolphin and Union population, and has prepared the federal component of this management plan (Part 1), as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the Government of the Northwest Territories, the Government of Nunavut, the Wildlife Management Advisory Council (NWT), and the Nunavut Wildlife Management Board, as per section 66(1) of SARA. SARA section 69 allows the Minister to adopt all or part of an existing plan for the species if the Minister is of the opinion that an existing plan relating to wildlife species includes adequate measures for the conservation of the species. The Government of Nunavut, Government of the Northwest Territories and Government of Canada provided the attached management plan for the Dolphin and Union population of Barren-ground Caribou (Part 2) as a guide to the jurisdictions responsible for managing the species in the Northwest Territories and Nunavut. The management plan was prepared in cooperation with communities, hunters and trappers organizations/ committees, wildlife management boards, territorial governments, federal departments and organizations within the range of Barren-ground Caribou, Dolphin and Union population.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of Barren-ground Caribou, Dolphin and Union population, and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[3] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

# Additions and Modifications to the Adopted Document

This section has been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut* (Part 2 of this document) and/or to provide updated or additional information.

Under SARA, prohibitions regarding the protection of species and their habitat do not apply to species of special concern. Conservation measures in the territorial management plan dealing with the protection of individuals and their habitat are still adopted to guide conservation efforts but would not result in federal legal protection.

The competent Ministers are not adopting section 6.6 “Managing Based on Population Status (Level)”. The implementation of the management approaches for harvest is under the jurisdiction of the territorial governments and co-management boards.

**Part 2 – *Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut [Proposed Final Management Plan for Approval]*, prepared by the Government of the Northwest Territories – Department of Environment and Natural Resources, the Government of Nunavut – Department of Environment, in cooperation with the Government of Canada – Environment and Climate Change Canada**

# Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut

## Proposed Final Management Plan for Approval

## July 2017

REMOVE before finalizing

This draft management plan was prepared jointly by the Government of Nunavut (GN) and the Government of the Northwest Territories (GNWT), in cooperation with the Government of Canada and co-management partners.

The GNWT, WMAC (NWT), GN and NWMB (NU) are asked to consider accepting this plan. In the final version of the management plan, it is anticipated that the NWT and Nunavut partners will add their logos here once this document is finalized and approved.

Once the Plan is complete it is expected that the plan will be accepted, maybe with some amendments, under the *Species at Risk (NWT) Act* and the federal *Species at Risk Act.*

Copies of the management plan are available at *www.nwtspeciesatrisk.ca* and *www.gov.nu.ca/environment*

**This document is a draft and should not be cited without permission from the Government of Nunavut and Government of Northwest Territories.**



ISBN to come.

This management plan recognizes and respects the intellectual property rights of the *Inuit Qaujimajatuqangit* holders, traditional knowledge holders, elders, hunters and others who shared their knowledge to develop this document. The information shared by individuals at joint planning workshops and at hunters and trappers committee /organization meetings cannot be referenced in other documents without the expressed permission of the individual, hunters and trappers committee /organization or other organization that provided the information.  This applies to comments cited from: Ulukhaktok Traditional Knowledge interviews 2011-2013; Tuktoyaktuk Community Meeting 2014; First Joint Meeting 2015; Second Joint Meeting 2016; Ekaluktutiak Hunters and Trappers Organization 2016; Kugluktuk Hunters and Trappers Organization 2016; Paulatuk Hunters and Trappers Committee 2016; and Olohaktomiut Hunters and Trappers Committee 2016.

**Cover photo**:   Dolphin and Union Caribou at High Lake, Nunavut, April 2008. Credit: K. Poole.

# PREFACE

The *Management Plan for the Dolphin and Union Caribou (Rangifer tarandus groenlandicus x pearyi) in the Northwest Territories and Nunavut* describes the management goals and objectives for Dolphin and Union Caribou and recommends approaches to achieve those objectives.

This plan was developed to meet the requirements for a Northwest Territories management plan under the territorial *Species at Risk (NWT) Act* as well as a national management plan under the federal *Species at Risk Act*, and to meet management needs in Nunavut. Development of the management plan respected co-management processes legislated by the *Inuvialuit Final Agreement* and the *Nunavut Land Claims Agreement*.

The management plan was prepared jointly by the Government of Nunavut and the Government of the Northwest Territories, in cooperation with the Government of Canada and co-management partners. Co-management partners involved in this process include: the Nunavut Wildlife Management Board, Kitikmeot Regional Wildlife Board, Nunavut Tunngavik Inc., Kitikmeot Inuit Association, Kugluktuk Hunters and Trappers Organization (HTO), Ekaluktutiak HTO, Omingmaktok HTO, Burnside HTO, Wildlife Management Advisory Council (NWT), Inuvialuit Game Council, Ulukhaktok Hunters and Trappers Committee (HTC), and the Paulatuk HTC.

Success in the management of this population depends on the commitment and collaboration of the many different constituencies that are involved in implementing the directions set out in this plan and will not be achieved by any group or jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Dolphin and Union Caribou, and Canadian society as a whole.

This management plan does not commit any party to actions or resource expenditures; implementation of this plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

# ACCEPTANCE STATEMENT

Each participating management agency to provide appropriate text that reflects their acceptance of the plan. For the NWT, insert text from the Conference of Management Authorities consensus agreement.

**To be completed as a final step once the management plan is finalized.**

# ACKNOWLEDGMENTS

Preparation of this document was funded by the Government of Canada (GC), Environment and Climate Change Canada; Government of Nunavut (GN), Department of Environment; and the Government of the Northwest Territories (GNWT), Department of Environment and Natural Resources. The principal writers of this document were Lisa Worthington, Species at Risk Recovery Planning Coordinator, GNWT; Amy Ganton, Species at Risk Biologist, GC; Lisa-Marie Leclerc, Regional Biologist, Kitikmeot Region, GN; Tracy Davison, Regional Biologist, GNWT; Joanna Wilson, Wildlife Biologist (Species at Risk), GNWT; and Isabelle Duclos, Species at Risk Biologist, GC.

A working group was established to develop the management plan, and the following members participated, in addition to the names listed above:

- Jimmy Haniliak – Ekaluktutiak Hunters and Trappers Organization
- Philip Kadlun, Colin Adjun, Jorgen Bolt and Larry Adjun – Kugluktuk Hunters and Trappers Organization
- Sam Kapolak – Burnside Hunters and Trappers Organization
- Luigi Toretti and Tannis Bolt – Kitikmeot Inuit Association
- David Lee and Bert Dean – Nunavut Tunngavik Incorporated
- James Qitsualik Taqaugak, Ema Qaqqutaq and Simon Qingnaqtug – Kitikmeot Regional Wildlife Board
- Mathieu Dumond, Myles Lamont and Drikus Gissing – GN
- Joshua Oliktoak – Olohaktomiut Hunters and Trappers Committee and the Inuvialuit Game Council
- Joe Ilasiak – Paulatuk Hunters and Trappers Committee and the Inuvialuit Game Council
- John Lucas Jr. and Charles Pokiak – Wildlife Management Advisory Council (NWT)
- Jan Adamczewski – GNWT
- Donna Bigelow – GC

The following organizations provided additional input and comments that improved the management plan:

- Ekaluktutiak Hunters and Trappers Organization
- Kugluktuk Hunters and Trappers Organization
- Olohaktomiut Hunters and Trappers Committee
- Paulatuk Hunters and Trappers Committee
- Kugluktuk Community Elders
- GN
- Wildlife Management Advisory Council (NWT)
- GNWT
- GC
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

# EXECUTIVE SUMMARY

## Management Planning for Dolphin and Union Caribou

Dolphin and Union Caribou play an essential role in the lives of the Inuit and Inuvialuit people. They are highly valued from a spiritual, economic, cultural and harvest perspective. They are also a species of special concern under the federal *Species at Risk Act* (SARA) and the Government of the Northwest Territories *Species at Risk (NWT) Act*.

It is essential to have a plan to sustain this population to help ensure the survival of Dolphin and Union Caribou for future generations. This plan describes management goals and objectives for Dolphin and Union Caribou as well as recommended approaches to achieve those objectives. This plan was developed collaboratively by co-management partners to meet management needs in Nunavut, Northwest Territories and at the national level. It recognizes the shared responsibilities for management under land claim agreements and species at risk legislation, and gives equal consideration to *Inuit Qaujimajatuqangit* (IQ), traditional knowledge (TK), and scientific knowledge.

## Background

Dolphin and Union Caribou are morphologically and behaviourally distinct from other barren-ground caribou populations and from Peary caribou. They migrate in the fall across the sea ice from Victoria Island to the mainland, where they spend their winters and in the spring, they migrate back to Victoria Island where they disperse to calve and raise their young. These migrations make seasonal connectivity of sea ice a key habitat requirement.

Scientific research conducted in 2015 indicates the latest population estimate is 18,413 ± 6,795 (95% Cl, 11,664-25,182). This indicates a decline in the population. A recent IQ/local knowledge study in Cambridge Bay also confirmed the perception of such a decline. Observations from this study included reduced body condition, a decline in the juvenile population (including calves and yearlings), increased signs of disease and an overall poor state of health among Dolphin and Union Caribou. Causes of mortality include drowning, predation, harvest, and disease to name a few.

Dolphin and Union Caribou are harvested by the communities of Kugluktuk, Umingmaktok, Bathurst Inlet and Paulatuk during the winter/spring, Ulukhaktok in the summer/fall, and Cambridge Bay in both seasons. Distribution of caribou in relation to community harvesting areas results in different harvest opportunities for each community between seasons and years.

## Threats to Dolphin and Union Caribou

Dolphin and Union Caribou are facing substantial threats to population persistence. Their primary threat is a reduction in sea ice connectivity that results both from ice-breaking activities and from sea ice loss due to climate change. A decrease in sea ice connectivity limits their range access, in particular, access to their migratory routes. Predation from wolves and grizzly bears, as well as harvest activities also present threats to Dolphin and Union Caribou. Other important threats include icing/freeze-thaw events (affecting access to forage), increased insect harassment and a rise in parasites and diseases. Climate change is an underlying driver of many of these threats. Mining, roads, flights, and competition from other species also present threats to Dolphin and Union Caribou.

**Management Goal and Objectives**

Recognizing the ecological, cultural and economic importance of Dolphin and Union Caribou, the goal of this management plan is to maintain the long term persistence of a healthy and viable Dolphin and Union Caribou population that moves freely across its current range and provides sustainable harvest opportunities for current and future generations.

Achieving the management goal would allow for a population level sufficient to sustain traditional Indigenous harvesting activities, and one that is consistent with land claim agreements and existing treaty rights of the Indigenous Peoples of Canada.

In order to attain this goal, five objectives were established, combined with twelve recommended approaches to achieve these objectives. These objectives and their corresponding approaches apply broadly across the population's range in both Northwest Territories and Nunavut. The approaches to management of the Dolphin and Union Caribou (Section 6.3) outline the priorities, recommended time frame and performance measures to complete the management objectives. The management plan will be reviewed every five years further to legislated guidelines under the federal SARA and the territorial *Species at Risk (NWT) Act*. However, the adaptive management approach allows for new information to be incorporated into the management framework and actions throughout this time. The order in which the objectives are presented here does not indicate, assign, or imply differential importance.

**Objective 1:** Adaptively co-manage Dolphin and Union Caribou using a community-based approach.

**Objective 2**: Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.

**Objective 3:** Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.

**Objective 4:** Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.

**Objective 5:** Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.

Harvest management and other management actions should also be informed by the level and trend of the population. This management plan recommends a framework describing how management actions should be adapted at different phases in the Dolphin and Union Caribou cycle, according to when the population is increasing, high, decreasing, or low.

There are already some measures in place that assist in managing Dolphin and Union Caribou, including land claim agreements, legislation, regulations, community conservation plans, and land use planning.

This plan is intended to provide guidance and direction to the co-management partners to help them with their decision-making for Dolphin and Union Caribou management. Ongoing communications, stakeholder and community participation, and cooperation will be fundamental to the plan's success.

The specific actions needed to maintain the Dolphin and Union Caribou population are provided in an appendix and will be managed by the responsible jurisdictions, consistent with this management plan.

# ACRONYMS

| | |
|---|---|
| **ATK** | Aboriginal Traditional Knowledge |
| **COSEWIC** | Committee on the Status of Endangered Wildlife in Canada |
| **DOE** | Department of Environment |
| **DU** | Designatable Units |
| **EIRB** | Environmental Impact Review Board |
| **EISC** | Environmental Impact Screening Committee |
| **ENR** | Environment and Natural Resources |
| **GC** | Government of Canada |
| **GN** | Government of Nunavut |
| **GNWT** | Government of the Northwest Territories |
| **HTC** | Hunters and Trappers Committee |
| **HTO** | Hunters and Trappers Organization |
| **IFA** | Inuvialuit Final Agreement |
| **IGC** | Inuvialuit Game Council |
| **IQ** | Inuit Qaujimajatuqangit |
| **ISR** | Inuvialuit Settlement Region |
| **IUCN** | International Union for the Conservation of Nature |
| **KIA** | Kitikmeot Inuit Association |
| **KRWB** | Kitikmeot Regional Wildlife Board |
| **NGO** | Non-governmental Organization |
| **NLCA** | Nunavut Land Claims Agreement |
| **NTI** | Nunavut Tunngavik Inc. |
| **NWMB** | Nunavut Wildlife Management Board |
| **NWT** | Northwest Territories |
| **RWO** | Regional Wildlife Organization |
| **TAH** | Total Allowable Harvest |
| **TK** | Traditional Knowledge |
| **SARA** | *Species at Risk Act* |
| **SARC** | Species at Risk Committee (NWT) |
| **SEA** | Strategic Environmental Assessment |
| **WMAC (NWT)** | Wildlife Management Advisory Council (NWT) |

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# *1.* INTRODUCTION

Dolphin and Union Caribou play an essential role in the lives of the Inuit and Inuvialuit in Nunavut and the NWT. They are highly valued by the Indigenous Peoples in these regions from a spiritual, economic, cultural and harvest perspective. Dolphin and Union Caribou have been harvested for many generations by communities in the Arctic and there is a sense of responsibility toward stewardship of this caribou population and its habitat.

In recognition of threats and declining population trends, as identified by Traditional Knowledge (TK), Inuit Qaujimajatuqangit (IQ), local knowledge and science, Dolphin and Union Caribou were listed as Special Concern under the federal *Species at Risk Act* (SARA) and the Government of the Northwest Territories (GNWT) *Species at Risk (NWT) Act*. Under these two acts, a management plan must be developed for the Dolphin and Union Caribou.

To help ensure the survival of this species, the management plan must respect Indigenous rights while managing human behaviour. In an effort to promote long term persistence of Dolphin and Union Caribou, the plan must find a balance between the resources used today, and the resources available to future generations.

# *2.* PLAN DEVELOPMENT

## *2.1 Purpose and Principles*

The Dolphin and Union Caribou management plan facilitates coordination and cooperation among management partners based on the shared goal, objectives and approaches established for the population. The plan will assist management partners in assigning priorities, understanding natural processes impacting caribou, and allocating resources in order to manage human impacts on this species.

Development of the management plan was guided by the shared responsibility to manage Dolphin and Union Caribou under components of the *Nunavut Land Claims Agreement* (NLCA), *Inuvialuit Final Agreement* (IFA), federal SARA, and the GNWT *Species at Risk (NWT) Act*. Joint management planning ensured a common vision and approach for the shared population, and there was an expectation that all management partners would have the opportunity to contribute. The plan was prepared using the best available IQ, TK, local and scientific knowledge and each of these perspectives was awarded equal consideration.

## *2.2 Planning Partners*

Planning partners refers to the groups, organizations and communities who are responsible for managing Dolphin and Union Caribou. Other organizations may be involved in managing Dolphin and Union Caribou, but they do not have management authority under land claim agreements or other legislation.

## Government of Canada

The **Government of Canada** (GC) has ultimate responsibility for the management of migratory birds (as described in the *Migratory Birds Convention Act, 1994*), fish, marine mammals, and other aquatic species (as described in the *Fisheries Act*). It also has responsibilities under the federal *Species at Risk Act* (SARA), including the implementation and enforcement of protection for individuals, residences and critical habitat for listed species. The federal Minister of Environment and Climate Change and the Minister responsible for the Parks Canada Agency are ultimately responsible for the preparation and completion of a national management plan for Dolphin and Union Caribou under SARA.

## Government of Nunavut

The **Government of Nunavut** (GN) Department of Environment (DOE) is responsible for the protection, management and sustainable use of wildlife in Nunavut. The GN conducts scientific research and collects IQ relevant to species of management concern in Nunavut. The GN works with co-management partners to develop and implement territorial management plans and federal recovery documents for species at risk. The Minister has the final authority to accept decisions made by the Nunavut Wildlife Management Board.

## Nunavut Wildlife Management Board:

The **Nunavut Wildlife Management Board** (NWMB) is the main instrument of wildlife management established under the NLCA under Article 5. The Board and its co-management partners work together to combine the knowledge and understanding of wildlife managers, users, and the public to make decisions concerning the management of wildlife in Nunavut. The NWMB makes decisions on Total Allowable Harvest (TAH) and non-quota limitations as per the NLCA under Article 5. In addition to the NWMB, the Nunavut Land Claims Agreement created other Boards to manage the land and resources in the Nunavut Settlement Area which include the Nunavut Planning Commission (NPC), the Nunavut Impact Review Board (NIRB), the Nunavut Water Board (NWB) and the Nunavut Surface Rights Tribunal (NSRT). The NWMB, NPC, NIRB and NWB, may act together as the Nunavut Marine Council when necessary to address issues of common concern relating to the marine areas of Nunavut.

## Kitikmeot Regional Wildlife Board

The **Kitikmeot Regional Wildlife Board** (KRWB) is responsible for providing ongoing advice and support to co-management partners, and allocating annual TAH, once it is set, to the affected communities. They also fulfill other wildlife co-management obligations in accordance with the NLCA under Article 5. KRWB is also responsible for reviewing management plans.

## Nunavut Tunngavik Inc:

**Nunavut Tunngavik Inc.** (NTI), although not a management authority, is responsible for ensuring that all processes adhere to the NLCA. The *Nunavut Wildlife Act* recognizes IQ in its legislation, which obligates Nunavut to make certain that Inuit voices are included. NTI provides information and supports the implementation of the NLCA Article 5 to the wildlife co-management partners as required.

**<u>Hunters & Trappers Organizations and Hunters & Trappers Committees:</u>**

The **Hunters and Trappers Organizations** (HTOs) in Nunavut and the **Hunters and Trappers Committees** (HTCs) in the NWT, while not necessarily management authorities, are each responsible for ensuring harvest reporting by members, allocating TAH among members where appropriate, and conducting community-based monitoring and research with the support of the other co-management partners. The Nunavut HTOs can set by-laws for their members and the NWT HTCs can make by-laws that become regulations enforceable under the *NWT Wildlife Act*. The following HTOs and HTCs were included in the development of the Dolphin and Union Caribou management plan: Kugluktuk HTO, Ekaluktutiak HTO (Cambridge Bay), Omingmaktok HTO (Bay Chimo), Burnside HTO (Bathurst Inlet), Olohaktomiut HTC (Ulukhaktok), and Paulatuk HTC.

**<u>Government of the Northwest Territories</u>**

The **Government of the Northwest Territories** (GNWT), represented by the Minister of Environment and Natural Resources (ENR), has ultimate responsibility for the conservation and management of wildlife and wildlife habitat in the NWT, in accordance with land claims and self-government agreements, and having due regard for existing, pending, and future interests in land. It is the ultimate responsibility of the Minister of ENR to prepare and complete a management plan for Dolphin and Union Caribou under the *Species at Risk (NWT) Act*.

**<u>Wildlife Management Advisory Council (NWT):</u>**

The **Wildlife Management Advisory Council (NWT)** [WMAC (NWT)] is the main instrument of wildlife management in the Inuvialuit Settlement Region (Western Arctic Region) of the NWT. The WMAC (NWT) advises the federal and territorial governments on wildlife policy, management, regulation, and administration of wildlife, habitat and harvesting in the Inuvialuit Settlement Region (ISR) (IFA, sections 14). The recommendations of this co-management group provide the foundation for caribou management in the ISR. These recommendations are based on best available information including TK, local knowledge and science. The WMAC (NWT) works collaboratively with the Inuvialuit Game Council, HTCs, and other governments in research, monitoring and management of caribou and their habitat. The WMAC (NWT) consults regularly with Inuvialuit Game Council and HTCs, and these groups assist the WMAC (NWT) in carrying out its functions. The WMAC (NWT) recommends appropriate quotas for Inuvialuit wildlife harvesting, including TAH for caribou when appropriate. The WMAC (NWT) also provides comments during environmental screening and review processes regarding the monitoring and mitigation of impacts of development on Dolphin and Union Caribou and their habitat.

**<u>Inuvialuit Game Council:</u>**

Under the IFA, the **Inuvialuit Game Council** (IGC) represents the collective Inuvialuit interest in all matters pertaining to the management of wildlife and wildlife habitat in the ISR. This responsibility gives the IGC authority for matters related to harvesting rights, renewable resource management, and conservation.

## *2.3 Management Planning Process*

Due to the multiple jurisdictions and agencies involved in managing Dolphin and Union Caribou, management must be carried out as a team to be successful. The management plan was prepared jointly by the GNWT-ENR and GN-DOE, in collaboration with the GC Environment and Climate Change, the Parks Canada Agency and co-management partners mentioned in Section 2.2.

To facilitate the plan development, an introductory meeting outlining the management planning process took place in February 2015 with representatives of communities and co-management partners within the range of Dolphin and Union Caribou. Two joint meetings were held in Nunavut: in Kugluktuk (March 2015) and Cambridge Bay (January 2016) with representatives of KRWB, KIA, NTI, WMAC (NWT), IGC, HTOs from Cambridge Bay, Kugluktuk, and Bathurst Inlet, and HTCs from Paulatuk and Ulukhaktok. GN, GNWT and GC also attended the meetings. The meeting participants discussed the content and framework of the management plan, new information on Dolphin and Union Caribou, threats to the population, approaches to address threats, and options for harvest management. The joint meetings provided opportunities for harvesters and co-management partners from Nunavut and the NWT to discuss Dolphin and Union Caribou issues and to share their knowledge. IQ, TK and local knowledge were shared to help form the foundation of this management plan and inform the document throughout. Notes were produced after each meeting that summarized the input and guidance provided by co-management partners (First Joint Meeting 2015; Second Joint Meeting 2016). As each draft of the management plan was completed, it was provided to all co-management partners for their review and input. The planning process is summarized in Figure 1.

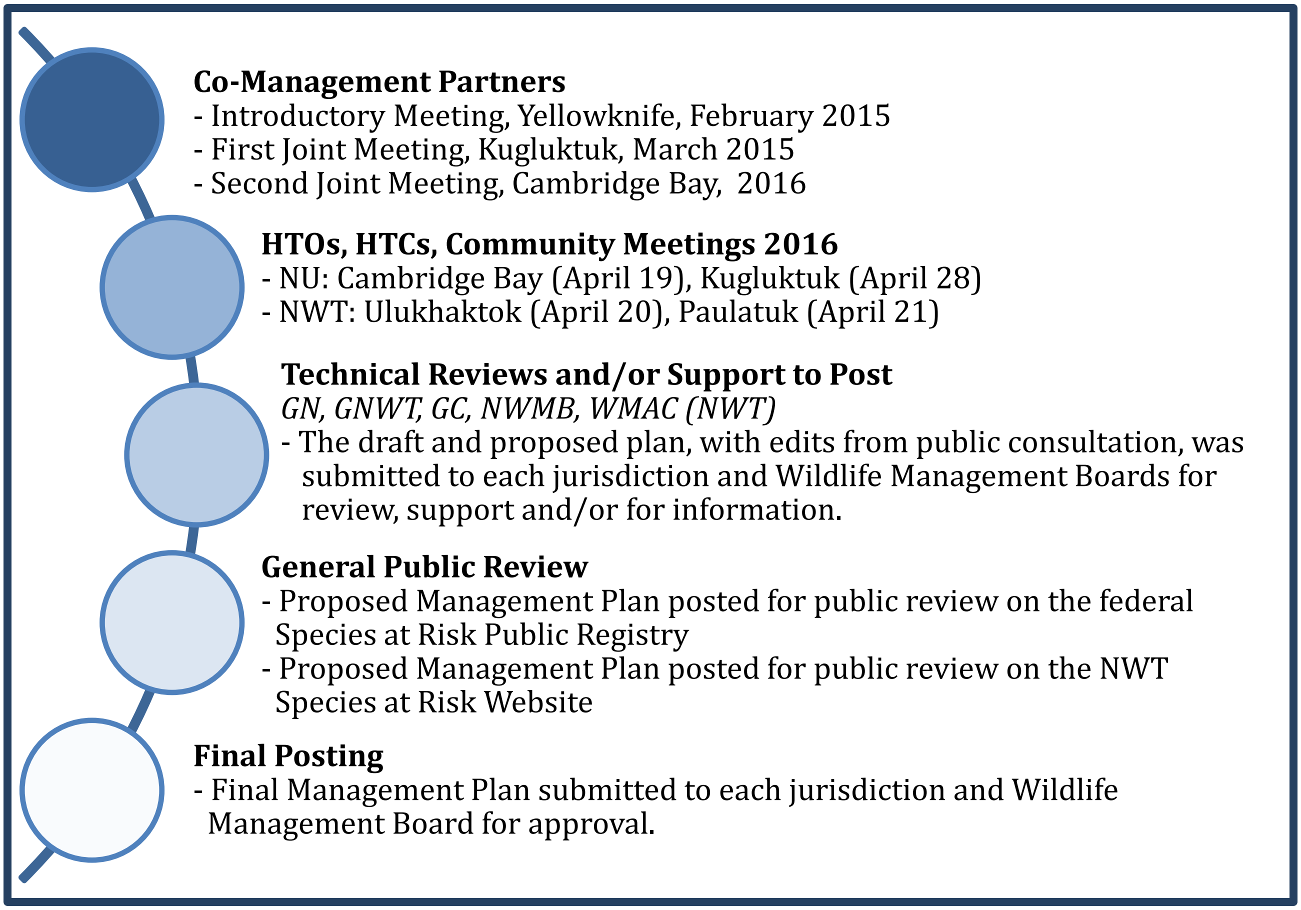


Figure 1. Management Planning Process for Dolphin and Union Caribou.

In addition, the GNWT and the WMAC (NWT) visited Ulukhaktok and Paulatuk in July 2014 to discuss listing the Dolphin and Union Caribou. They returned to the community of Ulukhaktok in June 2015 to discuss the Dolphin and Union Caribou Management Framework. Comments and feedback were considered and incorporated into the management plan.

Community meetings were held in Cambridge Bay, Kugluktuk, Paulatuk and Ulukhaktok in April 2016 to review the draft management plan. Each section of the plan was summarized and explained with the goal of collecting feedback from HTO and HTC board members and from community members. Notes were later produced that summarized the input and guidance provided by each community (Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Paulatuk HTC 2016; Olohaktomiut HTC 2016).

Input from all parties including the general public was solicited once more through the posting of the proposed draft plan for comment on the federal Species at Risk Public Registry and on the NWT species at risk website. GNWT also consulted on the draft management plan with relevant Indigenous organizations including the IGC and NTI with respect to potential infringement of established or asserted Indigenous or treaty rights.

Feedback received during engagement and consultation was considered when drafting the final plan. The final plan was then submitted to GN, GNWT, GC, WMAC (NWT), and NWMB for approval.

### *2.4 Inuit Qaujimajatuqangit, Traditional Knowledge and Local Knowledge*

This management plan incorporates scientific knowledge and local knowledge, and is guided equally by IQ and TK principles.

The term local knowledge used in this document fits the definition of Local Ecological Knowledge defined by Charnley et al. (2007): "Local ecological knowledge is defined here as knowledge, practices, and beliefs regarding ecological relationships that are gained through extensive personal observation of and interaction with local ecosystems, and shared among local resource users".

IQ is the system of values, knowledge, and beliefs gained by Inuit through generations of living in close contact with nature. For Inuit, IQ is an inseparable part of their culture and includes rules and views that affect modern resource use.

Inuvialuit prefer the term TK (Armitage and Kilburn 2015). TK is "a cumulative body of knowledge, know-how, practices and presentations maintained and developed by the peoples over a long period of time. This encompasses spiritual relationships, historical and present relationships with the natural environment, and the use of natural resources. It is generally expressed in oral form, and passed on from generation to generation by storytelling and practical teaching" (Smith 2006).

Recommendations for the management of Dolphin and Union Caribou will continue to be guided by the best available local knowledge, and IQ and TK information. Observations from elders and other knowledgeable community members, including local harvesters, are fully integrated into this management plan along with scientific research.

The practical application of IQ, TK, and local knowledge demonstrates the value of local consultations in order to document and preserve IQ and TK before it is lost. The communities of the western Kitikmeot region and the eastern ISR will continue to be engaged on an ongoing basis to ensure that IQ and TK as well as local knowledge are utilized in conjunction with scientific information in the management of the Dolphin and Union Caribou.

## *3.* HISTORICAL AND SOCIAL PERSPECTIVE

For thousands of years, the northern Indigenous Peoples have subsisted off the land, using all available resources, including caribou. Caribou have formed the foundation for the Inuit and Inuvialuit lifestyle and culture.

For many western Arctic communities, the Dolphin and Union Caribou have traditionally provided an important source of food and raw material. In earlier times, caribou bones and antlers were shaped into tools, sinew was used for thread and hides were used to make winter parkas, summer tents, and sleeping skins. Dolphin and Union Caribou continue to provide a strong social and economic base for the Inuit and Inuvialuit who live in their range by providing subsistence food and economic opportunities for local guides. Relationships in the communities are established and enhanced by sharing and exchanging the harvest.

On a spiritual level, the Inuit and Inuvialuit people hold tremendous respect toward caribou. This carries with it certain obligations not to unduly harm or disrespect the animal. Prayer and leaving offerings before hunting are important aspects of this belief. Respecting rules about the use of meat and hides, including sharing of harvest and not wasting meat, are also considered essential to this approach.

## *3.1 Communities that Harvest Dolphin and Union Caribou*

The distribution of Dolphin and Union Caribou crosses two jurisdictions - Nunavut and NWT. They are harvested by Indigenous, resident[1], and non-resident[2] harvesters in both territories. Dolphin and Union Caribou are harvested by the communities of Kugluktuk, Umingmaktok, and Bathurst Inlet in the winter/spring as well as Paulatuk during the winter. They are harvested in Ulukhaktok in the summer/fall, and Cambridge Bay in all seasons. During the spring season, some Cambridge Bay hunters cross to the mainland and can access Dolphin and Union Caribou as they migrate back to Victoria Island. This population may also be harvested by people from other communities, other Canadian provinces and territories, as well as non-Canadians (with restrictions).

## *3.2 Use of the Population and History of Harvest Management*

Opportunities to harvest caribou are highly dependent on caribou movement and distribution of the population in relation to human settlements. At the beginning of the last century, the Dolphin and Union Caribou range was closely tied with the Dolphin and Union

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[1] NWT Resident: A Canadian citizen or landed immigrant who has been living in the NWT for 12 continuous months.

Nunavut Resident: A Canadian citizen or landed immigrant who has been living in Nunavut for at least three months.

[2] Non-resident (NWT): A Canadian citizen or landed immigrant who lives outside the NWT or has not resided in the NWT for 12 months.

Non-Resident (Nunavut): A Canadian citizen or landed immigrant who lives outside Nunavut or has not resided in Nunavut for at least three months.

Strait, where caribou migrated from Victoria Island to the mainland. There, they were available for harvesting from outpost camps at Read Island and Bernard Harbour (First Joint Meeting 2015). During the 1920s, the caribou population began dwindling and at the same time, their migration to the mainland ceased. An eastward shift of caribou winter range made it possible for the community of Cambridge Bay, on the eastern side of Victoria Island, to rely on this population, as highlighted by IQ holders (First Joint Meeting 2015). Dolphin and Union Caribou were not available to the communities located on the Canadian mainland until the 1980s. At that point, they resumed their migration, this time through the Coronation Gulf, becoming accessible to hunters from Paulatuk, Kugluktuk, Umingmaktok and Bathurst Inlet.

There are challenges to evaluating the historical and present harvest pressure on this population. Past harvest reporting through harvest studies was voluntary in both jurisdictions and there are several sources of error that are common between the Inuvialuit and Nunavut harvest studies (Inuvialuit Harvest Study 2003; NWMB 2004). Some harvesters declined to be interviewed; this can be an issue, particularly if those hunters are very active. Some harvesters may have under-reported in order to avoid the survey or because of a misunderstanding of use of the data. Also, some harvesters may have been overlooked and not included in the harvest interviews. There is also the potential issue of inconsistent reporting and inability of harvesters to recall their harvest accurately. Further details on the errors and how they could have impacted results are found in the reports for each harvest study (Inuvialuit Harvest Study 2003; NWMB 2004). Current reporting of harvest is either voluntary or not collected; therefore harvest numbers are often unreliable and incomplete. This uncertainty was one of the reasons that the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Dolphin and Union Caribou as a species of special concern in 2004 (COSEWIC 2004), since a harvest of 2,000 to 3,000 caribou was estimated at this time based on the Kitikmeot Harvest study. This estimate did not necessarily account for the likely under-reporting of harvest (Gunn and Nishi 1998; Nishi and Gunn 2004).

The Inuvialuit Harvest study ran from 1988 to 1997. During that time the estimated harvest by the community of Ulukhaktok (Holman - calculated using reported harvest and response rates) was 189 to 681 caribou per year, with a mean of 441 (Inuvialuit Harvest Study 2003). However, the type of caribou was not specified. Based on the seasonal migrations, if it is assumed Dolphin and Union Caribou are only on Victoria Island between June and November, the maximum estimated annual Dolphin and Union Caribou harvest was 178 to 509 per year, with a mean of 329. In 1994/95, an Olokhatomiut HTC by-law was put in place for Peary caribou north of Minto Inlet (I/BC/03 area). The Inuvialuit Harvest Study data reflects this change in harvest with the overall caribou harvest declining to approximately 30% of levels at the beginning of the study (1988) but the proportion of caribou harvest in the winter (assuming Peary caribou) declining from > 45% in 1988 to less than 1% in 1997. Another harvest data collection took place in Ulukhaktok from 2001 to 2009. According to that study, reported harvest (not corrected for response rate) ranged from 32 to 360 caribou harvested per year in I/BC/04 (area south of Minto inlet and around Prince Albert Sound) (ENR 2015a). Based on Inuvialuit Harvest Study data and community comments, there is likely a small harvest of caribou north-east of Paulatuk along the coast.

The Nunavut Harvest Study - from 1996 to 2001 - revealed that Kugluktuk harvested on average 1,575 caribou annually, Cambridge Bay: 811, Bathurst Inlet: 93, and Umingmaktok: 176 caribou (NWMB 2004). In other words, this study shows a total annual subsistence harvest of 2,655 caribou from these four communities. However, the accuracy of the Nunavut harvest study has been questioned since hunters did not specify the type of caribou harvested or the population/herd from which they were harvested. Therefore, the proportion of Dolphin and Union Caribou taken annually in each of the communities still remains unknown. It is well known that the proportion of the harvest made up by each population/herd is very inconsistent and varies widely from year to year, based on distribution and the accessibility of each population/herd to the communities (Second Joint Meeting 2016). The preliminary results from the harvest of Dolphin and Union Caribou from 2010 to 2014, revealed a harvest of only 10 to 80 caribou. These were voluntarily reported as harvested on an annual basis around Kugluktuk (GN-DOE, in prep).

In both Nunavut and NWT, while subject to conservation principles, there are currently no harvest limitations on the Dolphin and Union Caribou for beneficiaries[3]; they can harvest this caribou to the full extent of their economic, social and cultural needs. Community members from both Ulukhaktok and Kugluktuk explained that they increase their harvest of Dolphin and Union Caribou in response to a decrease in access or availability of other populations/herds (Second Joint Meeting 2016). Some hunters agree that the cost of gas and food is so high that it limits or prevents them from harvesting. Fewer hunters go out now and fewer caribou are harvested as store bought food is available and the need to feed dog teams has diminished (First Joint Meeting 2015). Thus, there is a pressing need to have a stronger effort to monitor and manage harvest so future actions can address the current harvest pressure.

# *4.* SPECIES INFORMATION

## *4.1 Species Status and Assessment*

**COSEWIC Species Assessment Information** (COSEWIC 2004)

[3] A Beneficiary is an Aboriginal person who is on an enrollment list of a specified comprehensive land claim agreement and is entitled to certain rights under that agreement.

**Date of Assessment:** May 2004

**Common Name (population):** Barren-ground caribou (Dolphin and Union population)

**Scientific Name:** *Rangifer tarandus groenlandicus*

**COSEWIC Status:** Special Concern

**Reason for Designation:** This population of caribou is endemic to Canada. Once thought to be extinct, numbers have recovered to perhaps a quarter of the population historic size. They have not been censused since 1997 and are subject to a high rate of harvest, whose sustainability is questioned by some. They migrate between the mainland and Victoria Island and climate warming or increased shipping may make the ice crossing more dangerous. The population, however, increased substantially over the last three generations and was estimated at about 28000 in 1997.

**Canadian Occurrence:** Northwest Territories, Nunavut

**COSEWIC Status History:** The original designation considered a single unit that included Peary Caribou, *Rangifer tarandus pearyi*, and what is now known as the Dolphin and Union Caribou, *Rangifer tarandus groenlandicus*. It was assigned a status of Threatened in April 1979. Split to allow designation of three separate populations in 1991: Banks Island (Endangered), High Arctic (Endangered) and Low Arctic (Threatened) populations. In May 2004 all three population designations were de-activated, and the Peary Caribou, *Rangifer tarandus pearyi*, was assessed separately from the Dolphin and Union Caribou, *Rangifer tarandus groenlandicus*. The Dolphin and Union Caribou is comprised of a portion of the former "Low Arctic population", and it was designated Special Concern in May 2004.

## Assessment of Dolphin and Union Caribou in the NWT by the Species at Risk Committee (SARC 2013)

The Northwest Territories Species at Risk Committee met in Yellowknife, Northwest Territories on December 11, 2013 and assessed the biological status of Dolphin and Union Caribou in the Northwest Territories. The assessment was based on this approved status report. The assessment process and objective biological criteria used by the Species at Risk Committee are available at www.nwtspeciesatrisk.ca.

**Assessment: Special Concern in the Northwest Territories**
*The species is particularly sensitive to human activities or natural events but is not Endangered or Threatened.*

**Reasons for the assessment: Dolphin and Union Caribou fits criteria (a) and (b) for**

**Special Concern.**
*(a) – The species has declined to a level at which its survival could be affected by population characteristics, genetic factors or environmental factors but the decline is not sufficient to qualify the species as Threatened.*

*(b) – The species may become Threatened if negative factors are neither reversed nor managed effectively.*

Main Factors:

- Although there is too little information to assess long-term population trends of Dolphin and Union Caribou, there is evidence that the population has declined between 1997 and 2007.
- There is no possibility of rescue from neighbouring populations. Dolphin and Union Caribou are considered to be discrete from Peary caribou and barren-ground caribou, based on their morphology, genetics and behaviour (i.e., the distinct rutting area as well the herd's seasonal migrations across the sea ice of the Dolphin and Union Strait).
- Dolphin and Union Caribou are vulnerable to major environmental events such as changes in the timing of sea ice formation, changes to the thickness of sea ice, and icing and crusting events on their fall and winter range.

**NatureServe Ranks**: NatureServe ranks Dolphin and Union Caribou as unranked at the global level (TNR[4]) and imperiled-vulnerable at the national level (N2N3; , NatureServe 2015). Dolphin and Union Caribou are ranked as imperiled-vulnerable (S2S3) in the NWT and as unranked (SNR) in Nunavut.

**Legal listing**: Dolphin and Union Caribou is listed as Special Concern (2011) under Canada's SARA and is listed as Special Concern (2015) under the territorial *Species at Risk (NWT) Act*.

In Nunavut, Dolphin and Union Caribou are not assessed or listed under territorial endangered species legislation. The *Nunavut Wildlife Act* has provisions for species at risk but regulations are not enacted.

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[4] Types of ranks: T = subspecies. Definitions: NR = unranked.

Table 1. Summary of status designations.

| Jurisdiction | NatureServe Rank[2] | Status Assessment | Legal Listing |
|---|---|---|---|
| **Canada** | N2N3 | Special Concern (COSEWIC 2004) | Special Concern (SARA 2011) |
| **Nunavut** | SNR | N/A | N/A |
| **NWT** | S2S3 | Special Concern (SARC 2013) | Special Concern (*NWT Species at Risk (NWT) Act* 2015) |

[2] Types of ranks: N = national conservation status rank; S = sub-national (provincial or territorial) ranks. Definitions: 2 = imperiled; 3 = vulnerable; NR = unranked.

## *4.2 Species Names*

**Common name used in this report:** Dolphin and Union Caribou

**Other common names:** Island caribou (NWT and Nunavut; English), Arctic-island caribou (NWT and Nunavut; English), Mainland caribou (Ulukhaktok, NWT; English), Barren-ground caribou (Dolphin and Union population) (English), caribou du troupeau Dolphin-et-Union (French), Tuktuk (Inuktituk), Tuktu (Inuinnaqtun), Tuktu/tuktut (Siglitun), Tuttu (Ummarmiutun)

**Scientific name:** In 2004, COSEWIC designated Barren-ground Caribou (*Rangifer tarandus groenlandicus*), Dolphin and Union population, as special concern. The species was added to the List of Wildlife Species at Risk (Schedule 1) of SARA. In 2011, COSEWIC created 'Designatable Units' (DU) for caribou (*Rangifer tarandus*) in Canada using a number of variables to classify the different herds or groups of herds (Figure 2, COSEWIC, 2011). These DU descriptions provided a clear and consistent scheme for identifying DUs due to the complexity of *Rangifer tarandus* in Canada. The Dolphin and Union population of Barren-ground Caribou was determined to belong to *Rangifer tarandus groenlandicus* (DU2), and was simply referred to as Dolphin Union Caribou. Although this naming convention differs slightly from the COSEWIC assessment (2004) and Schedule 1 of SARA, the common name used henceforth in the management plan will follow the suggested 2011 DU name: Dolphin and Union Caribou.

The GNWT's Species at Risk Committee (SARC) used *Rangifer tarandus groenlandicus x pearyi* in their 2013 Status Report (SARC, 2013), and the GN also uses this naming convention to identify Dolphin and Union Caribou. Despite what is suggested by the Dolphin and Union Caribou's subspecies designation, genetic evidence reveals that it is distinct from the Peary caribou and from the migratory barren-ground caribou that is also of subspecies *groenlandicus* (McFarlane et al 2016).

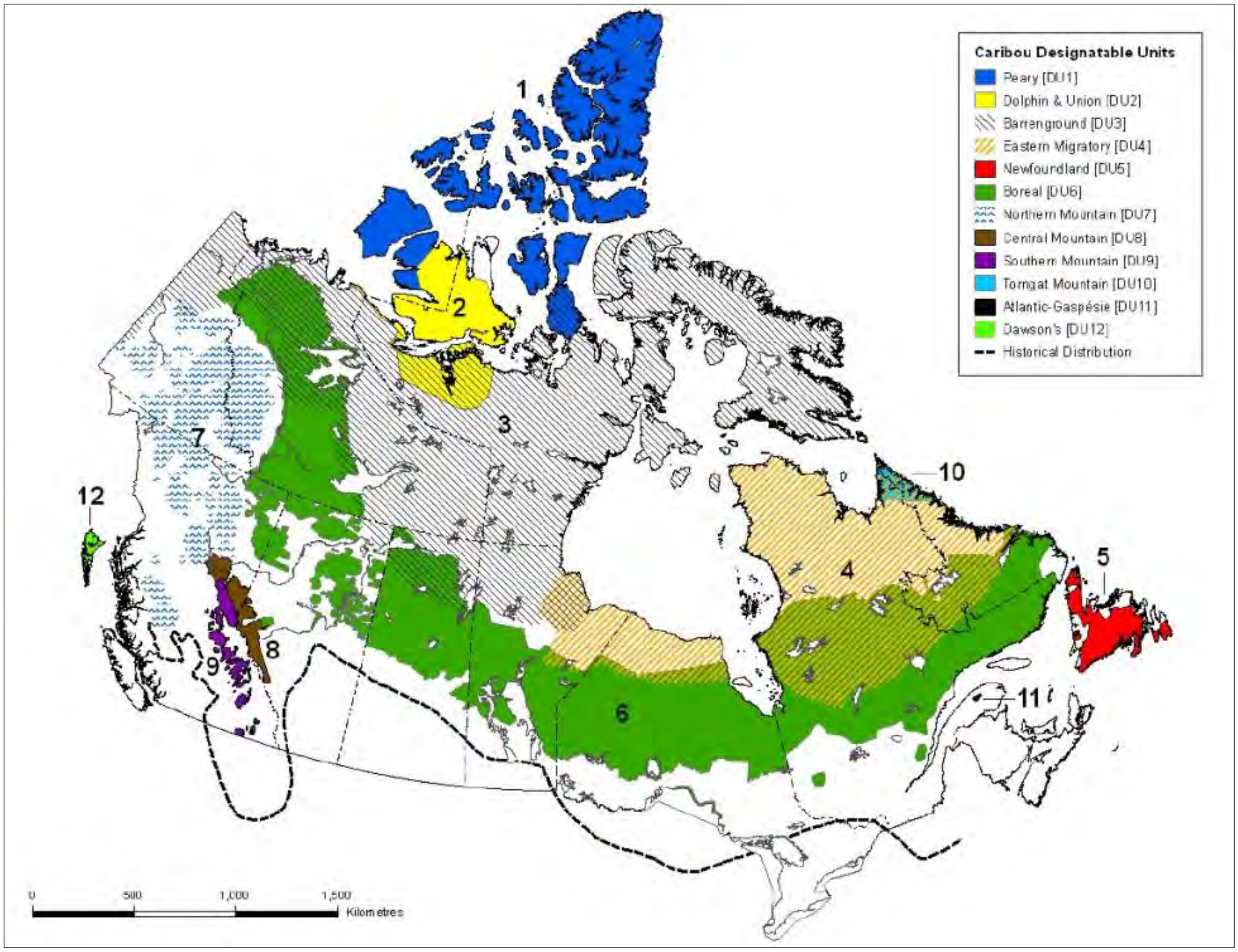


Figure 2. Caribou Range Map in Canada, broken down into Designatable Units (COSEWIC, 2011).

**Occurrence:** Dolphin and Union Caribou occur in Canada and are restricted to Victoria Island and the mainland opposite Victoria Island. They cross two jurisdictions: Nunavut and NWT.

## *4.3 Species Description and Biology*

Figure 3. Dolphin and Union Caribou near High Lake, west of Bathurst Inlet, April 2008. Photo by K. Poole, used with permission.

Dolphin and Union Caribou are morphologically and behaviourally different from other barren-ground caribou (*Rangifer tarandus groenlandicus*) populations and from Peary caribou (*Rangifer tarandus pearyi*) (COSEWIC 2011). They are best identified using a combination of characteristics (Kugluktuk HTO 2016). They are mostly white in winter, and are grey with white underparts in summer (Figure 3). They have grey down the front of their legs, unlike the white legs of Peary caribou, and the shape of their muzzle is different from barren-ground caribou. They are also larger than Peary caribou, but smaller than the darker brown barren-ground caribou. The antler velvet of the Dolphin and Union Caribou is most commonly pale grey, similar to Peary caribou; this is a striking distinguishing characteristic compared to the brown velvet of barren-ground or boreal woodland (*R.t. caribou*) caribou. Genetic analysis confirms that Dolphin and Union Caribou are genetically distinct from Peary and barren-ground caribou. Their physical similarity to Peary caribou suggests similar evolutionary pressures having evolved in a similar environment, but they share haplotypes with the neighbouring barren-ground caribou herds which suggests a certain degree of inter-breeding (Zittlau 2004; Eger et al. 2009; McFarlane et al. 2009; McFarlane et al. 2016).

One particular behaviour that distinguishes Dolphin and Union Caribou from the mainland barren-ground caribou populations is their seasonal migrations. Twice a year, thousands of Dolphin and Union Caribou cross the sea ice in a synchronous and coordinated way to reach their summer and winter grounds. Below a certain population threshold, migration may cease; in fact, this took place in the early 1920s when population numbers were very low. At the time, Dolphin and Union Caribou remained on Victoria Island year-round.

### 4.3.1 Life cycle and reproduction

Dolphin and Union Caribou population dynamics are not well-documented although the population shares some life-history strategies similar to barren-ground caribou. The rut starts in mid-October, concurrently with their fall staging and migration. It is typical for a Dolphin and Union Caribou bull to mate with more than one cow.

Accessibility of forage can impact a caribou cow's body condition, which then determines the age of first pregnancy and the annual likelihood that a cow will conceive (Thomas 1982; Gerhart et al. 1997). Under good conditions such as abundant forage, low stress and low parasitism, a female caribou can have a single calf every year (Heard 1990; Thorpe et al. 2001). Pregnancy rates are annually variable (Nishi 2000; Hughes 2006; CARMA 2012; SARC 2013).

Dolphin and Union Caribou are relatively long-lived with a reproductive lifespan of about 12 years (SARC 2013). Hughes (2006) found the age of harvested Dolphin and Union Caribou cows ranged from 1.8 to 13.8 years with a mean age of 6.5 years. One caribou with a marked ear was observed approximately 20 years after the marking program had stopped (First Joint Meeting 2015).

### 4.3.2 Natural mortality and survival

There are challenges in measuring natural mortality, and details on survival rates of Dolphin and Union Caribou are limited. Cow survival, measured using a small number of collared cows between 1999 and 2006, was relatively low (76%; Poole et al. 2010). Causes of mortality include drownings, predation, harvest, and malnutrition associated with both icing events as well as parasites and disease (Gunn and Fournier 2000; Miller 2003; Patterson unpubl. data 2002; Poole et al. 2010). These sources of mortality are discussed in detail in Section 5.

### 4.3.3 Diet

Caribou eat a variety of plants, depending on the time of year and plant availability. They are known to eat lichens, willows, grasses, dwarf birch, mountain avens, Arctic sorrel, mushrooms, moss campion and berries (Thorpe et al. 2001; Dumond et al. 2007; Olohaktomiut Community Conservation Plan 2008; Badringa 2010; Ulukhaktok TK interviews 2011-2013).

In the 1990s, rumen contents of Dolphin and Union Caribou were investigated in early and late winter on Victoria Island. In November, sedges, dwarf shrubs (mountain avens and willow) and forbs dominated their diet, while lichen and moss formed only a small fraction. In April, dwarf shrubs continued to dominate their diet. This is unusual, as winter caribou diets are usually dominated by lichen such as reindeer lichen, snow lichen and worm lichen (Staaland et al. 1997). However, the low lichen proportion in the Dolphin and Union Caribou diet is similar to that of Peary caribou, where lichen constitutes a small part of the available biomass and their diet (Miller and Gunn 2003). After the snow melts in mid-July, Dolphin and Union Caribou feeding generally focuses on moist sites and their diets include grasses and green willows (Dumond et al. 2007). Although their summer diet has not been investigated through science, Dolphin and Union Caribou have been described as having a very green stomach in the summer (Ulukhaktok TK interviews 2011-2013).

### 4.3.4 Habitat needs

Due to migrations between Victoria Island and the mainland (Table 2), a key habitat requirement for Dolphin and Union Caribou is the seasonal connectivity of the sea ice.

Table 2. Approximate timing of spring and fall migrations for Dolphin and Union Caribou

| Time of year | Migration on land or sea ice | Direction of the migration |
|---|---|---|
| Late March - April | Land | Move northward to mainland coast. |
| April | Sea ice | Migrate from mainland coast to Victoria Island and also to ancillary islands. |
| September - October | Land | Migrate to southern part of Victoria Island and gather in staging areas near southern coast. |
| End of October - December | Sea ice | Cross the sea ice to their winter range on the mainland. |

<u>Spring migration</u>

In late March and April, Dolphin and Union Caribou begin moving northward to the coast for their migration to Victoria Island (Figure 4). Some Indigenous Peoples have observed that prior to migration, Melbourne Island is an important area for staging (Gunn et al. 1997). During the migration, the Inuit indicate that Dolphin and Union Caribou leave Brown Sound area in April, moving from Arctic Sound and Rideout Island toward Elu Inlet and then across to Cambridge Bay. They also observe caribou crossing the Coronation Gulf, via the Kent Peninsula and arriving on Victoria Island, either north of Bathurst Inlet or further east at Cambridge Bay (Archie Komak, Ikaluktuuttiak in Thorpe et al. 2001). Poole et al. (2010) found a mean ice crossing distance northwards for collared cows of 40 km (± 7.2 km).

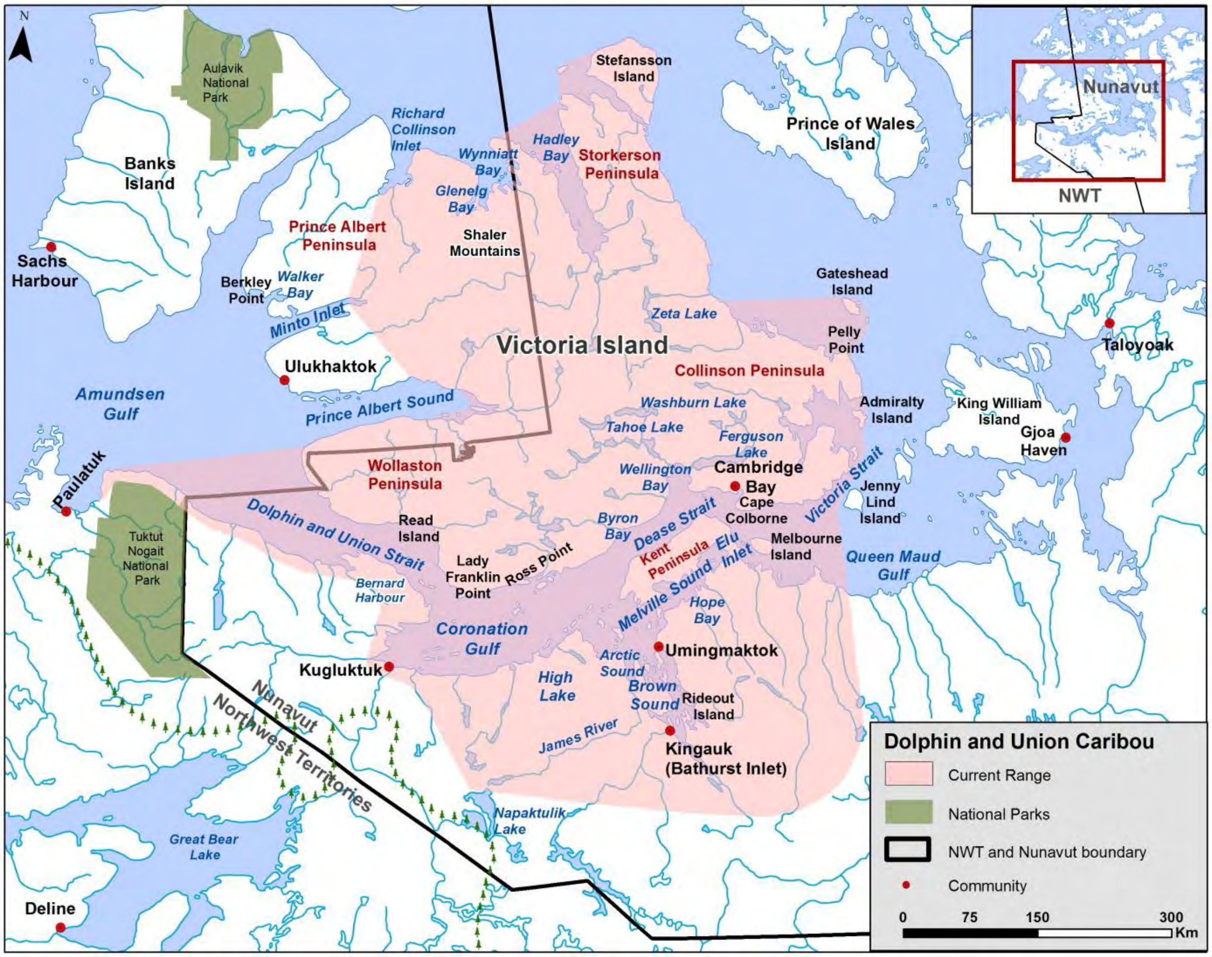


Figure 4. Notable place names and the current range of Dolphin and Union Caribou (NWT Environment and Natural Resources, range data developed for Species at Risk program 2016).

<u>Summer</u>

Although Dolphin and Union Caribou usually spend their summers on Victoria Island, they have also been found on the ancillary islands: Read Island, Gateshead Island, Jenny Lind Island and Admiralty Island. Their summer range is known to extend to the northern part of Victoria Island, in the Wynniatt Bay area, the Shaler Mountains and the northern extent of Storkerson Peninsula with rare sightings on Stefansson Island (Figure 4).

During the summer, Dolphin and Union Caribou adopt an individualistic calving strategy in which they give birth at locations dispersed across the island. They might calve alone or in small groups, but they do not form a large aggregation or use a distinct calving ground that can be delineated with confidence (Figure 5). Typically for other caribou such as the barren-ground caribou, large flat areas are chosen for calving, likely to facilitate effective detection of predators (Thorpe et al. 2001). Although barren-ground caribou females come back to the same site to give birth, this calving site fidelity has not been scientifically demonstrated for Dolphin and Union Caribou. The condition of the tundra may also impact where caribou cows choose to calve (Thorpe et al. 2001).

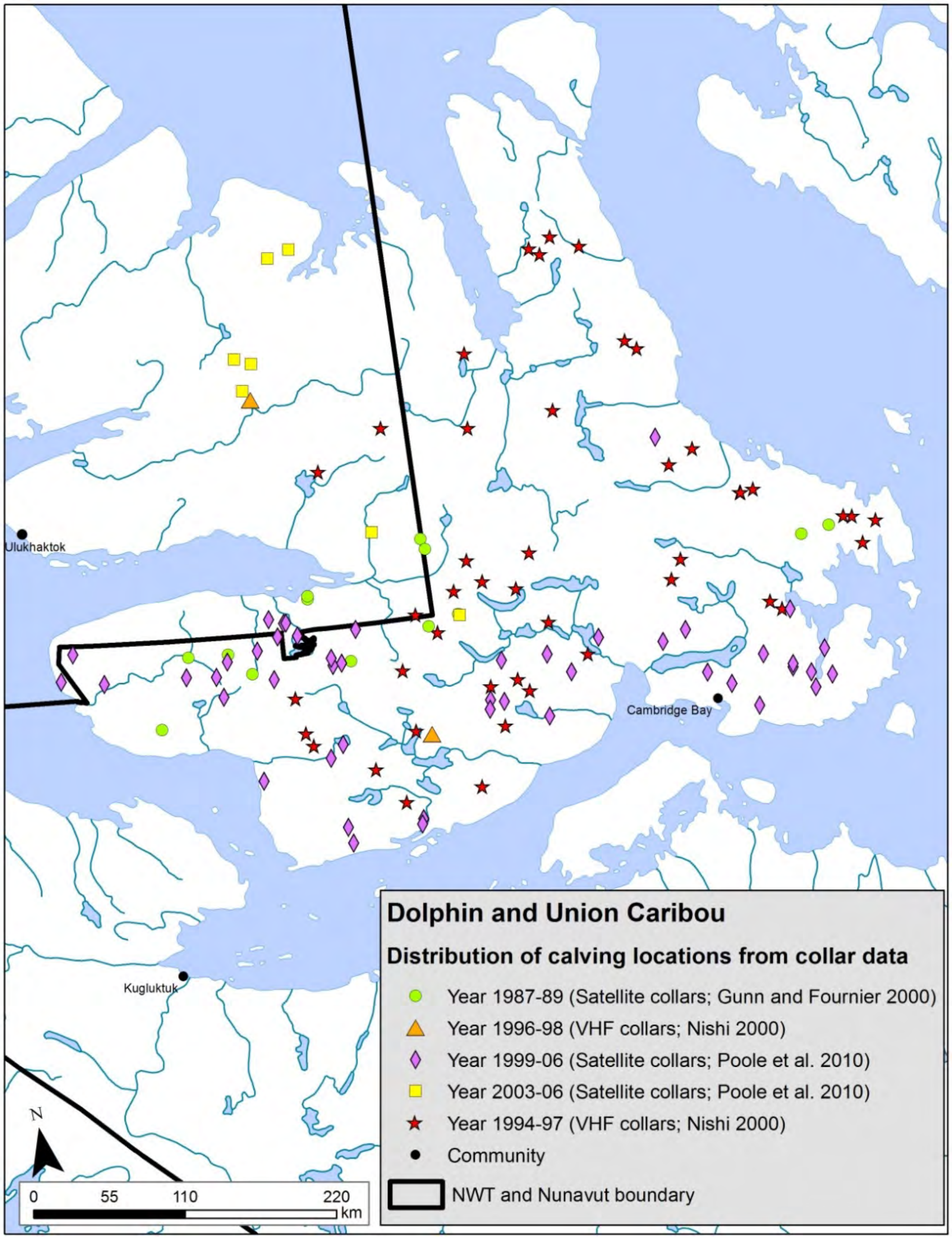


Figure 5. Distribution of calving locations from collared caribou. Data from 1987-89 (green dots; Gunn and Fournier 2000), 1994-97 (orange triangles; Nishi 2000), 1994-97 (red stars; Nishi 2000), 1999-2006 (purple diamonds; Poole et al. 2010) and 2003-06 (yellow squares; Poole et al. 2010). Figure modified from SARC 2013, by B. Fournier, GNWT-ENR 2016.

Food supply for the newborn calf and its mother is highly important, as newborns and mothers have high nutritional needs. During the summer, calves must grow quickly and store fat for the winter; therefore access to high quality vegetation is important (Thorpe et al. 2002). Caribou will often seek out areas where the snow has melted and fresh green growth is available. After their mother's milk, cottongrass may be the first vegetation consumed by calves (Thorpe et al. 2001).

During the summer, caribou typically seek cooler and damp areas where high winds provide relief from insects and the summer heat. They frequently find wet, marshy areas and may sometimes stand in water, or swim to escape the summer heat and insects. They also seek out shorelines as these areas provide protection from wolves at night and opportunities for grazing (Thorpe et al. 2001).

<u>Fall migration</u>

Between September and October, Dolphin and Union Caribou migrate to the southern part of Victoria Island to cross the sea ice to their winter range on the mainland (Figure 6). As they wait for sea ice to form, they gather in staging areas to feed and rest before making their migration. It is believed Dolphin and Union Caribou use their staging time for intensive feeding before their fall migration (Gunn et al. 1997).

Dolphin and Union Caribou typically cross the sea ice to the mainland between the end of October and early December, and the majority will cross in a short window of time. Caribou are seen crossing from Cape Colborne to Kent Peninsula within a few days (Nishi and Gunn 2004). Poole et al. (2010) observed caribou to take 4.0 days (± 0.53 d) to cross from Victoria Island to the mainland, while another observed this crossing to occur in one day (L. Leclerc Regional Biologist, GN, DOE, pers. comm. 2016). Poole at al. (2010) also found a mean ice crossing distance southwards for collared cows of 48.1 km (± 7.8 km).

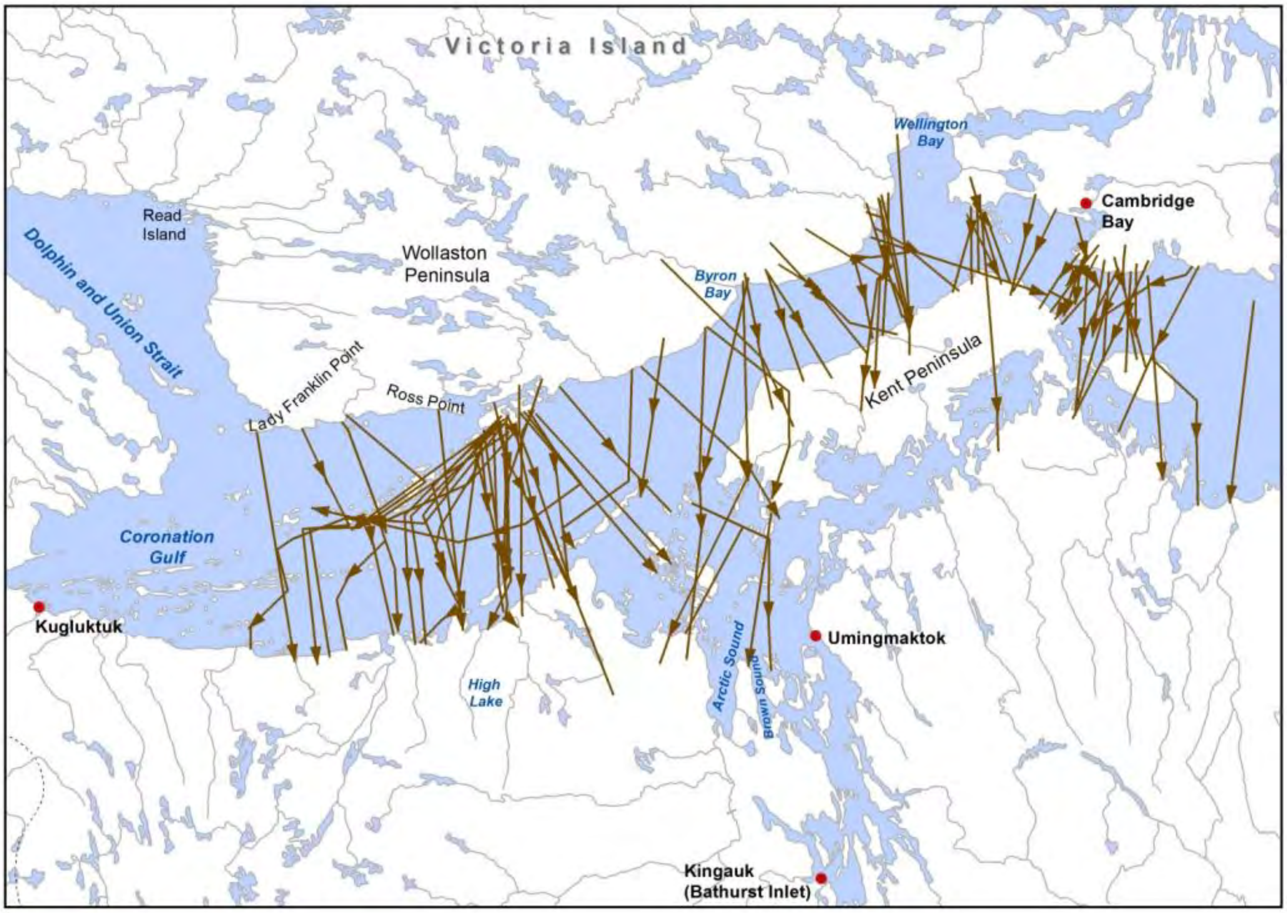


Figure 6. Dolphin and Union Caribou fall migration between Victoria Island and the mainland (modified from Poole et al. (2010), by B. Fournier, GNWT-ENR 2016).

<u>Winter</u>

Historically, Victoria Island was used as a wintering area for Dolphin and Union Caribou when caribou numbers were low and the sea ice crossing had temporarily ceased (see Section 4.4). Since the migration has resumed, the mainland has now become their wintering ground, where it typically offers rich winter feeding opportunities (Thorpe et al. 2001). Snow cover influences habitat selection as it is linked to the energy costs associated with digging through snow to access forage, as well as travelling within and among habitat patches. They typically avoid deep or “sleet-covered” snow as it is more difficult to access food (Thorpe et al. 2001). Therefore, one key habitat requirement is terrain and vegetation that offers choices to caribou as they adjust their foraging to changing snow conditions (Larter and Nagy 2001; SARC 2013).

## *4.4 Population and Distribution*

Observations of the population and distribution of Dolphin and Union Caribou through TK, IQ, local knowledge, and from science observations up to 1990, are described in Table 3. As seen in Table 3, limited scientific information is available for Dolphin and Union Caribou, with the majority of information provided through TK, IQ, and communities.

Table 3. Summary of observations on the population and distribution of Dolphin and Union Caribou, from IQ, TK, local knowledge, and science up to 1990.

| Timeline | Population | Distribution |
|---|---|---|
| Beginning of 20th century | - Little scientific information on population<br>- Information derived from explorers' log books, records from trading posts, observations from geologists during exploration trips (Manning 1960)<br>- Population thought to be abundant (100,000) and small portion of population remained on Victoria Island throughout the year while others migrated to mainland (Manning 1960) | - Known for seasonal migration across the Dolphin and Union Strait (First Joint Meeting 2015)<br>- Humans harvested caribou along this Strait for centuries (Manning 1960; Savelle and Dyke 2002; Brink 2005)<br>- Caribou stopped sea ice crossing to mainland, wintered on Victoria Island in 1920s (Gunn 2008)<br>- Caribou were not seen around Read Island and Byron Bay in 1950s (First Joint Meeting 2015)<br>- 1960s caribou began expanding their range to Cambridge Bay (First Joint Meeting 2015).<br>- Cambridge Bay hunters travelled up to 100 miles north/west on Victoria Island, to hunt Dolphin and Union Caribou or to hunt Peary Caribou on the northern part of the island (First Joint Meeting 2015; Olohaktomiut HTC 2016). |
| First half of 20th century | - Population declined (Gunn 1990)<br>- Caribou stopped migrating between mainland and Victoria Island (Nishi and Gunn 2004)<br>- Almost no caribou sightings in 1900s (Gunn 1990)<br>- 1920s caribou disappeared (Gunn 1990) | |
| 1970s – early 1980s | - Caribou sightings increased, particularly on southern/central Victoria Island (Gunn 1990) | - 1970s – 1997 saw a winter range expansion extending to southern Victoria Island (Figure 8)<br>- Winter migration across the sea ice to the mainland in 1980s (Nishi 2000)<br>- Caribou observed to winter on mainland coast and southern coast of Victoria Island (south of Cambridge Bay) in early 1990s (Figure 8)<br>- Early and mid-1990s - Hunter observations from outpost camps suggest the annual fall migration |
| 1990s | - Population decreasing around Ulukhaktok (Ulukhaktok TK Interviews, 2011-2013) | |
| 1960s – 1990s | - Cambridge Bay local knowledge (Tomaselli et al. 2016a): population increasing around Cambridge Bay | |

| Timeline | Population | Distribution |
|---|---|---|
| | | was consistent and extensive (Nishi and Gunn 2004) |
| 1990s – 2005 | - Cambridge Bay local knowledge (Tomaselli et al. 2016a): pre-declining period with high caribou numbers observed around Cambridge Bay. | -Caribou observed to winter on mainland (Figure 8)<br>-Winter range extending further south than in the past (TK and community knowledge sources cited in SARC 2013) |
| Mid-2005 – end of 2014 | Cambridge Bay local knowledge (Tomaselli et al. 2016a):<br>- Population declined but more evident since 2010<br>- Observed 80% less caribou in 2014 compared to 1990s<br>- Decrease in calves and yearlings<br>- Poorer body condition<br>- Increased observations of abnormalities/diseases in caribou | |
| 2011 – 2015 | - Decrease in numbers around Cambridge Bay (First Joint Meeting 2015) | |

**Population:**

In June 1994, an aerial survey was undertaken in the western two-thirds of Victoria Island and estimated a total of 14,539 ± SE 1,016 caribou which was later extrapolated to 22,368 caribou (Dumond and Lee 2013) (Figure 7). Aerial census during the fall rut is the best approach for population surveys of Dolphin and Union Caribou, and this method was first developed and used in 1997 by Nishi and Gunn (2004). They surveyed the south coast of Victoria Island when Dolphin and Union Caribou were gathered, waiting for freeze up and estimated the population at 27,948 ± SE 3,367 caribou. In 2007, Dumond estimated the population at 21,753 ± SE 2,343 in the survey area on the south part of Victoria Island. Dumond later extrapolated his estimate by increasing it to 27,787 ± CI[5] 7,537, to

[5] Confidence Interval: "A confidence interval accompanies a survey estimate, to represent the variation that exists with this method. It means that if the survey were to be done repeatedly under the same conditions, the estimates would fall within that range. So with a 95% confidence interval, if the survey was repeated many

account for caribou that were outside the survey zone (Dumond 2013; Dumond and Lee 2013). This was completed by using information on collared caribou that had not yet reached the coast at the time of the aerial survey. The same analysis was applied to the 1997 estimates resulting in a revised extrapolated estimate of 34,558 ± CI 6801 caribou (Dumond and Lee 2013). Statistically this decline is not significant ($z = 1.21$, $p = 0.23$), but when combined with other factors, it is thought that a decline is present for Dolphin and Union Caribou (SARC 2013). A trend in the population is difficult to establish from two estimates. Based on the 1997 and 2007 surveys, the conclusion to be made was that the population remained at best stable over that decade, although without monitoring it is impossible to consider how the herd number varied on an annual basis.

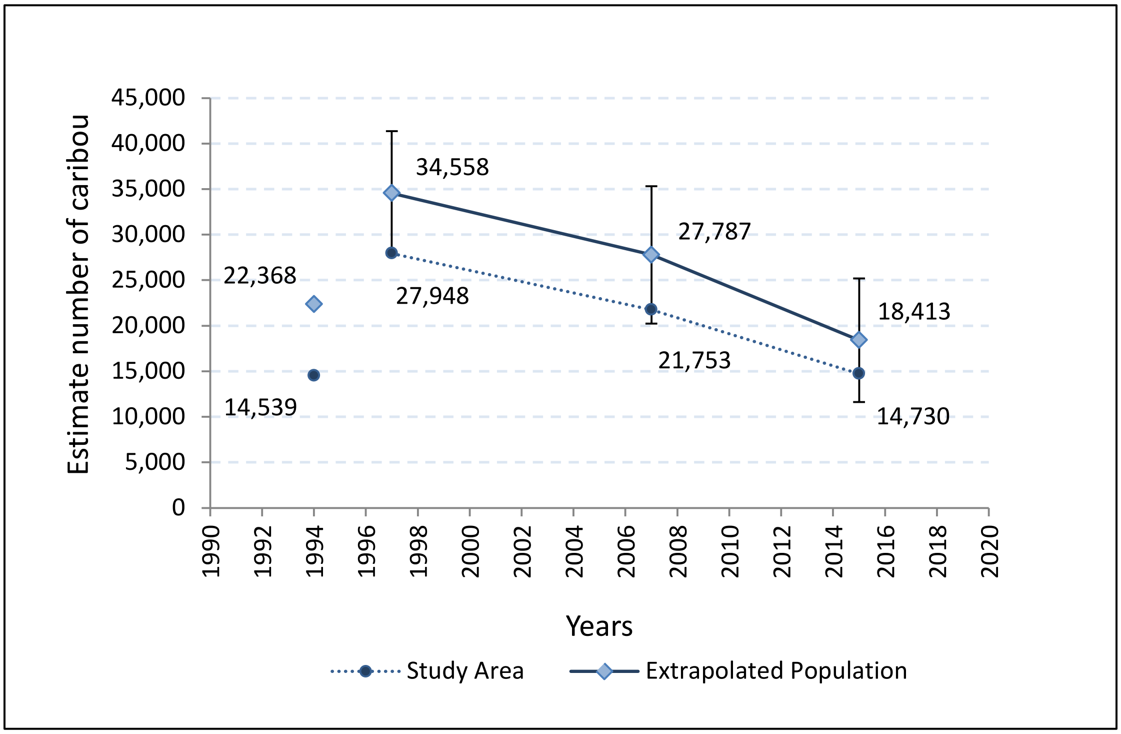


Figure 7. Population estimates from 1994 to 2015.

An aerial population assessment was completed in fall 2015, with the extrapolated population of Dolphin and Union Caribou estimated at 18,413 ± 6,795 (95% Cl, 11,664-25,182) when using information for the current collared caribou (Leclerc and Boulanger in prep.). This estimate shows signs of decline relative to the 2007 survey estimates (z-test,

times, 95% of the time the estimates would fall within that range.” (Advisory Committee for Cooperation on Wildlife Management 2016, p. 8)

Z=-2.19, p=0.036). There has been an overall decline of 33.8%, or 5% annually since 1997. More research and monitoring of this population are needed to better understand the rate of decline. This compares with IQ and local knowledge collected in a study conducted from summer to winter 2014 in the community of Ikaluktutiak (Cambridge Bay) on Victoria Island, Kitikmeot Region, Nunavut. By the end of 2014, community residents reported observing 80% (IQR[6]: 75-90%) fewer Dolphin and Union Caribou in the Ikaluktutiak area (Cambridge Bay area) compared to what they used to see in the 1990s (Tomaselli et al. 2016a). According to IQ and local knowledge, caribou began to decline around 2005, in conjunction with the decline of muskoxen observed in the same area. In addition, since the start of the decline, participants observed a decrease of the juvenile age class (calves and yearlings) that transitioned from 35% (IQR: 30-35) observed prior the decline to 20% (IQR: 15-30) during the decline; an overall decrease of the body condition status; and, finally, an overall increase in animals with abnormalities (morbidity) from 7.5% (IQR: 5-45) prior caribou decline to 30% (IQR: 10-47) during the decline (Tomaselli et al. 2016a). Thus, it will be important to monitor the Dolphin and Union Caribou herd closely over the next several years to obtain demographic characteristics and assess any further signs of decline in productivity and health of the population. More research and monitoring are planned by the GN.

[6] IQR, or interquartile range, is a measure used in descriptive statistics to represent the variability or spread of the observations. In particular, it represents the spread of the 50% of the observations around the median value (Upton and Cook 1996).

**Distribution:**

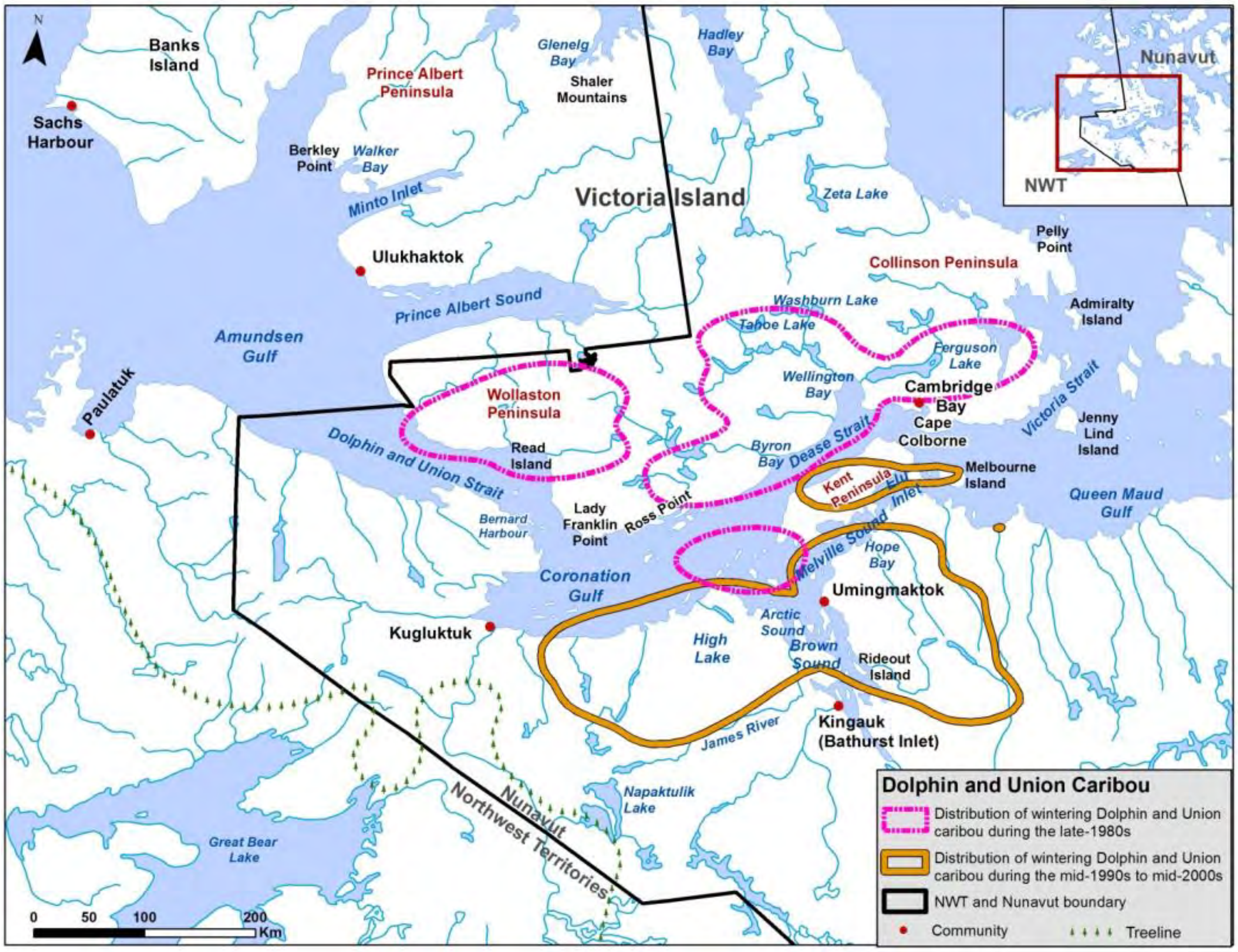


Figure 8. Approximate distribution of wintering Dolphin and Union Caribou during the late 1980s (pink line), and the mid-1990s to mid-2000s (gold line), based on radio-collared caribou. Data from Poole et al. (2010); figure reproduced from the SARC (2013) by B. Fournier, GNWT-ENR 2016.

From their contracted distribution in the first half of the 20th century, the Dolphin and Union Caribou range expanded eastward and southward (First Joint Meeting 2015) (see Figures 4 and 8). Although most of this population crossed the Dolphin Strait at the beginning of the century, the caribou are now more likely to cross closer to the Western Queen Maud Gulf and Dease Strait (Poole et al. 2010). In addition, some Indigenous Peoples indicate that over the last decade, they have observed Dolphin and Union Caribou outside of the species' regular winter range, as far south as the treeline and north of Great Bear Lake (Philip Kadlun of Kugluktuk, cited in Golder Associates Ltd. 2003). In the past 3-4 years around Cambridge Bay, Elders felt that the caribou were using a different migration route (First Joint Meeting 2015). Although speculative, these changes may be related to climate change as the caribou need to find safe ice to cross the strait. They may also need to extend their winter range farther south to find available forage.

# *5.* THREATS AND LIMITING FACTORS

## *5.1 Threat Assessment*

The process of determining threats to Dolphin and Union Caribou was initiated at a joint meeting of co-management partners in Kugluktuk in March 2015 (First Joint Meeting 2015). This meeting included local communities, organizations and government agencies and was followed up by a second joint meeting in January 2016 in Cambridge Bay (Second Joint Meeting 2016). The threats identified during these meetings are documented and explained in this section.

The Dolphin and Union Caribou threat assessment (Table 4) is based on the International Union for the Conservation of Nature (IUCN) - Conservation Measures Partnership unified threats classification system (2006). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 5.2. The threat classification table for Dolphin and Union Caribou (Table 4; Appendix A) was completed by a panel of IQ, TK and scientific experts on Dolphin and Union Caribou in December 2014 and updated in February 2016.

Table 4. Threat calculator assessment

| Threat # | Threat | Impact[a] | Scope[b] | Severity[c] | Timing[d] | Description |
|---|---|---|---|---|---|---|
| 1 | Residential & commercial development | Negligible | Negligible | Extreme | High | |
| 1.1 | Housing & urban areas | Negligible | Negligible | Extreme | High | |
| 3 | Energy production & mining | Low | Restricted | Slight | | |
| 3.1 | Oil & gas drilling | Not Calculated | | | Insignificant/ Negligible | |
| 3.2 | Mining & quarrying | Low | Restricted | Slight | High | • Mining (excluding roads / flights / shipping) |
| 4 | Transportation & service corridors | High | Pervasive - Large | Serious | Moderate | |
| 4.1 | Roads & railroads | Low | Restricted | Slight | Moderate | • Roads |
| 4.2 | Utility & service lines | Negligible | Negligible | Negligible | Unknown | |
| 4.3 | Shipping lanes | High | Pervasive - Large | Serious | High | • Marine traffic / ice breaking |
| 4.4 | Flight paths | Low | Restricted | Slight | High | • Scheduled flights |
| 5 | Biological resource use | Medium - Low | Pervasive | Moderate - Slight | High | |
| 5.1 | Hunting & collection | Medium - Low | Pervasive | Moderate - Slight | High | • Harvest |
| 6 | Human intrusions & disturbance | Negligible | Restricted | Negligible | High | |
| 6.1 | Recreational activities | Negligible | Negligible | Negligible | High | |
| 6.2 | War, civil unrest, & military exercises | Not Calculated | | | Insignificant/ Negligible | |
| 6.3 | Work & other activities | Negligible | Restricted | Negligible | High | • Unscheduled flights |
| 8 | Invasive & other problematic species & genes | High - Low | Pervasive | Serious - Slight | High | |
| 8.1 | Invasive non-native/alien species | Medium - Low | Large - Restricted | Moderate | High | • Parasites and diseases (both native and non-native) |
| 8.2 | Problematic native species | High - Low | Pervasive | Serious - Slight | High | • Predation (eg wolves, grizzly)<br>• Competition (eg muskoxen)<br>• Insect harassment |
| 8.3 | Introduced genetic material | Unknown | Large - Small | Unknown | High | • Interbreeding |
| 9 | Pollution | Not Calculated | | | | |
| 9.4 | Garbage & solid waste | Not Calculated | | | | |
| 11 | Climate change & severe weather | Medium – Low | Pervasive | Moderate - Slight | High | |
| 11.1 | Habitat shifting & alteration | Medium – Low | Pervasive | Moderate - Slight | High | • Sea ice loss<br>• Vegetation changes |
| 11.4 | Storms & flooding | Medium - Low | Large | Moderate - Slight | Moderate | • Icing Events |
| **Overall Threat Impact: Very High – High** | | | | | | |

[a] Impact is calculated based on scope and severity. Categories include: very high, high, medium, low, unknown, negligible

[b] Scope is the proportion of the population that can reasonably be expected to be affected by the threat within the next 10 years. Categories include: Pervasive (71-100%); Large (31-70%); Restricted (11-30%); Small (1-10%); Negligible (<1%), Unknown. Categories can also be combined (e.g., Large-Restricted = 11-70%).

[c] Severity is, within the scope, the level of damage to the species (assessed as the % decline expected over the next three generations [7years = 1 generation for Dolphin and Union Caribou]) due to threats that will occur in the next 10 years. Categories include: Extreme (71-100%); Serious (31-70%); Moderate (11-30%); Slight (1-10%); Negligible (<1%), Unknown. Categories can also be combined (e.g., Moderate to slight = 1-30%).

[d] Timing describes the immediacy of the threat. Categories include: High (continuing); Moderate (possibly in the short term [<10 years or three generations]); Low (possibly in the long term [>10 years or three generations]); Negligible (past or no direct effect); Unknown.

## *5.2 Description of Threats*

Threats are the proximate activities or processes that directly and negatively affect the Dolphin and Union Caribou population. There are a variety of threats that affect Dolphin and Union Caribou and their habitat across Victoria Island and the mainland. The threats presented here represent those found in both the NWT and Nunavut.

The overall calculated Threat Impact for this population is Very-High to High (Table 4). The most significant threats to Dolphin and Union Caribou are shipping lanes and predation. Other important threats are habitat change due to climate change (particularly sea ice loss), icing events, harvest, parasites, diseases and insect harassment. Mining, roads and aircraft flights are also threats to this species. Each threat discussed by the panel is described below from high to low impact and each threat category has a standard number that correlates to the IUCN classification system.

### 5.2.1. Changes to sea ice affecting migration

The threats that result in changes to sea ice affecting caribou migration (marine traffic [IUCN #4.3] and sea ice loss due to climate change [IUCN #11.1]) are discussed sequentially here due to their similar impacts, even though the causes differ.

<u>IUCN Threat #4.3 Shipping Lanes (High Impact)</u>

An increase in shipping traffic when sea ice is forming or during the ice season poses a grave threat to Dolphin and Union Caribou. The threat is exacerbated by a continually growing shipping season (due to a shorter sea ice season) that allows more access through the straits for marine traffic. Combined, these two factors interfere with the formation of sea ice and increase the risk of caribou drowning.

An increase in shipping, including icebreaking, is already evident in the straits between Victoria Island and the mainland - the primary migration route for Dolphin and Union Caribou (Poole et al. 2010; Dumond et al. 2013; ENR 2015b; ENR 2016; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Second Joint Meeting 2016). Similar observations were made with Peary Caribou (Miller et al. 2005), which can be related to Dolphin and Union Caribou. The number of transits through the Northwest Passage increased from four per year in the 1980s to 20-30 per year in 2009-2013 (ENR 2015b). The greater portion of these transits are icebreakers on coast guard and research duties, small vessels or adventurers, cruise ships, and tug and supply vessels with the majority of trips being made between August and October. A large portion of the rise in transits since the late 1980s is due to a rise in tug-supply vessels for the oil and gas industry, half of which have icebreaking capacity (ENR 2015b). The majority of ships travel through the Amundsen Gulf, Dolphin and Union Strait and Dease Strait, close to the Arctic mainland. Only 8% of transits travel the Beaufort Sea through the northern routes around Banks Island (ENR 2015b). Overall, annual commercial use of the Northwest Passage by ships with icebreaking capacity or that are escorted by icebreakers has been increasing rapidly. Higher risk of oil or waste spills, changes in ice conditions due to leads by ship wakes, and impacts on wildlife and marine species are some potential effects of increased shipping activities (ENR 2015b; ENR 2016).

Indigenous communities have observed this rise in marine traffic and are concerned about its impacts on sea ice formation. They have already noted an increase in the number of caribou drownings in recent years, sometimes hundreds of caribou (Thorpe et al. 2001; Miller et al. 2005; First Joint Meeting 2015; Second Joint Meeting 2016). One harvester mentioned that he had seen a ship break through 12 inches of ice in the third week of October during fall migration (Ekaluktutiak HTO 2016). Another community member explained that a further increase in shipping will likely not allow adequate time for the ice to re-freeze, since three inches of ice is needed to allow caribou to cross (First Joint Meeting 2015). The community's concerns extend to the safety of harvesters and others out on the ice as well as other species including muskox (Ekaluktutiak HTO 2016).

Researchers have also noted an increase in shipping, changes in timing and patterns of sea ice formation and its impact on caribou migration. Dumond et al. (2013) documented a delay in migratory movements due to the temporary maintenance of an open-water boat channel at Cambridge Bay in 2007. Shipping during the ice free season (June to August) has a negligible impact on Dolphin and Union Caribou. However, if shipping were to become year round, or earlier in the spring or late fall, there could potentially be further consequences for Dolphin and Union Caribou. An increase in shipping activities in October would impact sea ice formation, which could then impact Dolphin and Union migration (Table 2). Some researchers suggest that year round marine traffic and ice breaking activities could ultimately prevent the Dolphin and Union Caribou's fall and spring migrations altogether and fragment the Dolphin and Union range (Miller et al. 2005).

There is a strong economic incentive to allow more shipping and ice breaking activity in Canada's Arctic, particularly through the Northwest Passage. Nationally, it would provide opportunities for exploration and extraction of natural resources. It would also allow more access to tourism, particularly cruise ships traveling through the open channels. Internationally, the appeal of the Northwest Passage lies in the 11,000 km that would be removed from the Europe-Asia route through the Panama Canal and the 19,000 km that would be cut off the trip around Cape Horn for the supertankers that are too big to use the Panama Canal (Kerr, as cited in Miller et al. 2005). In fact, year-round shipping, and/or the creation of shipping lanes through Arctic waters have already been proposed as part of some resource extraction projects (Miller et al. 2005; Dumond et al. 2013) and the Canadian Coast Guard has been tasked with developing Northern Marine Transportation Corridors (Canadian Coast Guard 2014).

<u>IUCN Threat #11.1 Habitat Shifting and Alteration* (Medium - Low Impact)</u>

*Note - This threat as assessed includes vegetation changes, discussed in Section 5.2.5.

Among the many impacts of climate change across the Arctic (see the other aspects of IUCN Threat #11.1 Habitat Shifting and Alteration, below), the most significant impact for

Dolphin and Union Caribou is the change in sea ice along their migratory route. As noted in the threat listed above (shipping lanes), thinner and/or unstable ice cannot support the weight of caribou during their migration.

Warming temperatures in the Arctic are causing ice freeze-up to take place later in the fall, and spring thaw to take place earlier in the season (Miller et al. 2005; Gunn 2008; Poole et al. 2010; First Joint Meeting 2015; Kugluktuk HTO 2016; Second Joint Meeting 2016). On the south coast of Victoria Island, warmer fall temperatures have been recorded over the last sixty years, resulting in delays in sea ice formation. New ice formation (newly formed, less than 10 cm thick) occurred 10 days later in 2008 than in 1982, and grey ice formation (10-15 cm thick) formed 8 days later during the same period (Poole et al. 2010). Warmer temperatures diminish the chances of sea ice achieving uniform thickness and Inuit have reported high mortality among Dolphin and Union Caribou due to migration over thin, unstable and freshly formed sea ice (First Joint Meeting 2015; Second Joint Meeting 2016). Although caribou can swim, they are unlikely to cross distances longer than a few kilometres (Dumond et al. 2013) and sometimes cannot pull themselves out of the water (SARC 2013).

Climate change is seen by some Inuit as the most important threat for Dolphin and Union Caribou (First Joint Meeting 2015; Kugluktuk HTO 2016). With the change in sea ice formation, some Dolphin and Union Caribou may not complete their migration to the mainland and instead are left stranded on the ice, where they drift out to sea. They eventually perish from starvation and/or exhaustion, while attempting to swim back to land (Kugluktuk HTO 2016). There are hunters who have seen up to 150 caribou floating on a piece of ice in the Coronation Gulf and sometimes they are even found frozen into the sea ice with their head protruding from the ice (First Joint Meeting 2015). Other caribou have been known to swim to land but have perished soon after emerging from the water (Allen Niptanatiak and Dustin Fredlund, as cited in Dumond et al. 2013). Of the caribou who survive, in recent years, hunters have observed an increasing number on the mainland with a thick coat of ice on their fur, indicating that caribou fell through the ice but were able to make it to the nearby shore of the mainland (Poole et al. 2010; Dumond et al. 2013; Kugluktuk HTO 2016). Ice build-up on their fur is challenging for caribou and adds to their stress (Kugluktuk HTO 2016).

With the delay in freeze up, caribou may waste energy changing their movement pattern in the east-west direction looking for an ice formation that will allow them to start migration. One community member noted that Dolphin and Union Caribou were still migrating past Cambridge Bay in January of 2016, which was surprising since the caribou have usually finished their migration by January (Second Joint Meeting 2016). Other harvesters have noticed that some caribou try to cross the sea ice earlier than in the past, which is becoming increasingly dangerous (Kugluktuk HTO 2016).

The delay in freeze-up and milder fall conditions could also result in a longer staging time on the south coast of Victoria Island. This delay forces Dolphin and Union Caribou to use summer fat reserves and may also increase grazing pressure on portions of their range (Poole et al. 2010). A longer staging time, particularly on the southern coast of Victoria Island, also results in increased vulnerability to predation and harvest (Poole et al. 2010).

*Cumulative Impacts of Changes to Sea Ice*

Given their migration patterns, seasonal connectivity of the sea ice between Victoria Island and the mainland is essential to Dolphin and Union Caribou. Combined, marine traffic (calculated as a high impact threat) and climate change (calculated as a medium-low impact threat) can affect ice formation to the point where this species may be forced to stop their migrations. It is questionable whether Victoria Island could support a self-sustaining population if the ability to cross the ice is lost (Miller et al. 2005; Dumond et al. 2013). Although there was a time historically when migration across the sea ice stopped and caribou remained on Victoria Island year-round, caribou numbers at that time were extremely low, possibly due to icing events and the introduction of rifles (Manning 1960; Gunn 1990). Later in the 20th century, as the population increased, their migration resumed. It is believed that the sea ice connection may have been fundamental to the recovery of the Dolphin and Union Caribou (see Section 4.4).

### 5.2.2 Predation and competition

IUCN Threat #8.2 Problematic Native Species (High - Low Impact)

There are various species that may negatively affect the Dolphin and Union Caribou through predation or competition, but there is still uncertainty around their impacts at a population level.

***Arctic Wolves (Canis lupus arctos)***

Wolves are the primary predators of Dolphin and Union Caribou and their pressure on the population size is difficult to measure. Community members have noticed an increase in wolf numbers over the last 10 to 20 years. In interviews conducted in the 1990s, it was felt this increase did not have a negative effect on caribou (Adjun 1990); but more recently, Inuit and Inuvialuit have expressed serious concerns over a rise in wolf numbers and its potential impacts (Ulukhaktok TK interviews 2011-2013; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Second Joint Meeting 2016). One hunter reported that he saw seven or eight caribou taken down by wolves within one mile (Second Joint Meeting 2016). Some Indigenous Peoples have voiced concern that wolf predation is not being given enough attention, considering that wolves are the primary predators of Dolphin and Union Caribou (Ekaluktutiak HTO 2016).

In the 1960s, Inuit would traditionally track down wolf dens and kill wolf pups as a measure to control wolf numbers. Nowadays, this practice is becoming less common and these specific skill sets are slowly vanishing (First Joint Meeting 2015).

There is little scientific information available on wolf abundance or its impacts on caribou. Sightings of wolves during aerial surveys for caribou and muskoxen have increased (SARC 2013), although it is important to note that predator observations during aerial surveys are not indicative of a species' population size. Numbers of muskoxen increased on Victoria Island in the 1990s (Gunn and Patterson 2012) and it has been theorized that the muskox population may support more wolves, leading to a potential increase in predation of Dolphin and Union Caribou (SARC 2013). However, there is no direct scientific information on predation rates. More research is needed to learn about wolf interactions with Dolphin and Union Caribou.

***Grizzly Bear (Ursus arctos)***

Since the early 2000s, more grizzly bears have been observed on Banks Island and Victoria Island than in the past (Dumond et al. 2007; Slavik 2011; SARC 2013; First Joint Meeting 2015; Joint Secretariat 2015; Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016). This increase could be related to fewer bears being shot for food (Dumond et al. 2007) and/or a northward expansion of their range, perhaps due to changes in habitat and prey availability (SARC 2012a; SARC 2012b; SARC 2013; First Joint Meeting 2015). Grizzly bears usually focus their predation efforts on young caribou, particularly newborn calves. However, with the dispersed calving practices of Dolphin and Union Caribou, the impact of grizzly bears on this population may be limited (SARC 2013).

***Other predators***

Indigenous Peoples are also seeing more bald eagles. This presents further challenges to Dolphin and Union Caribou because bald eagles, like golden eagles, feed on calves (Kugluktuk HTO 2016).

***Muskoxen (Ovibos moschatus) and other herbivores***

Some Indigenous Peoples cite muskoxen as having a negative influence on Dolphin and Union Caribou due to competition for forage and/or avoidance (Gunn 2005; Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016). According to IQ and TK sources, muskoxen have been known to trample the ground and dig up plants, decreasing available forage for caribou (Ulukhaktok TK interviews 2011-2013). Some TK holders have expressed concern over the relationship between caribou and muskox, noting that muskoxen are known to displace the caribou by their smell (Ulukhaktok TK interviews 2011-2013). Other TK holders such as those near Umingmaktok, say that for the last 25 years, they have observed caribou and muskox sharing habitat and grazing next to each other during the winter months (First Joint Meeting 2015).

There are differing opinions in the scientific literature about whether and under what conditions muskoxen and other herbivores (e.g., hare, ptarmigan and lemming) compete with caribou for forage or space (Larter et al. 2002; Gunn and Adamczewski 2003). Muskox abundance increased on Victoria Island in the 1980s and 1990s (Gunn and Paterson 2012), but showed a decline from 2013-2014 (L. Leclerc, pers. comm. 2016). Schaefer et al. (1996) found that the habitat use patterns of muskoxen, hares and ptarmigan foraging on southeast Victoria Island in the 1990s did not overlap with caribou. However, Hughes (2006) found overlap in diet and habitat use between muskoxen and caribou on southern Victoria Island in the mid-2000s and suggested that inter-specific competition was taking place. It has also been suggested that muskoxen (as alternate prey) could sustain wolf predation on Dolphin and Union Caribou, or could influence caribou-parasite relationships (Hughes et al. 2009; SARC 2013).

***Geese***

Populations of Snow Geese (*Chen caerulescens*) and Ross's Geese (*Chen rossii*) on the east side of the Dolphin and Union Caribou wintering range have increased to well above their population objectives; they have now been designated as overabundant (CWS Waterfowl Committee 2014; 2015). The population of Greater White-fronted Geese (*Anser albifrons*) has also increased substantially since the late 1980s (CWS Waterfowl Committee 2015). In the Queen Maud Gulf, geese have become so abundant, they have expanded beyond prime nesting sites to marginal sites. Their substantial populations are affecting the vegetation, which raised concerns that arctic ecosystems were possibly imperiled through intensive grazing (Batt 1997). Their impacts include vegetation removal through the alteration or elimination of plant communities, which can transform the soil into mud and can cause changes to soil salinity, nitrogen dynamics and moisture levels (CWS Waterfowl Committee 2014; 2015). Communities indicate that these changes compromise Dolphin and Union Caribou forage during winter (First Joint Meeting 2015; Second Joint Meeting 2016). Snow geese and Ross's geese are subject to special conservation measures to control their abundance but success of the measures to date has been mixed (CWS Waterfowl Committee 2014).

Inuit and Inuvialuit have also noted an overabundance of geese over the past decade (First Joint Meeting 2015). In particular, they point out the resulting habitat destruction on Victoria Island. To date, there has been no scientific research examining the impacts of habitat destruction on caribou specifically, but community members have voiced concern over this trend (First Joint Meeting 2015).

### 5.2.3 Harvest

*IUCN Threat #5.1 Hunting and Collecting (Medium – Low Impact)*

Although this threat was assessed according to IUCN criteria as having a medium-low impact, arguments could be made to rank the threat as a high-low impact due to uncertainty of harvest levels. At the December 2014 meeting of scientific and TK experts, the impact classification was high-low. This was later changed to medium-low impact in February 2016 as the panel of experts felt this was more representative of the current impact of harvesting, given that the population has been less accessible to communities in recent years.

Harvest is important to beneficiaries in the communities within the range of the Dolphin and Union Caribou population. Dolphin and Union Caribou can currently be lawfully harvested by Indigenous Peoples and resident and non-resident hunters (defined in Section 3.1) throughout the Nunavut and NWT[7] range. Harvesting directly affects the caribou population by removing individuals from the herd. The impact of harvest is less important when caribou are abundant and numbers are increasing, particularly if the rate of harvest is low. However, harvest can have a negative impact when the population is declining or low, particularly if the rate of harvest is high. The effects of harvest on a population depend not just on the total number of caribou taken, but also on the sex ratio and age structure of the harvest, and whether the population is increasing, decreasing or stable.

Currently, harvest levels and overall harvest rate for the Dolphin and Union Caribou population are unknown. Therefore, there is uncertainty around how harvest affects the population trend. Harvest can have a greater impact on the population trend when the population is declining, since it exacerbates the decline, but the magnitude and extent of the impact is unknown. Previous harvest studies provide an indication of harvest levels at the time (see Section 3.2), but reporting was not (and still is not) mandatory for subsistence harvest. Therefore, the lack of recent data on harvest numbers and the challenges of identifying harvested caribou according to their population, creates considerable uncertainty in estimating harvest levels.

### 5.2.4 Parasites, diseases and insect harassment

*IUCN Threat #8.1 Invasive Non-native* Alien Species (Medium - Low Impact)*

*Note – both native and non-native diseases/parasites were considered in this category

Parasites, disease and insect harassment pose a moderate threat to Dolphin and Union Caribou through effects on body condition, pregnancy rates, and survival. Warmer temperatures allow for transmission of new parasites and diseases, and a longer staging time before fall migration creates prolonged exposure to these parasites and a potential increase in the rate of infection (Poole et al. 2010; Kutz et al. 2015; Tomaselli et al. 2016a). Local communities have reported a rise in diseased caribou (Poole et al. 2010; First Joint Meeting 2015; Tomaselli et al. 2016a) and some Inuit have expressed concern about its potential impacts on human health when consuming the meat (Kugluktuk HTA 2016; Olohaktomiut HTC 2016; Leclerc and Boulanger in prep.).

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[7] At the time of publication of this document, in the NWT, non-resident harvest is not taking place since there are no tags allocated for non-resident hunters.

Concern has been expressed by researchers and communities about brucellosis in Dolphin and Union Caribou and its potential impacts (Ekaluktutiak HTO 2016; First Joint Meeting 2015; Kutz et al. 2015; Olohaktomiut HTC 2016; Second Joint Meeting 2016). The *Brucella* bacterium (which causes Brucellosis) is known to circulate in northern caribou and is endemic in many populations. It was recently confirmed in Dolphin and Union Caribou (Kutz et al. 2015). Its confirmation was not surprising, as it is known that caribou across the barrenlands are periodically infected. Brucellosis is an important cause of infertility in caribou and may play an important role in population declines (Kutz et al. 2015). For example, *Brucella* was associated with the population decline of the Southampton barren-ground caribou population after it was newly introduced to that population (Government of Nunavut 2013). The bacterium also causes swollen joints, which can make caribou more susceptible to predation. Since the mid-2000s, more caribou have been observed with swollen joints and/or limping in the Cambridge Bay area (Tomaselli et al. 2016a). The bacterium has also been found in muskoxen in the same area (Tomaselli et al. 2016b; Tomaselli, PhD candidate, Faculty of Veterinary Medicine, University of Calgary, pers. comm. 2017).

Another bacterium, *Erysipelothrix rhusiopathiae*, appears to cause rapid death of animals in muskoxen and has been implicated in widespread muskox mortalities in the Western Canadian Arctic and Alaska (Kutz et al. 2015). Its impact on caribou is less clear, however the bacterium has been implicated as the cause of death in some barren-ground caribou and woodland caribou in Nunavut, Alberta and B.C. (Kutz et al. 2015; Schwantje et al. 2014). Serology shows that some Dolphin and Union Caribou have been exposed to the bacterium, indicating that it is circulating in the Dolphin and Union Caribou population (Kutz et al. 2015). It has been suggested that this pathogen might play a role in future Dolphin and Union Caribou population dynamics (Kutz et al. 2015).

Two types of lungworms and muscle worms have been detected in Dolphin and Union Caribou. Previously absent in the Arctic islands, *Varestrongylus eleguneniensis* was first discovered on Victoria Island in 2010 and affects both caribou and muskoxen (Kutz et al. 2014). The impacts on caribou are not known; however, it is not likely a major cause of disease (Kutz et al. 2015). It is believed this parasite was introduced by Dolphin and Union Caribou migrations to Victoria Island and warming temperatures have allowed its survival and spread. With warmer temperatures and a longer staging time on the island due to later freeze-up, there is now greater opportunity for exposure to the *Varestongylus* parasite and greater risk of transmission of both this and potentially other diseases (Kutz et al. 2014; Poole et al. 2010; Tomaselli et al. 2016a).

The second species which was recently detected in Dolphin and Union Caribou is *Parelaphostrongylus andersoni* (Kafle et al. in review). Found in caribou across the North American mainland, this parasite lives in the muscles of caribou and travels to the lungs via the bloodstream. In high numbers, the *Parelaphostrongylus* parasite can cause muscle inflammation and wasting as well as lung disease as the eggs and larvae migrate through the lungs (Kutz et al. 2015). The recent detection of this species is the first report of this parasite in Dolphin and Union Caribou and could signal a possible range expansion (Kafle et al. in review).

Nematode roundworms are commonly found as gastrointestinal parasites in caribou and muskoxen and at least two species are shared between muskoxen and Dolphin and Union Caribou (Kutz et al. 2014). At high levels, nematode parasites can cause reduced body condition and pregnancy rates (Hughes et al. 2009; Kutz et al. 2014). In recently collected Dolphin and Union Caribou samples, *Marshallagia marshalli* was detected, but at low levels that are not cause for concern (Kutz et al. 2015).

Warming trends in the Arctic are responsible for longer summers associated with a rise in insect harassment (First Joint Meeting 2015; Russell and Gunn 2016). This trend has been observed since the 1970's (Thorpe et al. 2001; Dumond et al. 2007). In particular, warm and dry weather is responsible for an increase in mosquitos while warm and wet summers produce more warble flies and nose bot flies (Dumond et al. 2007). Warmer temperatures have also allowed for an increase in the number of biting flies and the length of time they are out. Indigenous Peoples have observed an increase in warble flies, nasal bot flies and mosquitos on Victoria Island; where warble flies were previously observed only in the summer, they are now being seen in the spring as well (Bates 2007; Dumond et al. 2007). In the mainland part of the range, from 2000-2014 there was an increasing trend in cumulative January-June growing degree days, reflecting warming temperatures, as well as an increasing trend in the warble fly index (based on temperature and wind) (Russell and Gunn 2016).

With this increase in insects, caribou have been seen constantly running from or shaking off swarms of insects (Kugluktuk HTO 2016). In one severe case, a community member observed caribou running non-stop, back and forth over the period of a day as they tried to seek relief (First Joint Meeting 2015). The insects can sometimes be numerous enough that the caribou are forced to move kilometres back and forth. This avoidance behaviour uses energy and prevents caribou from eating, which affects both fat stores and body condition (First Joint Meeting 2015; Kugluktuk HTO 2016; Second Joint Meeting 2016). Lack of body fat influences the ability of Dolphin and Union Caribou to become pregnant, survive water crossings, migration and the winter season. Hughes et al. (2009) found that female Dolphin and Union Caribou with a high burden of warble infestation had less fat and a lower probability of being pregnant.

### 5.2.5 Other habitat changes due to climate change

*IUCN Threat #11.1 Habitat Shifting and Alteration* (Medium - Low Impact)*

*Note - This threat as assessed includes sea ice loss, discussed above under Section 5.2.1.

There are already many observations of warming temperatures caused by climate change across the Arctic (Riedlinger and Berkes 2001; Nichols et al. 2004; Hinzman et al. 2005; Barber et al, as cited in Poole et al. 2010; IPCC 2014; First Joint Meeting 2015) and warmer summer temperatures have been documented in the range of Dolphin and Union Caribou (Poole et al. 2010). The impacts of climate change on Dolphin and Union Caribou include sea ice loss (discussed in Section 5.2.1) increased insect harassment, and changes to diseases and parasites (both discussed in Section 5.2.4). There has been very little assessment of other changes to Dolphin and Union Caribou habitat, but changes to vegetation could impact the population, since the timing and amount of forage available influences body mass, pregnancy rates and survival (Thomas 1982; Heard 1990; Gerhart et al. 1997; Thorpe et al. 2001).

The warming trend in the Arctic has created a measurable increase in plant productivity (Normalized Difference Vegetation Index, or NDVI) across the western Arctic Islands (Barber et al. 2008; Walker et al. 2011). Changes in plant growth on the tundra were noticed by participants in an IQ study in the 1990s. They found that the vegetation on Victoria Island was becoming more diverse and plentiful with warming temperatures (Thorpe et al. 2001). Such observations suggest that more and better forage may be increasingly available on Victoria Island for caribou. However, in TK interviews conducted from 2011-2013 in Ulukhaktok, poor plant growth linked to dry conditions and freezing was raised as a concern for caribou (Ulukhaktok TK interviews 2011-2013).

Overall, the impacts of climate change on vegetation are complex and there is currently not enough information available to determine whether the cumulative impacts from climate change will generally prove positive or negative for Dolphin and Union Caribou.

### 5.2.6 Icing events

*<u>IUCN Threat #11.4 Storms and Flooding (Medium – Low impact)</u>*

Freeze-thaw events and freezing rain can make a layer of ice on the ground or snow that covers vegetation and makes it inaccessible to foragers (Elias 1993; Ulukhaktok TK interviews 2011-2013). Since only part of the range is affected, these events are localized and may affect only a portion of the population. Where there are large areas affected by icing events, Dolphin and Union Caribou have to live off their fat reserves or move elsewhere, and may perish from starvation (Elias 1993; Thorpe et al. 2001; Ulukhaktok TK interviews 2011-2013). Researchers sometimes associate the years of frequent icing events with a reduction in caribou numbers and fewer harvesting opportunities (Thorpe et al. 2001). For example, in the winter of 1987-88 Cambridge Bay hunters reported freezing rain and caribou dying along the coast; caribou carcasses were later found that appeared to have been malnourished (Gunn and Fournier 2000).

There are indications that icing events are becoming more common in the Dolphin and Union Caribou range. Knowledge holders from the Bathurst Inlet area interviewed by Thorpe et al. (2001) reported an increase in the frequency of freezing rain and freeze-thaw cycles in the 1990s, and some knowledge holders from Ulukhaktok recently reported that freezing rain was happening more now than in the past (Ulukhaktok TK interviews 2011-2013). Scientists have also expressed concern that icing events will become more frequent since climate change models predict warmer temperatures and greater precipitation in the Arctic (e.g., Rinke and Dethloff 2008; Vors and Boyce 2009; Festa-Bianchet et al. 2011). As such, icing events have the potential to become a serious threat to Dolphin and Union Caribou.

### 5.2.7 Mining

*<u>IUCN Threat #3.2 Mining and Quarrying* (Low Impact)</u>*

*Note - This threat as assessed does not include roads, flights or shipping associated with mines. These are considered under IUCN Threats numbers: 4.1 - Roads and railroads, 4.3 – Shipping Lanes, 4.4 – Flight paths and 6.3 – Work and other activities.

Industrial development, particularly mining and activities related to mining, have been identified as a threat to Dolphin and Union Caribou and on the mainland. There are mining exploration projects located in their winter range and one mine is currently entering its operational phase. There is evidence that mining impacts caribou distribution on a local and regional scale as caribou respond to industrial projects by selecting habitat at increasing distances up to the estimated zone of influence (area of reduced caribou occupancy) (Boulanger et al. 2012). Even a small spatial disturbance can have a major effect on caribou (Forbes et al. 2001) and impacts appear to be more important during the calving and pre-calving period (Weir *et al*., 2007; Dyer *et al*., 2001; Nellemann *et al*., 2001). Some research has indicated a decrease in reproductive rates associated with an increase in industrial activities due to habitat alteration, loss or fragmentation (Nellemann et al. 2003). If mines are developed or expanded, they could impact caribou movements, displace caribou from winter foraging sites, and increase access for hunting (SARC 2013). Future mining projects and possible expansion of current mining activities have the potential to disrupt migration corridors and winter feeding grounds (Tuktoyaktuk Community Meeting 2014; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016; Paulatuk HTC 2016; Second Joint Meeting 2016). Once industrial operations cease, concerns may be raised during site cleanups; for example, a caribou was seen with barbed wire from an old Distant Early Warning (DEW) line site caught in its antlers (First Joint Meeting 2015). Although the overall impact of mines to Dolphin and Union Caribou was assessed as low, it was recognized that a higher percentage of the caribou population may be directly affected by mines in the future (Appendix A).

### 5.2.8 Roads

*<u>IUCN Threat #4.1 Roads and Railroads (Low Impact)</u>*

Roads currently have a very small effect on the Dolphin and Union Caribou population, but they could become more of an issue within the next 10 years if the mines and associated roads that are currently being proposed are developed. For example, KIA and the Government of Nunavut have proposed a mine with an all-weather road ending at Grays Bay, west of Bathurst Inlet; the transportation system is known as the Grays Bay Road and Port Project (GBRP). Once completed, it will include 227 km of road connecting the rich mineral resources of Canada to the Arctic shipping routes.

Permanent or temporary roads such as winter roads may influence the spring migration by crossing the caribou migration route (Olohaktomiut HTC 2016). A proposed road to connect mines to a new port in Bathurst Inlet could also impact caribou (Back River Project 2015). Even a single road in the range of Dolphin and Union Caribou could be encountered by a large proportion of the caribou population. Roads also allow increased access for hunters – something that has proven to be a serious issue for other caribou (Vistnes and Nellemann 2008; J. Adamczewski Wildlife Biologist, Ungulates, GNWT, ENR, pers. comm. 2016) and for animals in general (Benítez-López et al. 2010).

Combined with direct mortality, there could be indirect effects from roads, such as changes to caribou movements, and/or displacement from winter foraging sites (SARC 2013). Disturbances such as vehicles can increase energetic costs for caribou if the disturbances interrupt caribou feeding or cause them to move away (Weladji and Forbes 2002).

### 5.2.9 Flights

This section refers to scheduled flights [IUCN #4.4] and flights for other purposes such as research, outfitting and industrial activities [IUCN #6.3].

Caribou are not necessarily disturbed by all air traffic, but low-level aircraft flights and the associated noise can disturb them and lead to increased energetic costs (Weladji and Forbes 2002; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016; Second Joint Meeting 2016;). Community members have voiced concern over aircraft, emphasizing that flights, particularly around mining sites, are already bothering Dolphin and Union Caribou. Some communities note there appears to be an increase in unscheduled aircraft and helicopter flights, and they have voiced unease about the impacts in terms of flight frequency, height and noise (Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Olohaktomiut HTC 2016). Communities are also worried about industry failing to respect guidelines (Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Olohaktomiut HTO 2016; Second Joint Meeting 2016). It has been suggested that flights should be at high altitude over calving areas or should not be allowed at all where caribou are calving (SARC 2013; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Second Joint Meeting 2016).

From 2010 to 2014, the average number of airplane and helicopter takeoffs and landings per day at airports was 3.7 in Ulukhaktok, 9.1 in Kugluktuk, and 14.1 in Cambridge Bay

(Statistics Canada 2014). This statistic does not include flights taking off from other locations such as field camps and mine sites.

*IUCN Threat #4.4 Flight Paths*  (Low Impact)*

*Note - This threat as assessed includes scheduled flights only.

An increase in mining activities may result in more scheduled flights, which could increase the level of disturbance to Dolphin and Union Caribou.  In the future, scheduled flights to mines could outnumber flights to communities, although flights would be mostly at high altitude and would disturb caribou during takeoff and landing. Caribou may also be disturbed if current flight paths for scheduled flights were altered to overlap with calving areas.

*IUCN Threat #6.3 Work and Other Activities  (Negligible Impact)*

Helicopters and fixed-wing aircraft used by surveyors, mine workers, outfitters, the military, and researchers can be disruptive to Dolphin and Union Caribou, particularly during the calving season.  Flights around mine sites to move equipment and workers, and conduct other mine-related work, creates disturbance, and flights around field camps to carry out research can also be disruptive to Dolphin and Union Caribou.

#### 5.2.10  Other threats

A number of other possible threats were considered and deemed to have unknown impact, negligible impact, or no direct effect at the present time (i.e. impact not calculated by the IUCN threat calculator).  These threats are explored in Appendix A, with the following results.  Airborne pollutants were thought to have no direct effect at the present time and introduced genetic material was thought to have an unknown impact although some exchange with mainland herds had occurred. Recreational activities / housing and urban areas / utilities and service lines had a negligible impact.  Garbage and solid waste / oil and gas drilling / war, civil unrest and military exercise did not calculate an impact.

### *5.3 Knowledge Gaps*

There are knowledge gaps about Dolphin and Union Caribou that need to be addressed to assist in management. The key knowledge gaps are listed below.

**High Priority:**

1. Population/demography: Demographic information such as pregnancy, survival and recruitment rates are all important indicators of population trend that can inform management decisions. These data are lacking for Dolphin and Union Caribou.

2. Health of caribou, including disease parasites, toxicology and contaminant load. This would also include examining transfer of disease through migratory bird droppings

and/or insects. Research was conducted in 2015 on caribou health, including disease and parasites; the results of this research should be analyzed and reported, and monitoring of caribou health should continue.

3. Harvest: In order to establish an appropriate harvest rate that allows for a self-sustaining population, accurate harvest data is necessary. Harvest reporting is currently not mandatory so precise harvest numbers, including sex ratio, are unknown. Therefore, accurate harvest data is needed in order to determine appropriate harvest rates by local communities.

4. Predator-prey relationships: There has been very little research carried out on the relationship between Dolphin and Union Caribou and their predators (wolves and grizzly bears). Scientific information is lacking on predation rates and how predators affect Dolphin and Union Caribou at the population level. It was agreed that further research should be carried out on these relationships (First Joint Meeting 2015).

5. Potential impact of future development on Dolphin and Union Caribou: Since Dolphin and Union Caribou winter in an area of high mineral potential where future mine sites and roads may be built, knowledge should be gathered focusing on the impact of these potential developments on herd resilience and population trend.

**Medium Priority:**

6. Vegetation changes and diet: Climate change may impact Dolphin and Union Caribou through changes to vegetation including the timing, growth, and types of plants. These changes are not well understood. There is also a need for more information on the diet of Dolphin and Union Caribou, to better understand these changes.

7. Changes to insect population and distribution: Climate change may lead to an increase in insect harassment, transfer of disease through insects and potentially the establishment of new insect species in Dolphin and Union Caribou range. Research on these topics would be helpful for understanding the potential impacts on Dolphin and Union Caribou.

**Low Priority:**

8. Competition: Concerns have been raised about the impacts of muskoxen and over-abundant geese on Dolphin and Union Caribou and their habitat. More research examining the impacts of these interactions would assist in managing Dolphin and Union Caribou.

9. Interbreeding: There has been concern expressed over potential interbreeding between Dolphin and Union Caribou and other subspecies and populations of caribou. There is very little research on the degree of interbreeding (if any) and its possible impacts. More knowledge on this topic would benefit Dolphin and Union Caribou.

# 6. MANAGEMENT

## 6.1 Management Goal

Recognizing the ecological, cultural and economic importance of Dolphin and Union Caribou, the goal of this management plan is to maintain the long term persistence of a healthy and viable Dolphin and Union Caribou population that moves freely across its current range and provides sustainable harvest opportunities for current and future generations.

## 6.2 Management Objectives

There are five objectives for the management of Dolphin and Union Caribou. These objectives apply broadly across the population's range in both NWT and Nunavut. They are listed in Table 5 in no particular order.

Table 5. Management objectives

| | |
|---|---|
| Objective 1 | Adaptively co-manage Dolphin and Union Caribou using a community-based approach. |
| Objective 2 | Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach. |
| Objective 3 | Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods. |
| Objective 4 | Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range. |
| Objective 5 | Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities. |

## *6.3 Approaches to Management of the Dolphin and Union Caribou*

This management plan recommends the approaches discussed below (Table 6) to achieve the management objectives. It provides additional information for each management approach including the relative priority, time frame, threats and/or knowledge gaps addressed, and performance measures and indicators. More specific recommended actions under each approach are provided in Appendix B. All management partners will need to work collaboratively on these approaches, and depending on the partner's mandate, some could work more closely on specific approach(es) or action(s). Individual community level plans and/or HTO/HTC initiatives can also be carried out to implement these approaches.

Table 6. Approaches to management of the Dolphin and Union Caribou.

| Objective | Management Approaches | Threats and/or knowledge gaps addressed | Relative Priority[8] / Time frame[9] | Performance Measures[10] |
|---|---|---|---|---|
| **Objective #1:**<br><br>**Adaptively co-manage Dolphin and Union Caribou using a community-based approach.** | 1.1 Hold regular meetings with co-management partners, Indigenous governments and organizations, and local harvesting committees to make recommendations on Dolphin and Union Caribou management, and to implement these, using co-management processes and adaptive management principles. | Enables adaptive management.<br>• Potential to address all threats and provide information on all knowledge gaps | Critical / Ongoing | • Co-management partners share IQ, TK, local and scientific knowledge with each other on an ongoing basis.<br>• All co-management partners review and discuss management practices & recommendations through attending regular meetings. |

[8] **Relative priority** can be *critical, necessary* or *beneficial*. Critical approaches are the highest priority for the conservation of Dolphin and Union Caribou and should be implemented sooner rather than later. Necessary approaches are important to implement for the conservation of Dolphin and Union Caribou but with less urgency than critical. Beneficial approaches help to achieve management goals but are less important to the conservation of the species compared to critical or necessary.
[9] **Relative timeframe** can be short-term, long-term, or ongoing. Short-term approaches should be completed within five years (2023) and long-term approaches require more than five years to complete (2028). Ongoing approaches are long-term actions carried out repeatedly on a systematic basis
[10] **Performance Measures:** This table represents guidance from all partners as to the priority of the approaches and appropriate measure of performance.

| Objective | Management Approaches | Threats and/or knowledge gaps addressed | Relative Priority[8] / Time frame[9] | Performance Measures[10] |
|---|---|---|---|---|
| **Objective #2:**<br><br>**Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.** | 2.1 Encourage flow and exchange of information between management partners, communities, industry, regulatory boards, non-governmental organizations (NGOs), and the public, using various approaches to promote better understanding of Dolphin and Union Caribou and the threats they face. | • Potential to address all threats and provide information on all knowledge gaps | Necessary/ Ongoing | • Community members such as teachers, elders, and others detect an increased knowledge level by youth regarding traditional hunting practices and overall Dolphin and Union Caribou management.<br>• Knowledge level of industry and regulatory boards increases with respect to Dolphin and Union Caribou management, by considering Dolphin and Union Caribou in project proposals.<br>• Knowledge level of public increases with regard to Dolphin and Union Caribou (possibly via NGO public education).<br>• More communities share harvesting information with one another.<br>• Increase in information collected and information products (e.g., e-mails/ pamphlets/presentations) available to managers and communities. |
| **Objective #3:**<br><br>**Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.** | 3.1 Monitor Dolphin and Union Caribou population number, distribution, and demographic indicators to determine population level and trend. | Enables adaptive management<br><br>**Knowledge Gaps:**<br>• Population/ demography<br>• Interbreeding | Critical / Ongoing | • Maintain a long term monitoring program for population level, distribution and demographic indicators; trends in population are monitored using IQ, TK, local knowledge and scientific methods.<br>• Increase in monitoring information that is collected.<br>• Increased knowledge with respect to knowledge gaps. |
| | 3.2 Improve our overall understanding of Dolphin and Union Caribou | Enables adaptive management | Critical / Ongoing | • Increase knowledge of how climate change, parasites, diseases, insects, muskoxen/geese competition, and |

| Objective | Management Approaches | Threats and/or knowledge gaps addressed | Relative Priority[8] / Time frame[9] | Performance Measures[10] |
|---|---|---|---|---|
| | health, biology and habitat requirements, diet, and effects of climate change. | **Threats:**<br>• Habitat changes due to climate change<br>• Predation and competition (muskoxen and geese)<br>• Parasites, diseases and insect harassment<br>• Changes to sea ice affecting migration<br>**Knowledge Gaps:**<br>• Health of caribou<br>• Vegetation changes and diet<br>• Changes to insect population and distribution<br>• Competition from muskoxen and geese<br>• Interbreeding | | interbreeding impact the Dolphin and Union Caribou population.<br>• Increase co-management partner knowledge of these impacts on Dolphin and Union Caribou and of their biology through meetings and information products. |
| | 3.3 Assess cumulative impacts on Dolphin and Union Caribou population and habitat. | • Potential to address all threats and provide information on all knowledge gaps | Necessary/ Ongoing | • Cumulative effects model is developed and used. |
| | 3.4 Co-ordinate the gathering of information and research among different co-management partners and research institutions. | • Potential to address all threats and provide information on all knowledge gaps | Necessary/ Ongoing | • Increase in number of collaborative research projects carried out.<br>• Results shared with co-management partners.<br>• Relevant information compiled. |

| Objective | Management Approaches | Threats and/or knowledge gaps addressed | Relative Priority[8] / Time frame[9] | Performance Measures[10] |
|---|---|---|---|---|
| **Objective #4:**<br><br>**Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.** | 4.1 Monitor changes to habitat from anthropogenic and natural disturbances on an ongoing basis. | **Threats:**<br>• Changes to sea ice affecting migration<br>• Mining<br>• Roads<br>• Predation and Competition (geese and muskoxen)<br><br>**Knowledge Gaps:**<br>• Diet and vegetation changes (climate change)<br>• Competition (geese and muskoxen) | Critical / Ongoing | • Information on changes to habitat (natural & man-made) is collected and shared frequently with co-management partners. |
| | 4.2 Proactively work with marine/ industry/transportation organizations and regulators to minimize human and industrial disturbance and seek ways to preserve sea ice crossings. | **Threats:**<br>• Changes to sea ice affecting migration (climate change, shipping, ice-breaking)<br>• Mining<br>• Roads<br>• Flights<br><br>**Knowledge Gaps:**<br>• Diet and vegetation changes (climate change) | Critical / Ongoing | • Potential partners and mechanisms are identified for collaborative work on appropriate actions listed under 4.2, including seeking ways to preserve sea ice crossings.<br>• Guidelines, standard advice and best practices are developed, accepted, and used, including during project reviews.<br>• Dolphin and Union Caribou concerns are brought forward in regulatory processes.<br>• Dolphin and Union Caribou habitat needs are incorporated into land use planning (including terrestrial and marine areas). |
| | 4.3 Manage populations of other species that affect Dolphin and Union Caribou habitat. | **Threats:**<br>• Predation & Competition (geese, muskoxen) | Necessary/ Short Term | • Decrease in populations of overabundant species (e.g., geese).<br>• Periodic reports on population level of overabundant species. |

| Objective | Management Approaches | Threats and/or knowledge gaps addressed | Relative Priority[8] / Time frame[9] | Performance Measures[10] |
|---|---|---|---|---|
| | | **Knowledge Gaps:**<br>• Competition (geese and muskoxen) | | |
| **Objective #5: Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.** | 5.1 Obtain accurate harvest data. | **Threats:**<br>• Harvesting beyond a sustainable rate<br><br>**Knowledge Gaps:**<br>• Population/ demography<br>• Harvest<br>• Health of caribou (disease, toxicology and contaminant load)<br>• Interbreeding | Critical / Ongoing | • Increased awareness among community members of the importance of reporting accurate and complete harvest data.<br>• Accurate harvest data is collected and shared among all co-management partners.<br>• Increased awareness and use of caribou sample kits among harvesters. Basic kits could ask for information on the date/location of harvest, assessment of body condition, measurements of back fat depth, skin, hair and feces collection etc. |
| | 5.2 Manage harvesting activities within acceptable limits using adaptive management techniques included in Section 6, to ensure that harvesting opportunities are available in the future and treaty rights are fully respected. | **Threats:**<br>• Harvesting beyond a sustainable rate<br><br>**Knowledge Gaps:**<br>• Population/ demography<br>• Harvest | Critical / Ongoing | • Refine and adapt Dolphin and Union Caribou harvest management guidance as new information becomes available.<br>• Recommendations on harvest management are put forward to the respective wildlife management boards and territorial Minister for decision and potential implementation. |
| | 5.3 Manage predators using adaptive management techniques included in Section 6 as a natural and necessary part of the ecosystem. (Note that establishing specific actions of a predator management program, and implementing such a program is beyond the scope of this management plan.) | **Threats:**<br>• Predation and Competition<br><br>**Knowledge Gaps:**<br>• Predator/Prey relationships | Necessary / Ongoing | • Development and delivery of hunter education and training takes place that focuses on harvesting of wolves and proper handling of hides. |

## *6.4 Approaches to Achieve Objectives*

Some of the threats to Dolphin and Union Caribou such as climate change, pollution and contaminants are broad in scope and cannot be directly addressed by this management plan. Since these range-wide threats are caused by humankind, national and international cooperation and collaboration should be promoted to help mitigate them. The impact of these threats on Dolphin and Union Caribou should be highlighted through the appropriate regional, national and international fora. In addressing these threats, all management partners will need to work collaboratively and can choose to work on approaches and actions that are most suitable for their particular organisation's mandate.

**Objective #1:**

**Adaptively co-manage Dolphin and Union Caribou using a community-based approach.**

**Approaches to achieve Objective #1:**

1.1 Hold regular meetings with co-management partners, Indigenous governments and organizations, and local harvesting committees to make recommendations on Dolphin and Union Caribou management, and to implement these recommendations using co-management processes and adaptive management[11] principles.

The natural environment is always changing; accordingly, threats may change and a species' reaction to these threats may also change. Using adaptive management practices allows managers to cope with these changes. Regular meetings, rotating among NWT and Nunavut communities, would provide a strong foundation for adaptive management. These meetings would allow co-management partners to jointly review the most up-to-date information on the state of Dolphin and Union Caribou, and the results of new research. The management plan will be reviewed at least every five years but more frequent reviews and meetings in NWT and Nunavut communities could take place when needed (Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016). This would help to work towards a management plan that is used and where management actions are adjusted as necessary. Regular trans-boundary meetings of the management partners are recommended. Continuing to work collaboratively with Inuit and Inuvialuit governments and organizations, wildlife management boards, communities, harvesters and industry is essential to adapt management practices. Just as IQ, TK and local knowledge form the foundation of this management plan, management partners should help ensure this

[11] Adaptive management is a systematic approach for continually improving management policies or practices by deliberately learning from the outcomes of management actions

knowledge continues to be brought to the decision-making table and guides the management of Dolphin and Union Caribou. This is reiterated by Indigenous Peoples since, as they point out, they are the main voice for wildlife in the communities (Ekaluktutiak HTO 2016; Paulatuk HTC 2016; Olohaktomiut HTC 2016). One harvester mentioned that the Dolphin and Union Caribou Management Plan was a good example of collaborative co-management (Paulatuk HTC 2016).

**Objective #2:**

**Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.**

**Approaches to achieve Objective #2:**

2.1 Encourage flow and exchange of information between management partners, communities, industry, regulatory boards, non-governmental organizations (NGOs), and the public, using various approaches to promote better understanding of Dolphin and Union Caribou and the threats they face.

Nunavut and NWT communities, management partners, elders, hunters, youth, industry and the public each have a role to play in management of Dolphin and Union Caribou. Exchanging information helps all parties to appreciate their roles and responsibilities and helps to build and maintain support for the successful management of Dolphin and Union Caribou. It also helps ensure that all perspectives are integrated into management, and that caribou managers are aware of on-the-ground matters such as the population and health status of the caribou and the state of its habitat.

A variety of methods can be used to communicate information. For example, meetings with industry can be held, and within communities, outreach and education can take place through various meetings and workshops with co-management partners. Outreach can also happen more informally through one-on-one communication between community members and staff employed in co-management organizations. Other methods of outreach may be used depending on the demographic, such as home visits, school visits, social media, and out on the land trips.

These community venues can be used to teach hunters about recognizing disease and parasites in caribou, how to determine if meat is edible and how to prepare it accordingly (Kugluktuk HTO 2016). To further alleviate concern over diseased caribou and its impacts on human health, communities have suggested that harvesters bring back a tissue sample to the conservation officer or regional biologist to test for parasites and/or disease when anomalies are observed (Ekaluktutiak HTO 2016; Olohaktomiut HTC 2016). The suggestion was also made that hunters should take a disease/parasite booklet with them while out on the land (Kugluktuk HTO 2016). Other communication links can be built by supporting community monitoring programs and by finding ways to work with industry on contributing information to research and monitoring.

**Objective #3:**

**Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.**

**Approaches to achieve Objective #3**

3.1 Monitor the Dolphin and Union Caribou population number, distribution, and demographic indicators to determine population level and trend. (Knowledge Gaps # 1, 3).

3.2 Improve our overall understanding of Dolphin and Union Caribou health, biology and habitat requirements, diet, and effects of climate change. (Knowledge Gaps # 2, 4, 5).

3.3 Assess cumulative impacts on Dolphin and Union Caribou population and habitat. (Knowledge Gaps # 1-8).

3.4 Co-ordinate the gathering of information and research among different co-management partners and research institutions. (All Knowledge Gaps).

There has been limited information available on the population abundance and trends of Dolphin and Union Caribou, but the development of a research program can provide the foundation to answer the defined knowledge gaps, such as the recent collaring and surveying of the population in Nunavut in 2015. Managers can build on this information through continued monitoring of population size and trend, including important demographic indicators such as pregnancy, survival (particularly females) and calf recruitment rates; this information should be shared with communities (Ekaluktutiak HTO 2016). Geographic areas of importance to Dolphin and Union Caribou, including their preferred migratory sea ice routes, would also be identified through this initiative.

At the time of writing this document (2015-2016), research on Dolphin and Union Caribou health including disease, parasites and contaminants is taking place and initial analyses have been completed. Some impacts from climate change include changes in vegetation growth and insect harassment, and research examining these impacts should be promoted. A better understanding of Dolphin and Union Caribou diet is needed to understand these impacts. Expanding community-based monitoring programs that provide information on Dolphin and Union Caribou, such as caribou sampling kits, will also improve knowledge on health, condition, diet, population trends and predators.

Inuit and Inuvialuit have voiced concern that wolf populations appear to be increasing in Dolphin and Union Caribou range, and to some extent grizzly bears (First Joint Meeting 2015; Second Joint Meeting 2016). However, there is little scientific information available on predator abundance or how predators impact Dolphin and Union Caribou populations. Management would benefit from an improved understanding of predator abundance and the relationship between Dolphin and Union Caribou and their predators. Dolphin and Union Caribou also interact with other herbivores such as other barren-ground caribou, muskoxen and geese. A stronger understanding of how these interactions affect Dolphin and Union Caribou and their habitat would assist in managing this population.

Threats that may have low or negligible impacts by themselves can have a significant effect when they are combined. A cumulative effects model would be a valuable tool to help managers understand the relative importance of different pressures on Dolphin and Union Caribou and how they ultimately determine the state of the population. Such a model can also be used in the co-management process (Objective #1) to help predict the consequences of different management scenarios and to develop more effective mitigation measures.

Knowledge gaps should be prioritized and addressed by all parties to work toward a collaborative and coordinated approach to research and monitoring activities. Some questions can be addressed through community-based monitoring and surveys, while other research questions can be explored through partnerships with academic researchers or other agencies. Documenting IQ, TK and local knowledge on a continuing basis is expected and can help to fill knowledge gaps and inform management. Industry may also provide a potential source of data for management of Dolphin and Union Caribou. Local communities should also be informed and kept up-to-date on the collected data including numbers, body condition and overall health (Ekaluktutiak HTO 2016).

**Objective #4:**

**Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.**

**Approaches to achieve Objective #4**

4.1 Monitor changes to habitat from anthropogenic and natural disturbances on an ongoing basis.

4.2 Proactively work with marine/industry/transportation organizations and regulators to minimize human and industrial disturbance and seek ways to preserve sea ice crossings.

4.3 Manage populations of other species that affect Dolphin and Union Caribou habitat.

Monitoring habitat change, which includes sea ice, will allow management partners to keep track of the degree to which Dolphin and Union Caribou habitat has been disturbed, both by climate change and more direct industry-based activities including ice-breaking activities, shipping and mining exploration. This is a key step in ensuring that Dolphin and Union Caribou needs are taken into account by organizations (e.g, Department of Fisheries and Oceans, Transport Canada, or the Nunavut Marine Council) in decision-making about shipping activities and land use, having due regard for existing, pending and future interests in land allowed under territorial land legislation and precedent. A collective approach with all relevant management partners is required in decision-making about land use, including land use planning.

Some communities say that shipping should not be allowed through the Northwest Passage from freeze-up to break-up; in other words, during the fall, winter or spring (Ekaluktutiak HTO 2016; Second Joint Meeting 2016). Seeking out and collaborating with different authorities such as government agencies, community organizations, shipping companies, tourism operators and industry will be required in order to minimize disturbance to Dolphin and Union Caribou and fragmentation of their habitat. A better understanding about authorities that manage ship traffic is needed to inform this collaboration. Some communities have expressed concern that industry is not following guidelines or respecting important identified caribou habitat (Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Olohaktomiut HTC 2016; Paulatuk HTC 2016). As such, guidelines, standard advice and best practices related to aircraft, shipping, tourism, and industry should be developed including, if necessary, amendments to existing legislation. These should be promoted and then followed by monitoring and an evaluation of compliance with these guidelines and practices.

Management of other species that may affect Dolphin and Union Caribou, such as muskoxen or overabundant geese, requires collaboration with all levels of governments. Promoting harvest of overabundant species such as geese may assist in reducing habitat destruction.

**Objective #5:**

**Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.**

**Approaches to achieve Objective #5**

5.1 Obtain accurate harvest data.

5.2 Manage harvesting activities within acceptable limits using adaptive management techniques included in Section 6, to ensure that harvesting opportunities are available in the future and treaty rights are fully respected.

5.3 Manage predators using adaptive management techniques included in Section 6 as a natural and necessary part of the ecosystem.

This objective focuses on ensuring a long term harvest of Dolphin and Union Caribou by beneficiaries and other harvesters. While carefully considering the limitations on harvest data, population level, trend, and demographic indicators (from Objective #3) and harvest rate should be considered in determining appropriate harvest management, as outlined in Section 6.6. Other management in addition to harvest should also be adaptively informed by population level and trend, as described within the approaches under Objective #1 and in Section 6.6.

The collection of accurate, complete and reliable harvest data, which includes the number of caribou harvested and the sex ratio, is crucial. This can be achieved by proactively working with local harvesting committees and other groups to estimate harvest levels of Indigenous hunters. This has typically proven to be a difficult task; therefore educating communities on the importance of reporting is an essential part of this approach. Estimated total harvest levels should be reported annually to caribou management authorities, HTOs/HTCs, and co-management partners, as the importance of communities remaining informed with respect to new data was highlighted (Ekaluktutiak HTO 2016). With this data, an appropriate harvest rate can be determined.

With information on population level and trend, demographic indicators and harvest rate, co-management partners can follow the processes outlined for wildlife management in land claims. Management partners should annually review harvest information and population information, to manage harvesting activities within acceptable limits that allow for a viable, self-sustaining caribou population. This approach would use different management techniques that correspond to different stages of the caribou population cycle, as discussed in further detail in Section 6.6: *Managing based on Population Level.* If it appears they are not doing so , then management partners may have to consider management recommendations (such as harvesting limits) to achieve the management goals.

Responsible harvesting practices that minimize negative impacts on the Dolphin and Union population should be promoted to sustain harvest for future generations. This includes teaching youth and inexperienced hunters about responsible harvesting practices and good marksmanship, since elders are noticing many wounded caribou from young and inexperienced hunters (Second Joint Meeting 2016). In this situation, actions should be community-based (Ekaluktutiak HTO 2016): by integrating IQ and TK into the school system and/or taking youth/inexperienced hunters out on the land, more experienced harvesters could assist in teaching them about traditional harvesting practices. Traditional practices focus on avoiding harvest of both cows with calves, and the leaders of herds, good marksmanship, ability to distinguish types of caribou, and avoiding wastage of meat. Less experienced hunters would also benefit from learning about the harvest of prime bulls during sport hunts and its negative impacts on the health of the population (Kugluktuk HTA 2016). Hunters also suggest to avoid leaving gut piles out on the land to curb the attraction of wolves (Olohaktomiut HTC 2016). Promoting harvest of alternative species that are available can also provide an option in reducing harvest of Dolphin and Union Caribou.

Establishing specific actions of a predator management program, and implementing such a program is beyond the scope of this management plan. However, educating and training hunters about how to harvest predators can help with managing predators as a natural and necessary part of the Dolphin and Union Caribou's ecosystem. At the time of writing this plan, Inuit communities in Nunavut may harvest wolves legally with no harvest limits, provided they follow the rules of the *Nunavut Wildlife Act*. In NWT, the Inuvialuit may also lawfully harvest wolves with no harvest limits or conditions (NWT Summary of Hunting

Regulations 2015), provided that they follow wastage provisions in the *NWT Wildlife Act*. At the first joint meeting in Kugluktuk, it was agreed that further research on predator-prey relationships is needed to inform management (First Joint Meeting 2015).

## *6.5 Current Management and Other Positive Influences*

Positive influences on Dolphin and Union Caribou are factors likely to promote population growth. These can be classified into two main categories: 1) management actions that are being implemented; and 2) positive environmental changes (such as an increase in vegetation) that may promote population growth.

**Current management**

In the NWT and Nunavut, there are some measures in place that assist in managing Dolphin and Union Caribou, including land claim agreements, legislation, regulations, community conservation plans, and land use planning. The collaborative, responsive co-management regimes set up under land claims have a positive influence on Dolphin and Union Caribou because they allow for concerns to be addressed through adaptive management with participation from all partners.

**<u>NWT</u>**

*Co-management regime*

The comprehensive land claim affecting the Western Arctic Region of the Northwest Territories was settled in 1984. The settlement was passed into federal law and is known as the Inuvialuit Final Agreement (IFA). In the NWT portion of the Inuvialuit Settlement Region (ISR), wildlife is managed in accordance with section 14 of the IFA. This section defines the principles of wildlife harvesting and management, identifies harvesting rights, and explains the co-management process and conservation principles. It defines the structure, roles, and responsibilities of the Wildlife Management Advisory Council (NWT) (WMAC (NWT)), governments, the Inuvialuit Game Council (IGC), the Inuvialuit HTCs, the Environmental Impact Screening Committee (EISC) and the Environmental Impact Review Board (EIRB). WMAC (NWT) is responsible for listening to concerns raised about wildlife and addressing these concerns through the use of the adaptive management model, which allows management of a species to be adapted according to new circumstances.

*Harvest management*

In the NWT, big game hunting regulations help to manage the harvest of Dolphin and Union Caribou (NWT Summary of Hunting Regulations 2015). There are harvest limits applied to NWT residents, meaning Canadian citizens or landed immigrants who have been living in the NWT for at least a year, but who are not beneficiaries of the IFA. At the time of publication of this document, hunting season for NWT residents runs from August 15th to November 15th and residents are allowed two bulls. For non-residents and non-Canadians, there is a sport hunting season from August 15th to October 31st and hunts must be guided;

however there are currently no tags allocated for these hunters, so sport hunting is not taking place (WMAC (NWT), pers. comm. 2016). There are presently no restrictions or limitations on Indigenous harvest of Dolphin and Union Caribou in the NWT.

*Other conservation plans*

Conservation priorities for the NWT portion of the range have been formalized through Inuvialuit Community Conservation Plans. The Olohaktomiut (Ulukhaktok) Community Conservation Plan (OCCP, 2008) identifies a number of specific areas important to Dolphin and Union Caribou on northwestern Victoria Island and recommends that those "lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption". The Plan also recommends other actions that could bring positive results for Dolphin and Union Caribou. These include:

- Identify and protect important habitats from disruptive land uses.
- Share your harvest with others in the community.
- Do not harvest more than is needed.
- Harvest on sustainable basis, and in a manner consistent with recommendations of the HTC.
- The HTC will encourage a voluntary ban on caribou hunting where required.
- A management plan for Victoria Island Caribou will be developed.

The IFA allows for land use planning (s.7.82), which can be pursued by communities within the ISR if desired.

**<u>Nunavut</u>**

*Co-management regime*

In Nunavut, wildlife is managed according to Article 5 of the NLCA. Article 5 sets out the creation of the NWMB, which is the primary instrument of wildlife management in Nunavut. Article 5 defines the roles of the NWMB, Government, HTOs, and the Regional Wildlife Organization (RWO) which is the KRWB in the Kitikmeot Region. In Nunavut, each of the co-management partners fulfills its respective role as defined in the NLCA.

*Harvest management*

The *Nunavut Wildlife Act,* an additional management tool, sets out harvest management, licensing, reporting and sample submission.

According to the NLCA, Dolphin and Union Caribou are listed under schedule 5-1 as big game. Because TAH is not set on this population, Inuit have the right to harvest to the full level of their economic, social, and cultural needs. As long as there is no conservation concern, Article 5 is constitutionally protected and trumps all other harvesting rules or regulations for Inuit.

The GN treats each caribou population, regardless of spatial overlap, separately and distinctly for TAH recommendations. Non-beneficiaries, within three months of residency, have an open hunting season to legally harvest five caribou per person per year with a valid hunting license; however during their first two years as residents of Nunavut, non-beneficiaries must hunt with a guide.

In addition, harvest is regulated via a tag system available for sport hunts. The previous NWT Big Game regulations (grandfathered into Nunavut legislation when Nunavut was established), set a limit of 35 barren-ground caribou sport hunting tags on Victoria Island and the Kent Peninsula on the mainland (R-118-98, Dated 14 August, 1998). These tags were shared by Kugluktuk and Cambridge Bay. Although the Kugluktuk HTO made a motion to suspend all caribou commercial and sport hunts for all herds, sport hunting for non-residents (Canadian and non-Canadian) continues to take place in the fall out of Cambridge Bay. The main outfitter for sport hunts for Dolphin and Union Caribou is the Ekaluktutiak HTO, which allows up to two barren-ground caribou (including Dolphin and Union Caribou) per person through an outfitter. There is currently no commercial harvest of Dolphin and Union Caribou. No maximum hunting limits on barren-ground caribou exist for beneficiaries.

*Other conservation plans*

In the Nunavut portion of the range, the *Nunavut Land Use Plan* is currently under development and contains conservation measures for Dolphin and Union Caribou. Although the public hearing process is not yet complete and the plan is not finalized, it provides recommendations to regulatory authorities to mitigate the impacts of shipping traffic on spring and fall caribou sea ice crossings (Nunavut Planning Commission 2016).

Communities, HTOs and government have been working with industry to limit the impacts of human activities on Dolphin and Union Caribou. For example, the Cambridge Bay HTO made recommendations regarding seasonal restrictions on shipping and at least one mining company has made a voluntary commitment to limit shipping to the open water season (Ekaluktutiak HTO 2016; Second Joint Meeting 2016). Some mining companies have also created flight rules to minimize their impact on caribou.

During the 1940s and 1950s, Inuit tried to reduce geese populations by picking white-fronted and snow geese eggs, always ensuring that they left two eggs; if fewer eggs were left, the geese would lay even more (First Joint Meeting 2015). This practice is still in effect, as families come back each spring with the intent of taking eggs (First Joint Meeting 2015; Second Joint Meeting 2016).

**Environmental changes**

Warming temperatures in the Arctic are changing the vegetation and presumably changing the availability of forage for Dolphin and Union Caribou (see Section 5.2.5). The relationships between local conditions (e.g., precipitation, air temperature), forage and population trend can be complex (e.g., Ozful et al. 2009) and it is unknown to what degree any positive effects of climate change may or may not offset the negative effects.

## *6.6 Managing Based on Population Level*

Many caribou populations/herds vary naturally in abundance (Zalatan et al. 2006; Bergerud et al. 2008; Parlee et al. 2013) and there is still uncertainty about the parameters of the Dolphin and Union Caribou cycle. Similar cycles occur in other wildlife and the causes of these cycles are not known definitively, but predators, disease, vegetation and weather each play a role (Caughley and Gunn 1993, Krebs 2009). The interaction of these variables and/or their cumulative impacts may also play a role in population cycles. Based on hunters' observations, the last low in the Dolphin and Union Caribou population cycle seems to have occurred in the mid-1900s (Nishi and Gunn 2004), and the last high occurred around 1997 (Tomaselli et al. 2016a), with a declining trend indicated in the 2015 population assessment (Leclerc and Boulanger in prep.). The necessary historical data to accurately determine the natural range of variation of the Dolphin and Union Caribou may be lacking, but there is now sufficient research to determine whether Dolphin and Union Caribou have been increasing, stable or decreasing in the last 19 years (see Section 4.4 for details).

While developing this management plan, co-management partners discussed how management actions should vary depending on where the Dolphin and Union Caribou population is in its cycle. As a result, certain management actions are recommended below for each population phase. These are intended as advice for decision-makers and a starting point for management. Co-management partners would still follow their decision-making process as outlined in the NLCA and IFA in order to implement management actions.

### 6.6.1. Determining population status

A population cycle can be divided into 4 phases: high, declining, low and increasing (Figure 9). All co-management partners agreed that the Dolphin and Union Caribou cycle involved these four phases. IQ, TK, local knowledge and science were used to define the thresholds and to outline parameters that allow co-management partners to determine when the population is in each phase of the cycle. Although Figure 9 focuses on population levels, other indicators may be considered when establishing the status of Dolphin and Union Caribou. These would include demographic indicators, such as number of calves, recruitment, survival (particularly females), pregnancy rates, and environmental indicators (e.g., climate change, disease, anthropogenic pressure). Climate change will have an indirect, but underlying influence on some of these indicators.

**High:**

The population is considered in the high status when it is above 60% of the highest recorded population estimates. For Dolphin and Union Caribou, this is considered to be above 24,000 as the last population peak of the Dolphin and Union Caribou population was about 40,000. From the low number of caribou observed by community members in the 1950s, the corrected 1997 population estimate represented this first scientifically measured high for the Dolphin and Union population (Nishi and Gunn 2004). The peak, therefore set at 40,000, represents the high end of the confidence interval of the 1997 population estimate. At this phase, the population migrates in large numbers between Victoria Island and the mainland. The population can sustain a greater harvest rate and the range is at its maximum.

**Declining:**

The declining phase represents between 20% and 60% of the highest population estimate, with a declining trend. It is at the point that the population reaches approximately 24,000 Dolphin and Union Caribou, that concerns about the population trend should be raised. The combination of negative anthropogenic and environmental factors could accelerate the rate of decline in the population. Management recommendations to slow down the decrease in population should be put forward at this point.

**Low:**

The population is considered to be in the low phase when it is below 20% of the highest population estimate, which would represent a population estimate of under 8,000 Dolphin and Union Caribou. During this phase, the Dolphin and Union Caribou population is at greater risk of overharvesting and its range is greatly contracted to the point where migration between Victoria Island and the mainland may stop. Minimizing harvesting and human impact on habitat would reduce pressure on this population and could help increase the recovery rate of the population.

**Increasing:**

The increasing phase would be between 20% and 60% of the highest population estimate (between 8,000 and 24,000 caribou) with an increasing trend. Caribou abundance and range expands during this phase and the demographic indicators will show a positive trend. If Dolphin and Union Caribou have halted their sea ice crossing during the declining and low phases, it is during this phase that the migration between Victoria Island and the mainland could resume.

As new pertinent information becomes available, it is recommended that co-management partners plan a joint meeting to suggest a change from one phase to the next phase (Figure 9). At a minimum, every 5 years, all the new information should be collected and considered to review the population level and trend.

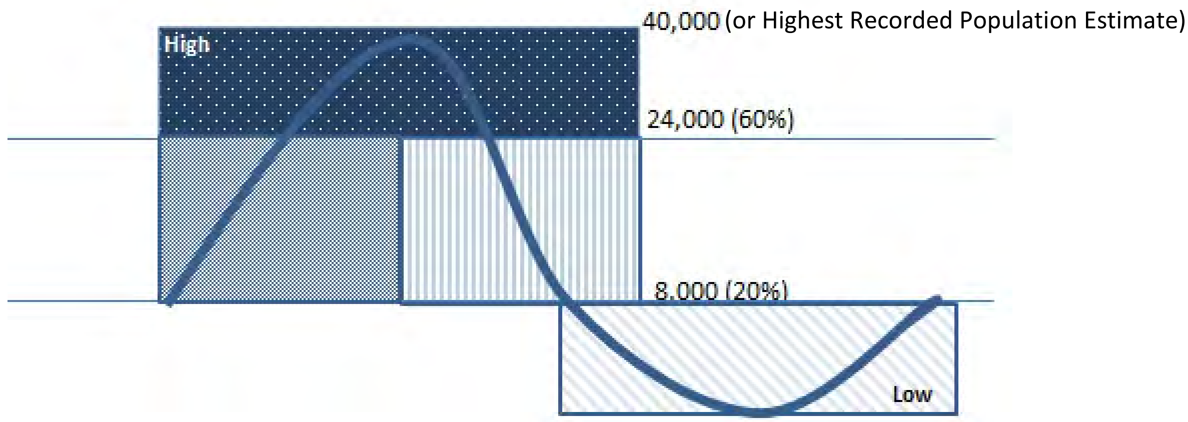
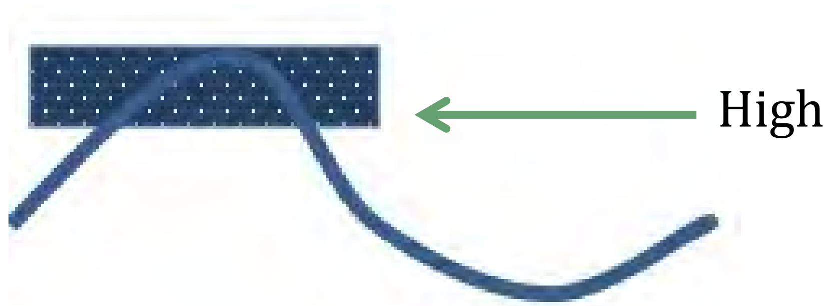



Figure 9. Dolphin and Union Caribou cycles: Determining the location of the Dolphin and Union Caribou population within its cycle. The Dolphin and Caribou population cycle is unpredictable and may vary due to changing magnitude and impact of threats.

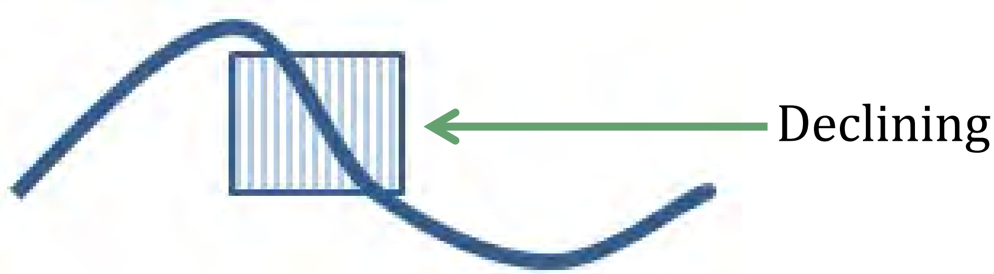
### 6.6.2. Management actions recommended

Despite the information gaps with respect to population status, basic management principles can still be applied to maintain a healthy sustainable caribou population. Co-management partners realize the need to use the best available information for managing Dolphin and Union Caribou. The management actions taken, and the point at which they are taken, depend on where the population is in its cycle. Managers should also be mindful of maintaining the population within its natural levels of variation.

Development of this plan required extensive discussion about management actions. For each phase of the Dolphin and Union Caribou cycle, the co-management partners came to an agreement to recommend certain actions, including harvest management to reflect potential conservation issues. These actions were developed by co-management partners at the Second Joint Meeting (2016) and reviewed and revised through consultation with all the communities, HTOs/HTCs that harvest Dolphin and Union Caribou, and other co-management partners (Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Olohaktomiut HTC 2016; Paulatuk HTC 2016). These actions are described below.

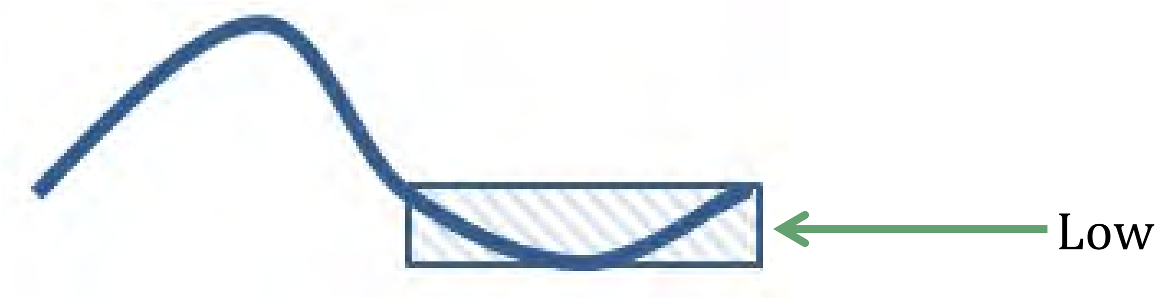



**High Status:**
- Educate harvesters and youth on how to harvest respectfully and how to harvest alternative species that are available.
- No harvest restrictions on beneficiaries.
- Consider other types of harvests based on community and land claims, including the use of commercial harvest to control over-population.
- Support reporting of harvest and community-based monitoring programs.
- Conduct research and monitoring; have sample kits to monitor harvest.
- Encourage research on predators and ease management of predators.
- Working group of stakeholders meets.
- Industry activities should meet a baseline standard and follow their wildlife monitoring and mitigation plan.



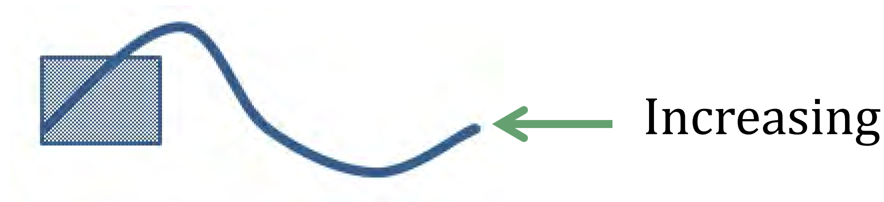

**Declining status:**
- Educating and integrating information into the school system on topics including: the importance of using the whole caribou, how to hunt alternative wildlife, and harvest of predators.
- No harvest restriction on beneficiaries.
- Consider harvest restriction on non-beneficiaries, such as no resident, outfitter or commercial harvest.
- Consider setting non-quota limitation; e.g., bull-dominated (selecting younger and smaller bulls), limited harvest of females (such as 5% cow harvest), or seasonal limits.
- Support reporting of harvest and community-based monitoring program.

- Increase research and monitoring; have sample kits to monitor harvest.
- Encourage research on predators, and manage predators as a natural and necessary part of the ecosystem, based on the jurisdiction's needs.
- The working group of stakeholders should meet more frequently.
- Consider adding more restrictions on industry activities that affect caribou.




**Low Status:**

- Educating and integrating information into the school system on topics including: the importance of using the whole caribou, how to hunt alternative wildlife, and harvest of predators.
- Educate people on new restrictions and management that may be in place.
- Consider establishing effective mandatory mechanisms to reduce overall harvest, as appropriate for the community (e.g., TAH). Mechanisms would be reviewed to determine if more reductions are needed.
- Resident, non-resident, outfitter or commercial harvest remain closed.
- Consider removing non-quota limitation; e.g., bull-dominated (selecting younger and smaller bulls), limited harvest of females (such as 5% cow harvest), or seasonal limits.
- Harvest from alternative healthy populations of wildlife available.
- Support reporting of harvest and community-based monitoring program.
- Increase research and monitoring; have sample kits to monitor harvest.
- Encourage research on predators, and manage predators as a natural and necessary part of the ecosystem, based on the jurisdiction's needs.
- The working group of stakeholders should meet more frequently.
- Consider stricter restrictions for industry activities that affect caribou.




**Increasing Status:**

- Educate harvesters and youth on how to harvest respectfully and how to harvest alternative species that are available.
- Educate on the restriction and management in place.
- Consider removing the TAH.
- Easing of harvest restrictions and consider implementing non-quota limitation.
- Support report of harvest and community-based monitoring program.
- Conduct research and monitoring; have sample kits to monitor harvest.
- Encourage research on predators and ease management of predators.
- Working group of stakeholders meets.
- Industry activities should meet a baseline standard and follow their wildlife monitoring and mitigation plan.

These recommended management actions respect how Inuit and Inuvialuit have been managing wildlife for hundreds of years and take into consideration input and knowledge from the community members of each harvesting community. However, co-management partners can take action to help the Dolphin and Union Caribou at any time, using their powers and responsibilities laid out in land claim agreements (for example, the ability of HTOs and HTCs to make by-laws; see Section 2.2). There is a need for increased community involvement in the management and regulation of harvest and land use for Dolphin and Union Caribou. If communities choose to implement their own restrictions, they are still encouraged to discuss these restrictions with other co-management partners.

The recommended management actions are intended as advice for decision-makers. Co-management partners would still follow the decision-making processes outlined in the NLCA and IFA in order to implement them.

# 7. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving the management goal (Section 6.1)

- The status of Dolphin and Union Caribou has not become threatened or endangered when reassessed by SARC every 10 years, and by COSEWIC every 10 years.
- The Dolphin and Union Caribou population allows for continued subsistence harvests.

- Dolphin and Union Caribou move freely throughout their range on Victoria Island and the mainland.

In addition to these performance indicators, the performance measures set out in Table 6 will provide pertinent information to assess interim progress towards achieving the ultimate management goal.

# *8.* NEXT STEPS

Management partners will use this plan to help in assigning priorities and allocating resources in order to manage human impacts on Dolphin and Union Caribou. This management plan will be reviewed every five years and may be updated. At least every five years, there will be a report on the actions undertaken to implement the plan and the progress made towards meeting its objectives.

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# APPENDIX A: IUCN THREAT CLASSIFICATION TABLE AND THREAT CALCULATOR RESULTS FOR DOLPHIN AND UNION CARIBOU

The threats classification is based on the IUCN – Conservation Measures Partnership unified threats classification system. These international standards for describing threats were utilized in order to provide consistency between different species, and improve data sharing and coordination among species at risk and other related wildlife programs. To reduce duplication of effort, GC and COSEWIC collaborated in organizing the completion of the threats calculator as it is required for both the management plan and the upcoming COSEWIC status assessment of Dolphin and Union Caribou. Co-management partners, scientific experts and representatives from the six HTOs/HTCs within the range of Peary caribou were invited to attend a teleconference to fill out the threats calculator. A training session for HTO and HTC representatives was held beforehand, and a teleconference in December 2014 as well as February 2016 were held to evaluate the threats. The teleconferences were attended by:

- Joseph Oliktoak (Olohaktomiut HTC - Ulukhaktok)
- Joeseph Illasiak and Diane Ruben (Paulatuk HTC)
- David Nivingaluk and Kevin Klengenberg (Kugluktuk HTO)
- Jimmy Haniliak, Howard Greenley and George Angohiatok (Ekaluktutiak HTO – Cambridge Bay)
- Ema Qaggutaq (KRWB)
- Tracy Davison, Lisa Worthington Suzanne Carriere and Nic Larter (GNWT)
- Lisa-Marie Leclerc and Melanie Wilson (GN)
- Justina Ray (COSEWIC Terrestrial Mammals Specialist Subcommittee Co-chair)
- Dave Fraser (COSEWIC, Government of British Columbia)
- Donna Hurlburt (COSEWIC Indigenous Traditional Knowledge Subcommittee Co-chair)
- Lee Harding (Report writer for COSEWIC)
- Kim Poole (Aurora Wildlife Research)
- Lisa Pirie, Donna Bigelow, Dawn Andrews, Amy Ganton and Isabelle Duclos (GC)
- Peter Sinkins (Parks Canada Agency)

Participants calculated an overall threat impact of Very High to High for Dolphin and Union Caribou. Threats were ranked in terms of scope, severity and timing, and the rankings were automatically rolled up into an impact for each threat as well as an overall impact.

**Impact** of the threat on Dolphin and Union Caribou is calculated based on scope and severity. Categories include: very high, high, medium, low, unknown, negligible.

**Scope** is the proportion of the population that can reasonably be expected to be affected by the threat within the next 10 years. Categories include: Pervasive (71-100%); Large (31-70%); Restricted (11-30%); Small (1-10%); Negligible (<1%), Unknown. Categories can also be combined (e.g., Large-Restricted = 11-70%).

**Severity** is, within the scope, the level of damage to the species (assessed as the % decline expected over the next three generations [7 years = 1 generation for Dolphin and Union Caribou]) due to threats that will occur in the next 10 years. Categories include: Extreme (71-100%); Serious (31-70%); Moderate (11-30%); Slight (1-10%); Negligible (<1%), Unknown. Categories can also be combined (e.g., Moderate to slight = 1-30%).

**Timing** describes the immediacy of the threat. Categories include: High (continuing); Moderate (possibly in the short term [<10 years or three generations]); Low (possibly in the long term [>10 years or three generations]); Negligible (past or no direct effect); Unknown.

| | |
|---|---|
| Species: | Dolphin & Union Caribou (DU2) |
| Date: | Meeting #1: 12/08/2014; Meeting #2: 08/02/2016 |
| Assessor(s): | Meeting #1: Justina Ray (COSEWIC), Dave Fraser (COSEWIC, BC), Suzanne Carriere (COSEWIC, NWT), Nic Larter (COSEWIC, NWT), Donna Hurlburt (COSEWIC, Aboriginal Traditional Knowledge (ATK)), Lee Harding (report writer), Tracy Davison (GNWT), Lisa Worthington (GNWT), Lisa-Marie Leclerc (GN), Melanie Wilson (GN), Donna Bigelow (GC), Dawn Andrews (GC), Lisa Pirie (GC), Kim Poole (Aurora Wildlife Research), David Nivingalok (Kugluktuk HTO), Kevin Klengenberg (Kugluktuk HTO), Ema Qaggutaq (KRWB), Joseph Oliktoak (Olohaktomiut HTC)<br><br>Meeting #2: Justina Ray (COSEWIC), David Fraser (COSEWIC), Lisa-Marie Leclerc (GN), Ema Qaggutaq (KRWB), Amy Ganton (GC), Isabelle Duclos (GC), Peter Sinkins (Parks Canada Agency), Jimmy Haniliak (Ekaluktutiak HTO), Howard Greenley (Ekaluktutiak HTO), George Angohiatok (Ekaluktutiak HTO), Joshua Oliktoak (Olohaktomiut HTC), Myles Lamont (GN), Diane Ruben (Paulatuk HTC), Joe Illasiak (Paulatuk HTC). |

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Overall Threat Impact Calculation Help:

| Threat Impact | | Level 1 Threat Impact Counts: high range | low range |
|---|---|---|---|
| A | Very High | 0 | 0 |
| B | High | 2 | 1 |
| C | Medium | 2 | 0 |
| D | Low | 1 | 4 |
| Calculated Overall Threat Impact: | | Very High | High |

| | |
|---|---|
| **Assigned Overall Threat Impact:** | **AC = Very High - High** |
| **Overall Threat Comments:** | Two threat calculator meetings were held (8/12/2014 and 8/2/2016), and results were combined |

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| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 1 | Residential & commercial development | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | |
| 1.1 | Housing & urban areas | | Negligible | Negligible (<1%) | Extreme (71-100%) | High (Continuing) | Scope includes portion of species range that is alienated by human settlements plus a buffer zone for animals displaced by disturbance. There is the possibility that municipal boundaries may increase in the coming years, but this still makes the scope very low. Although very few D&U animals are or will be exposed to this threat, any that come within a certain distance of human settlements will very likely be killed, hence the high severity. |
| 3 | Energy production & mining | D | Low | Restricted (11-30%) | Slight (1-10%) | | |
| 3.1 | Oil & gas drilling | | Not Calculated (outside assessment timeframe) | | | Insignificant/ Negligible (Past or no direct effect) | No seismic activity or O&G development at present, and not expected in the foreseeable future within the D&U range |
| 3.2 | Mining & quarrying | D | Low | Restricted (11-30%) | Slight (1-10%) | High (Continuing) | The scope is currently very low, but it is plausible for this to increase with a higher percentage of the population being directly affected by mines themselves within the next 10 years. This does not include shipping, flights, or roads associated with mines, which are counted elsewhere here. Most direct mortality from the mines themselves will be very low. |
| 4 | Transportation & service corridors | B | High | Pervasive - Large (31-100%) | Serious (31-70%) | Moderate (Possibly in the short term, < 10 yrs) | |
| 4.1 | Roads & railroads | D | Low | Restricted (11-30%) | Slight (1-10%) | Moderate (Possibly in the short term, < 10 yrs) | Currently the scope is negligible but if MMG/Izok Corridor proceeds with its project for a mine with an all-weather road from the coast 325 km inland, (or a similar one, e.g., within the Hope Bay greenstone belt) the impact of roads would greatly increase. It is possible that other development will happen in next 10 years. It is not believed that this project would include a network of winter roads coming off the all- |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | weather road. Even one road, depending on where it is situated, could be encountered by a large proportion of the population. The direct impact of that road (mortality) will still be low, even if indirect effects are high |
| 4.2 | Utility & service lines | | Negligible | Negligible (<1%) | Negligible (<1%) | Unknown | |
| 4.3 | Shipping lanes | B | High | Pervasive - Large (31-100%) | Serious (31-70%) | High (Continuing) | Category includes both open water and ice-breaker shipping. Open water shipping (which currently occurs) is not an issue, rather impact is entirely from winter shipping that involves any ice breaking (including relatively thin ice that does not qualify as ice breaking by Transport Canada definitions). Currently most activity is local ice-breaking activity early season around Cambridge Bay, but occasional ships are passing through so this threat is already occurring. The current proposal for shipping out of the bottom of Bathurst inlet could affect half the D-U population. Impact of shipping depends on timing. Caribou can start crossing as early as October 15 and into December. 2-3 boats during migration could entirely stop migration and cause 40% of the animals to drown. On the other hand, the whole population doesn't cross at same time and ice can refreeze between crossings. Not every icebreaking event will cause massive fatalities. |
| 4.4 | Flight paths | D | Low | Restricted (11-30%) | Slight (1-10%) | High (Continuing) | Category is for regularly scheduled flights, i.e., to mines. The possibility of scheduled flights increasing significantly, especially when/if proposed projects start operating. Large planes to mines could be more than flights to communities. On the other hand, flights are mostly high, and only go only low for landing. Modelling work has shown relatively low direct impact. Severity is likely at the low end of slight (1-10%) range. If flight paths were to change to impact calving, the severity would increase. |
| 5 | Biological resource use | CD | Medium - Low | Pervasive (71-100%) | Moderate - Slight (1-30%) | High (Continuing) | |



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| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 5.1 | Hunting & collecting terrestrial animals | CD | Medium - Low | Pervasive (71-100%) | Moderate - Slight (1-30%) | High (Continuing) | Harvesting of Dolphin-Union caribou is unregulated. There is no hunting season or limit. Harvest levels change depending on location of caribou in a given year, and availability of other harvested species. 3 communities harvest Dolphin-Union caribou: Ulukhaktok (harvest in summer), Cambridge Bay (harvest in fall), and Kugluktuk (harvest in winter and spring when they come across the ice). There may be a shift in harvest from mainland caribou, which are in steep decline. D&U population has declined since the last surveys, but has also changed its distribution such that animals are not so accessible to these communities anymore. This will decrease harvest. Very large range of uncertainty in severity due to unknown harvest levels and uncertainty of population numbers in the future. Score for severity encompasses both worst and best case scenarios. Also, a change in distribution may expose animals to harvest elsewhere. |
| 6 | Human intrusions & disturbance | | Negligible | Restricted (11-30%) | Negligible (<1%) | High (Continuing) | |
| 6.1 | Recreational activities | | Negligible | Negligible (<1%) | Negligible (<1%) | High (Continuing) | |
| 6.2 | War, civil unrest & military exercises | | Not Calculated (outside assessment timeframe) | | | Insignificant/ Negligible (Past or no direct effect) | Military exercises not a threat in this region; no seasonal overlap with D&U caribou |
| 6.3 | Work & other activities | | Negligible | Restricted (11-30%) | Negligible (<1%) | High (Continuing) | Includes (primarily) research activities (e.g., surveys and capture/collaring) |
| 8 | Invasive & other problematic species & genes | BD | High - Low | Pervasive (71-100%) | Serious - Slight (1-70%) | High (Continuing) | |
| 8.1 | Invasive non-native/alien species | CD | Medium - Low | Large - Restricted (11-70%) | Moderate (11-30%) | High (Continuing) | This category includes all diseases and pathogens (both native and non native). Climate change expected to increase parasites and disease. Parasites increasing and expected to increase further. Lungworm increasing in muskox, but not necessarily fatal. We do have to include that we seeing evidence that there is potential for more to occur. Biting flies are also an issue. |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| 8.2 | Problematic native species | BD | High - Low | Pervasive (71-100%) | Serious - Slight (1-70%) | High (Continuing) | This category includes all predator/competitor interactions (both native and non-native). Grizzly bears have moved into Victoria Island in the last decade or so can have an impact on numbers. Wolves have increased on Victoria Island. Given the multi-prey interactions, predators like wolves have potential to wipe out caribou when muskox numbers are high. Impact is greater with a small population, and less when they have the opportunity to escape the predators. Severity and Scope could be high during the fall migration while they are waiting for the sea ice to form, but there is enormous uncertainty. |
| 8.3 | Introduced genetic material | | Unknown | Large - Small (1-70%) | Unknown | High (Continuing) | Interbreeding with Barren-ground and Peary caribou. Although there are some claims that D&U is a hybrid (Rangifer groenlandicus x pearyi), this is not accurate. Genetics work over past decade shows Dolphin-Union as a genetically distinct population with a very small amount of Peary intergradation. A significant number of individuals would need to be inter-breeding to impact population. Communities have seen Peary caribou traveling with D&U, Barrenground traveling with D&U (more rare). Chances of hybridization are low due to the separation of the rutting grounds. Likely on the low end of both the scope and severity ranges, although the higher degree of uncertainty on severity reflects our lack of knowledge on the impacts of interbreeding. Really, particularly considering ATK, the impacts are unknown. |
| 9 | Pollution | | | | | | |
| 9.4 | Garbage & solid waste | | | | | | Contaminants are not currently regarded as a threat, given successful clean-up of the Dew Line. |
| 11 | Climate change & severe weather | CD | Medium - Low | Pervasive (71-100%) | Moderate - Slight (1-30%) | High (Continuing) | |
| 11.1 | Habitat shifting & alteration | CD | Medium - Low | Pervasive (71-100%) | Moderate - Slight (1-30%) | High (Continuing) | Category includes changes to habitat (vegetation and ice) conditions due to climate change over the next decade. Scope will affect entire population. With respect to severity, there is and will be much variability (i.e., positive and negative effect). Could get a trophic shift where there is a mismatch of greening and caribou life cycle, which could affect calving and calf survival. There is also a possibility that forage could increase with climate change. In either case, severity is |

| Threat | | Impact (calculated) | | Scope (next 10 Yrs) | Severity (10 Yrs or 3 Gen.) | Timing | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | not likely to be very severe. Could get a bad year or two, but will recover unless hits every year repeatedly, which is unlikely. With respect to ice, there is a small core area for Dolphin-Union, so ice conditions aren't as big a threat as they were to Peary Caribou. |
| 11.4 | Storms & flooding | CD | Medium - Low | Large (31-70%) | Moderate - Slight (1-30%) | Moderate (Possibly in the short term, < 10 yrs) | Icing events (storms) not as big an issue for Dolphin-Union as it is for Peary, and is currently unknown for D&U. Scope: Because winter range is a small area, one storm event could impact a large portion of the population. Over 3 generations, expect to be able to recover from a weather event, unless happens repeatedly year after year. Less likely to have bad weather events for multiple years in a row, which would knock back the population without a chance for recovery. |

Of the threats explored in Section 5.2, a number of issues were not assessed by the threat assessment group, or were unknown / negligible / impact not calculated. Information about these threats is provided below.

*IUCN Threat #9.5 Air-borne Pollutants (impact not discussed by IUCN panel but discussed at Kugluktuk and Cambridge Bay joint Dolphin and Union Caribou meetings)*

Contaminants produced in other parts of the world are carried up to the Arctic by global air currents and can enter Dolphin and Union Caribou through their food (Gamberg 2016). Sampling in 1993 and 2006 found relatively low levels of organochlorine, heavy metal and radio nuclide contaminants in Dolphin and Union Caribou, although Dolphin and Union Caribou had higher mercury levels compared to the Porcupine herd of barren-ground caribou (Macdonald et al. 1996; Gamberg 2008, 2016). Some Indigenous Peoples expressed concern over potential contamination and pollution from mining sites that could affect caribou and other wildlife (Ekaluktutiak HTO 2016). Contaminants do not appear to be current threats to Dolphin and Union Caribou health (SARC 2013), but some community members voiced concern over potential future contaminants, particularly if the levels and types of contaminants grow (First Joint Meeting 2015; Second Joint Meeting 2016). Therefore, continued monitoring is important since contaminants can change as ‘new’ chemicals become more common, such as brominated flame retardants (PBDEs) and fluorinated compounds (Gamberg 2016).

*IUCN Threat #8.3 Introduced Genetic Material (Unknown Impact)*

The impact of Dolphin and Union Caribou interbreeding with other types of caribou is unknown. Some communities have observed Dolphin and Union Caribou travelling with Peary caribou, and Kugluktuk hunters have observed Dolphin and Union Caribou travelling with barren-ground caribou. Some elders report that interbreeding is occurring between Peary caribou and barren-ground caribou and that Dolphin and Union Caribou are actually the result of this interbreeding (Ekaluktutiak HTO 2016). More research is needed to understand the impacts of interbreeding for Dolphin and Union Caribou, and the implications it may have for the population.

*IUCN Threat #6.1 Recreational Activities (Negligible Impact)*

Concerns have been voiced over the potential impacts of tourism activities including individuals disembarking from boats or vehicles and tourists walking on caribou grounds (First Joint Meeting 2015; Second Joint Meeting 2016). These tourism activities usually take place during the summer months when caribou are widely dispersed on Victoria Island.

*IUCN Threat #1.1 Housing and Urban Areas (Negligible Impact)*

Human settlements are a threat because caribou that travel near human settlements are at more risk of being harvested. However, human settlements are considered to have a negligible impact because relatively few Dolphin and Union Caribou are exposed to these settlements across their range.

*IUCN Threat #4.2 Utility and Service Lines (Negligible Impact)*

Utilities and service lines currently have a negligible impact on Dolphin and Union Caribou, as there are very few utility and service lines in this population's range.

*IUCN Threat #9.4 Garbage and Solid Waste (Impact Not Calculated)*

With the successful clean-up of the DEW (Detection Early Warning) Line, garbage and solid waste was not regarded as a threat to Dolphin and Union Caribou when the threat classification table was completed. However, one community expressed concerns that garbage and solid waste should not be restricted to DEW Line sites as garbage was observed coming from the sea (Kugluktuk HTO 2016).

*IUCN Threat #3.1 Oil and Gas Drilling (Impact Not Calculated)*

According to one community member, in the 1970s and 1980s oil and gas exploration caused caribou to avoid their area by moving 100 miles away from all the noise (First Joint Meeting 2015). However, there is currently no oil and gas development or seismic activity occurring in the range of Dolphin and Union Caribou, and these activities are not expected within the foreseeable future.

*IUCN Threat #6.2 War, Civil Unrest, and Military Exercises (Impact Not Calculated)*

The time of year that military exercises occur does not overlap temporally or spatially with caribou in the area. However some community members have voiced concern over DEW-lines in this region disturbing the migration route of Dolphin and Union Caribou (Olohaktomiut HTC 2016). Despite these concerns, military exercises overall were not seen as a threat to Dolphin and Union Caribou when the threat classification table was completed.

# APPENDIX B: DOLPHIN AND UNION CARIBOU MANAGEMENT FRAMEWORK

**Outline of goal, objectives, approaches and actions**
**Based on Group Discussions in Kugluktuk: March 25 – 27, 2015; and Cambridge Bay: January 11 – 13, 2016**

**MANAGEMENT GOAL/VISION:**

Recognizing the ecological, cultural and economic importance of Dolphin and Union Caribou, the goal of this management plan is to maintain the long term persistence of a healthy and viable Dolphin and Union Caribou population that moves freely across its current range and provides sustainable harvest opportunities for current and future generations.

**OBJECTIVES:**
These are five objectives for the management of Dolphin and Union Caribou. These objectives apply broadly across the population's range in both NWT and Nunavut.

1. Adaptively co-manage Dolphin and Union Caribou using a community-based approach.

2. Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.

3. Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.

4. Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.

5. Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.

**APPROACHES AND ACTIONS TO ACHIEVE THESE OBJECTIVES:**
Recommended approaches (numbered as X.X.) are grouped on the following pages under each objective. More specific actions (numbered as X.X.X) are grouped below under each approach.

**Objective #1:**
**Adaptively co-manage Dolphin and Union Caribou using a community-based approach.**

1.1 Hold regular meetings with co-management partners, Indigenous governments and organizations, and local harvesting committees to make recommendations on Dolphin and Union Caribou management, and to implement these, using co-management processes and adaptive management principles.

- 1.1.1 Incorporate local knowledge, IQ and TK and ensure that plans and actions for Dolphin and Union Caribou management are informed by this knowledge.
- 1.1.2 Continue to work with wildlife management advisory boards, game councils and local HTO/HTCs on Dolphin and Union Caribou monitoring, stewardship and management.
- 1.1.3 Work with industry on best practices, mitigation, and research.
- 1.1.4 Collaborate with industry and other partners on monitoring so that information can be combined at a large spatial scale to give a big picture view.
- 1.1.5 Continue engaging hunters, industry and public about Dolphin and Union Caribou management.
- 1.1.6 Annually review new information on population status and habitat, and adapt management practices accordingly.
- 1.1.7 Conduct regular trans-boundary meetings of Dolphin and Union Caribou co-management partners, rotating among NWT and Nunavut communities, to review information and population level and trend and discuss management.
- 1.1.8 If necessary, recommend alternative management actions (e.g., stricter habitat and/or harvest management) allowing for natural variation in numbers.
- 1.1.9 Every five years, report on management actions and progress made toward meeting objectives in management plan.

**Objective #2:**
**Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.**

2.1 Encourage flow and exchange of information between management partners, communities, industry, regulatory boards, non-governmental organizations (NGOs), and the public, using various approaches to promote better understanding of Dolphin and Union Caribou and the threats they face.

- 2.1.1 Conduct out on the land trips, where experienced hunters (elders if they're able) take youth out on the land.
- 2.1.2 Use social media and the internet to reach out to youth.
- 2.1.3 Conduct school visits (possibly elders if they're able) to educate youth about managing Dolphin and Union Caribou.

2.1.4 Conduct community meetings to exchange information with communities about management of Dolphin and Union Caribou.

2.1.5 Investigate possible mechanisms to foster industry participation in research and monitoring.

2.1.6 Ensure ongoing communication through supporting and improving community monitoring programs.

**Objective #3:**
**Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.**

3.1 Monitor Dolphin and Union Caribou population number, distribution and demographic indicators to determine population level and trend.

3.1.1 Expand community monitoring programs that provide information on Dolphin and Union Caribou condition, population size and trends, predators, changes in distribution, and timing of seasonal movements.

3.1.2 Develop and implement both a short and long term monitoring schedule, to monitor demographic indicators such as pregnancy, survival and recruitment rates.

3.1.3 Develop and implement a schedule to assess population status every five years, based on the framework in Section 6.6.

3.1.4 As technologies and research methods evolve, continue investigating alternative, effective methods to obtain population information.

3.2 Improve our overall understanding of Dolphin and Union Caribou health, biology and habitat requirements, diet, and effects of climate change.

3.2.1 Identify geographic areas of importance to Dolphin and Union Caribou through research and community/TK.

3.2.2 Monitor changes in predator abundance.

3.2.3 Promote research on relationships between Dolphin and Union Caribou and predators (including relatively new predators such as the grizzly bear on Victoria Island).

3.2.4 Promote research on relationships between Dolphin and Union Caribou and other species (e.g., other ungulates, geese).

3.2.5 Promote and/or continue research on Dolphin and Union Caribou population, habitat, vital rates, and health and condition, including possible contaminants.

3.2.6 Promote research on Dolphin and Union Caribou diet and vegetation growth, including changes as a result of climate change.

3.2.7 Promote research on insects and insect harassment, particularly as it relates to climate change.

3.2.8 Promote research on feasibility of alternative tools for population growth (e.g., translocation, domestication).

3.2.9 Promote research of the impacts of climate change on Dolphin and Union Caribou habitat and population.

3.2.10 Promote research on examining the impacts of road versus flight transportation on caribou.

3.3 Assess cumulative impacts on Dolphin and Union Caribou population and habitat.
3.3.1 Develop an approach to modelling cumulative effects to help predict the consequences of different anthropogenic impacts and to develop more effective mitigation measures.

3.4 Co-ordinate the gathering of information and research among different co-management partners and research institutions.
3.4.1 Identify knowledge gaps and establish high priority research questions.
3.4.2 Co-ordinate research activities with different research institutions and promote high priority research.
3.4.3 Ensure local involvement in research activities (planning, field research).
3.4.4. Promote national and international cooperation and collaboration to mitigate range-wide threats in Canada, such as climate change, pollution and contaminants.

**Objective #4:**
**Minimize disturbance to habitat and preserve sea ice crossings to maintain the ability of Dolphin and Union Caribou to move freely across their range.**

4.1 Monitor changes to habitat from anthropogenic and natural disturbances on an ongoing basis.
4.1.1 Track human and industry-caused landscape changes.
4.1.2 Monitor industrial and tourism activity including shipping traffic.
4.1.3 Track changes to sea ice and potential impacts to Dolphin and Union Caribou.

4.2 Proactively work with marine/industry/transportation organizations and regulators to minimize human and industrial disturbance and seek ways to preserve sea ice crossings.
4.2.1 Investigate mechanisms and authorities that manage shipping traffic within federal government and industry (e.g., Transport Canada) to discuss and move forward shipping concerns (e.g., amending legislation, establishing regulations including seasonal limitations for industry shipping and cruise ships during migration season, and adjusting these in response to caribou level and trend, if necessary).
4.2.2 Collaborate with federal government departments (e.g., Department of Fisheries and Oceans) to examine the potential role that marine protected areas could play in protecting the sea ice component of the migration route.
4.2.3 Develop guidelines, regulations, standard advice, and best practices for shipping, tourism and industry (including flights) that can be regulated and evaluated.

- 4.2.4 Monitor and evaluate compliance with (or implementation of) regulations, guidelines standard advice, and best practices mentioned in 4.2.3.
- 4.2.5 Identify organizations (e.g., HTOs, NWMB, Nunavut Marine Council, and communities) who could/would play a lead role in promoting standard advice and guidelines for shipping, tourism and industry.
- 4.2.6 Ensure important areas for Dolphin and Union Caribou (including sea ice crossings) are brought forward in the Nunavut land-use planning process.
- 4.2.7 For lands in the NWT that overlap with the NWT-portion of the Dolphin and Union Caribou range, explore how a land use planning process under the IFA (s.7.82) might be used to provide greater certainty to land management while maintaining habitat for the population.
- 4.2.8 Bring forward Dolphin and Union Caribou concerns through Interventions in Nunavut Environmental Impact Review Board and NWT's EIRB processes.
- 4.2.9 Work with industry, researchers, regulators, governments, HTOs/HTCs and communities to minimize aircraft flights over Dolphin and Union Caribou areas during calving and post-calving season.
- 4.2.10 Work with federal-provincial-territorial committees/working groups so that Canada 2020 goals and objectives can help inform approaches to management of Dolphin and Union Caribou.

4.3 Manage populations of other species that affect Dolphin and Union Caribou habitat.

- 4.3.1 Promote traditional harvesting of overabundant species through subsistence and sport hunts.
- 4.3.2 Approach other governments to open hunting season earlier for geese.
- 4.3.3 Promote collection of geese eggs within communities.

**Objective #5:**
**Ensure management is based on population level so future generations can benefit from sustainable harvesting opportunities.**

5.1 Obtain accurate harvest data.

- 5.1.1. Increase awareness of the importance of reporting accurate and complete harvest data.
- 5.1.2. Work with local HTOs/HTCs and regional Wildlife Management Boards to collect accurate information on harvest levels, including submission of harvest return sheet. .
- 5.1.3. Report estimated total harvest levels, including the number harvested and the sex ratio, to caribou co-management partners.

5.2 Manage harvesting activities within acceptable limits using adaptive management techniques included in Section 6, to ensure that harvesting opportunities are available in the future and treaty rights are fully respected.

- 5.2.1. Investigate and consider defining acceptable harvest levels appropriate for different population size and trend in the population.
- 5.2.2. Elders teach youth and less experienced hunters about wise harvesting practices that minimize negative impacts on caribou; includes no wasting of meat, harvesting only what is needed, proper marksmanship, ability to distinguish types and sex of caribou; avoid harvest of cows with calves as well as population leader; submission of samples.
- 5.2.3. Promote alternative food sources through encouraging harvest of other species.
- 5.2.4. Annually review harvest levels and make management recommendations if necessary (e.g., temporary harvest limitations).

5.3 Manage predators using adaptive management techniques included in Section 6, as a natural and necessary part of the ecosystem.

- 5.3.1. Educate and train hunters about how to harvest predators.
- 5.3.2. Continue current management of predator harvesting, according to each jurisdiction’s needs.

# APPENDIX C: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all federal SARA recovery planning documents, in accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (Canadian Environmental Assessment Agency and Privy Council Office 2010). The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the *Federal Sustainable Development Strategy'*s (Environment Canada 2013) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the plan itself, but are also summarized below in this statement.

It is anticipated that the activities identified in this management plan will benefit several species and the environment by promoting the conservation of Dolphin and Union Caribou. A number of species listed under SARA are present within the range of Dolphin and Union Caribou, including Peary caribou (*Rangifer tarandus pearyi*), polar bear (*Ursus maritimus*), peregrine falcon (*Falco peregrinus anatum/tundrius*), red knot (*Calidris canutus*) *islandica* and *rufa* subspecies, eskimo curlew (*Numenius borealis*), and short-eared owl (*Asio flammeus*). Species under consideration for SARA are also present in the range of Dolphin and Union Caribou and include grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*), buff-breasted sandpiper (*Tryngites subruficollis*), and red-necked phalarope (*Phalaropus lobatus*). Some species that are not listed under SARA but are considered rare include Banks Island alkali grass (*Puccinellia banksiensis*), and Drummond bluebell (*Mertensia drummondii*).

Predators to Dolphin and Union Caribou, like the Arctic wolf (*Canis lupus arctos*), may benefit from an increase in caribou populations particularly if other prey species such as muskoxen (*Ovibos moschatus*) decline. However, increases to predator populations may have adverse impacts to Dolphin and Union Caribou if their populations become very large. Conversely, a reduction in Dolphin and Union Caribou populations may have negative implications for predators. Species that share the same area with Dolphin and Union Caribou may also benefit from Dolphin and Union Caribou habitat conservation measures.

Provided conservation measures and management actions are applied, it is unlikely that the present management plan will produce significant negative effects on the Arctic environment.

This management plan will contribute to the achievement of the goals and targets of the *Federal Sustainable Development Strategy for Canada* (Environment Canada 2013). In particular, the plan directly contributes to the Government of Canada's commitment to restore populations of wildlife to healthy levels, protect natural spaces and wildlife, and protect the natural heritage of our country.

# Dolphin and Union Caribou First Joint Meeting Report

Kugluktuk, March 25-27 2015

Department of Environment, Government of Nunavut Iqaluit, Nunavut

## Executive Summary


On March 25-27, 2015 a joint meeting was held in Kugluktuk, NU. This meeting was organized by the Government of Nunavut and all co-managements partners were present: Nunavut Tunngavik Inc (NTI), the Hunters and Trappers Organization (HTO) from Kugluktuk and Cambridge Bay, Kitikmeot Regional Wildlife Board (KRWB), Kitikmeot Inuit Association (KIA), Olohaktomuit Hunters and Trappers Committee, Paulatuk Hunters and Trappers Committee/Inuvialuit Game Council, Wildlife Management Advisory Committee (WMAC), Government of Northwest Territory and Environment Canada. The participants are listed in Appendix I, followed by the workshop agenda, Appendix II and presentations in Appendix III. Over the three day meeting, delegates and representatives from co-management organizations engaged in round table discussion. They discussed the status of the Dolphin and Union Caribou and the framework of a joint management plan.

Various threats facing Dolphin and Union Caribou were brought to the table in addition to the numerous concerns of HTO's from both Nunavut and Northwest Territories. Discussions surrounding possible mitigation actions, management strategies, anthropogenic and natural threats, population fluctuations, migration changes and the effects of hunting and predation were all discussed at length. Meeting delegates unanimously agreed that furthering our understanding of the migration behaviors and the natural mortality that occurs while crossing sea ice had to be investigated further. The impact of wolves and grizzly bears on calving and wintering grounds was highlighted as a research priority, as was the significance of marine traffic affecting sea ice formation during the fall and spring migrations. It was agreed that delays in sea-ice formation during the fall migration would likely be of increasing concern in the future, as temperatures in the Arctic continue to rise. Potential management actions were discussed at length, however it was decided that no management actions should be decided until more information pertaining to population size, calving success, predation and migration behaviors could be answered.

During the joint meeting, scientific information was presented to the participants to reflect past monitoring efforts on the Dolphin and Union Caribou. Community perspectives on Dolphin and Union caribou were highlighted, as well as the current usage of this resource by the community and a review of existing and future threats was discussed. The need to have a common management plan in place created jointly by the different jurisdictions was well founded. Based on extensive discussions between all co-management partners at this meeting, a draft framework was produced.

Finally, the last session of the meeting was reserved for Traditional Inuit Knowledge perspectives. Two elders, Tommy Norberg and Isaac Klengenberg joined the discussion to provide their knowledge and insight into the Dolphin and Union Caribou movements and population fluctuation during their lifetimes.

The Government of Nunavut, Department of Environment (DOE) will consider information shared during the workshop to write a joint Dolphin and Union Management Plan. Thus, the joint meeting report will be used by the delegates to report back to their communities and share

the information provided at this initial meeting. A second meeting of this group is tentatively planned for late 2015 in Cambridge Bay.

## Preface

This report represents the Government of Nunavut, Department of Environment's best efforts to accurately capture and translate all the information that was shared during the Dolphin and Union Caribou joint meeting with the inter-jurisdictional co-management partners.

The views expressed herein do not necessarily reflect those of the Department of Environment, Nunavut or Government of Nunavut.

Delegates during the first day of the Joint Dolphin Union Management Meeting in Kugluktuk

# Contents

# 1.0 Purpose and Objectives of the Workshop

## 1.1 Meeting Objectives

The purpose of the workshop was to bring wildlife co-management partners together to share knowledge on the Dolphin and Union Caribou, share concerns, and work collaboratively towards a draft framework. The meeting objectives were as follows:

- Review scientific background and current and on-going research programs
- Review and discuss the proposed management planning process for the Dolphin-Union Caribou Management Plan
- Develop a management framework to address species needs, threats, management objectives and broad strategies and conservation measures
- Identify, review and discuss Inuit Quajimajatuqangit and Traditional Ecological Knowledge and establish how it can be incorporated into the management plan
- Seek a commitment from participants on how to engage and participate in the development of the Dolphin and Union Caribou Management Plan

The workshop was divided into two different sections:

1) Joining different management processes and what do we know?
2) What can we do to conserve the Dolphin and Union?

The goal of the first session was to inform participants about current on-going research programs, clarify with the co-management partners the different territorial and federal processes in place that require a management plan, and the need to work together to avoid duplicating efforts and to make it a more homogeneous process. The second session aimed to propose a framework for developing a joint Dolphin and Union Management Plan and discuss how Traditional Knowledge can be equally incorporated into the management plan, as per the Nunavut Land Claims Agreement (NLCA). Thus, this joint meeting engaged the co-management partners in the development of a Dolphin and Union management plan. This report was written based on the discussion that took place during the meeting; verbal quotes from the participants are italicized, whereas information taken from notes and minutes are not.

# 2.0 Workshop Participants and Structure

## 2.1 Workshop Participants

The workshop was attended by the representatives from the following organizations:

Canada:

- Environment and Climate Change Canada (ECCC)

Northwest Territory:

- Olohaktomuit Hunters and Trappers Committee
- Paulatuk Hunters and Trappers Committee/Inuvialuit Game Council
- Wildlife Management Advisory Committee (WMAC)
- Government of Northwest Territory (GNWT)

Nunavut:

- Hunters and Trappers Organizations (HTOs)- Kugluktuk, Cambridge Bay
- Elder Advisory Committee (EAC) with the Department of Environment
- Nunavut Tunngavik, Inc (NTI)
- Kitikmeot Regional Wildlife Board (KRWB)
- Kitikmeot Inuit Association (KIA)
- Department of Environment, Government of Nunavut (DOE)

### 2.2 Format of Discussions

During the workshop, presentations by biologists and collaborators provided background information on the current population and status of the Dolphin and Union Caribou and the process of species-at-risk and management planning for each jurisdiction. Presentations were followed by a question and answer period allowing delegates to provide input based on their experience and observations. Since the group was relatively small, there were no "breakout sessions", but a group discussion and round table conversations took place to capture the perspectives and current management practices from each of the co-management partners.

One afternoon was dedicated to compiling a rough framework of a potential shared management plan between the three governmental jurisdictions taking into consideration all comments and concerns expressed by other co-management partners and elders that were present. This framework is provided below as management objectives and concerns about threats on the Dolphin and Union Caribou population. It is a compilation of efforts representing both scientific and Traditional Knowledge expertise.

This framework is a working document that will be modified and further discussed with the co-management partners and reviewed at a tentative fall meeting after survey and collar data have been completed.

## 3.0 Session 1: Joining Differing Management Processes and Addressing Knowledge Gaps

### 3.1 Scientific Background

Scientific information was presented to the participants; the past monitoring efforts of the Dolphin and Union Caribou and the proposed research program for 2015-2019. The Dolphin and

Union Caribou is the most genetically differentiated of the barren-ground caribou and have unique migration behaviors and a distinct phenotype. They do not form well-defined calving ground and have a more individualist calving strategy followed by fall and spring sea-ice migrations. The Wildlife Biologist, Lisa-Marie Leclerc and Jan Adamczewski presented more specific information from their respective jurisdictions.

The DOE presented information on the distribution, the migration pattern and the previous population surveys of this unique caribou. The range of the Dolphin and Union Caribou encompasses the west and east side of Bathurst Inlet for wintering ground and uses most of Victoria Island for summering ground (Figure 1). Dumond and Lee[1] (2013) provided revised estimates of 34,558 ± 95% CL 6,801 in 1997 and 27,878 ± 95% CL 7,537 in 2007 (Figure 2). Co-management partners provided information on a potential crossing between Victoria Island and King William Island that was previously unreported in the scientific literature and this local knowledge will be incorporated to forge the current research programs.

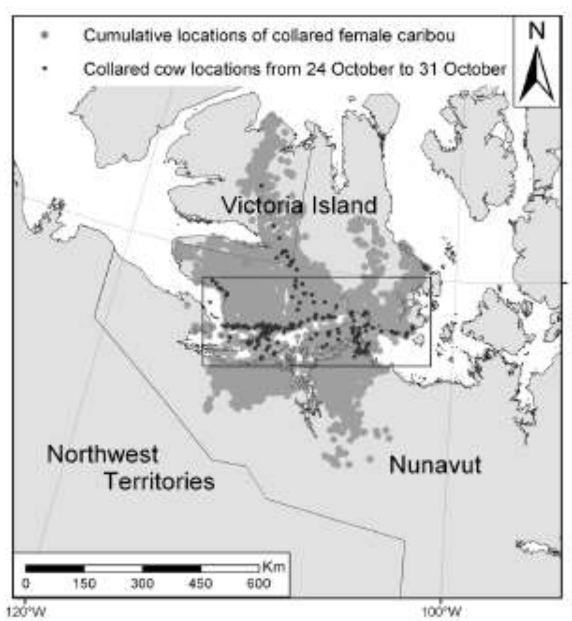



*Figure 1: From 1999-2005 satellite collar locations, the cumulative annual distribution of Dolphin and Union caribou was generated and represented on the picture in grey (from Dumond and Lee, 2013)*

[1] Dumond M. and Lee D. (2013). Dolphin and Union Caribou herd Status and Trend. Arctic. Vol 66. No 3: 329-337.

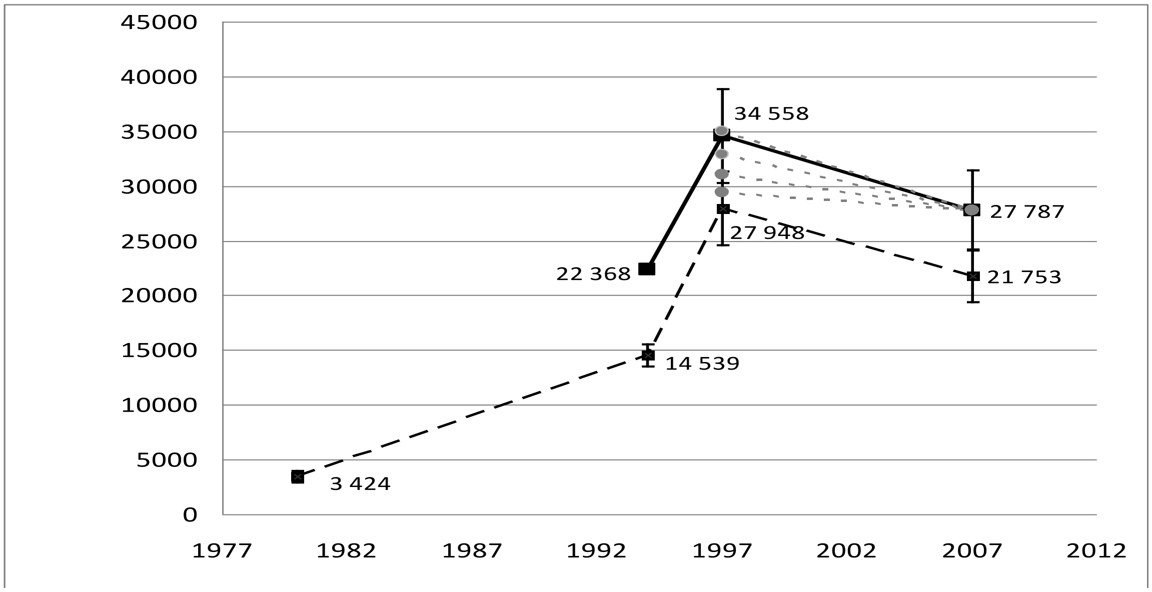



*Figure 2: Variation of the Dolphin and Union caribou herd estimates from 1980 to 2007.The dark grey dashed line shows the estimate in the study area and the black solid line shows the extrapolated estimate for the whole herd (from Dumond and Lee, 2013).*

The Dolphin and Union research program 2015-2019 will aims to fill the following knowledge gaps:

- Population estimates and habitat selection/range
- Herd health (diseases and toxicology)
- Use of new technologies (drones and new collar design)
- Mortality associated with fall migration and its impact on the herd

The GNWT presented background information form the "Species Status Report for Dolphin and Union Caribou (*Rangifer tarandus groelandicus x pearyi*) in the Northwest Territories" document written by the Species at Risk Committee (SARC) in 2013. An animation showing the compilation of collared caribou movement by NWT and Nunavut from 1987 to 2006 was presented. Attention was drawn to the fall and spring migration date as well as the main crossing point. From what is seen today, difference in the Dolphin and Union migration pattern was highlighted. This animation reveled one of the numerous applications of collaring caribou. Thus, the Dolphin and Union are found in the Northwest part of Victoria Island from July to October.

## 3.2 Processes under the Federal Species at Risk act (SARA) and Territorial Species at Risk (NWT) act.

Environment and Climate Change Canada:
The Dolphin and Union caribou was assessed by COSEWIC in 2004 and listed under the *Species at Risk Act (SARA)* in 2011 as a species of Special Concern. Due to this Special Concern status, a Dolphin and Union Management Plan is required before 2016/2017 under the "Three-Year Recovery Document Posting Plan". This federal legislation was explained to all co-management

partners and example of completed management plans for other species under the same listing was brought to the table as an object of discussion.

Government of Northwest Territories:
The Territorial *Special at Risk (NWT )Act* assessed the status of the Dolphin and Union caribou in 2013 and this species was then listed in 2015 as a species of Special Concern. Under this status, GNWT has until March 2017 to complete a management plan for the NWT. The management plan has a more specific layout with the first section covering the background information about the species biology and a section about the strategies and approaches to attain the management goal.

Government of Nunavut/ NTI
The Government of Nunavut, Department of Environment (DOE), is responsible for the protection, management and sustainable use of the caribou, such as the Dolphin and Union. The DOE is also responsible for conducting research, in addition to provide supportive information to the co-management partners, is involved in development of management plans for sound management. The *Nunavut Wildlife Act* recognizes *Inuit Qaujimajatuqangit* (IQ) and NTI ensures that Inuit knowledge is then integrated fully into management planning. As the provisions for Species as Risk designation under the *Nunavut Wildlife Act* have not been enacted, Nunavut does not have to produce a management plan by a specific date.

## 3.3 Community Perspectives:

Round table discussion (from minutes):

**Ulukhaktok**: The development of a young hunter program was suggested as a means to keep the younger generation on the land and to learn traditional methods of hunting and harvest. Concerns regarding freezing rain events affecting spring and fall survival of caribou were brought up, these were also shared by the other communities. Community members were being paid to collect sea ice thickness using Polar Bear funding and this could be a way of increasing community engagement. Harvest reporting in Ulukhaktok is carried out by having a community member go door-to-door to collect harvest records that otherwise would not be accounted for. Concerns regarding the future of healthy and abundant land foods for future generations were made very evident by Joshua Oliktuak, who emphasized the importance of maintaining sustainable levels of caribou in Nunavut and The Northwest Territories. The suggestion was made that industry should be responsible for paying for research to address the questions of impacts on adjacent areas.

**Paulatuk**: No comments

**Tuktoyaktuk**: The community of Tuktoyaktuk had recently created a park that was known to be a key calving area for the Bluenose West herd, but allowed for Inuit harvest and access for hunting. There was a suggestion to pursue a similar project for caribou calving grounds in Nunavut. This community is concerned regarding cruise ships dumping bilge water into the gulf. In addition, they expressed concern about the impacts of tourists and potential invasive plants and insects if visitors leave the cruise ships. The importance of understanding animal movements was expressed by Charles Pokiak and he acknowledged that the impacts on animals that occurs from collaring was worth undertaking for the information gained. The ability for communities to meet face-to-face with biologists was also expressed as an important aspect for caribou research.

**Cambridge Bay**: Jimmy Haniliak explained how in the 1950's when he moved to Cambridge Bay, that no island caribou were seen and he had to travel to the mainland (Bay Chimo) to find them. When island caribou began to return, he would travel 100 miles northwest where he would get Peary Caribou, which tasted different than mainland caribou. He noticed that some animals would drown going south and that those returning in the spring were thin and had little fat reserves. Discussions with elders from Cambridge Bay seems unanimous that there has been an observed change in migration route during the fall, utilizing areas east of Cambridge Bay to a much larger extent than previously. Movements from Ferguson Lake east, with crossings to King William Island have been observed personally by Jimmy Haniliak and also believed they return the same way in May. Concerns regarding increased numbers of Grizzly bears and wolves on Victoria Island were expressed multiple times. Human garbage and debris has been observed affecting caribou, such as barbed wire caught in the antlers of caribou. Ships breaking sea ice in the fall was a major concern expressed by every community. This was experienced by people from Cambridge Bay when NTCL were breaking ice in the channel every 12 hours. This prevented caribou from crossing the channel. The suggestion of allowing HTO's to charge fees for land use was made.

*Photo 1: Elder Jimmy Haniliak showing where Dolphin-Union Caribou were now crossing sea ice in eastern Victoria Island*

**Kugluktuk**: Concerns regarding caribou mention them been seen frozen in ice and groups as large as 150 animals could be seen floating on large pieces of ice in the Coronation Gulf. Multiple mentions of caribou being seen with ice balls on their fur in the fall from having fallen through sea ice during their migration were made. Jorgan Bolt mentioned that he has seen bugs being so thick that caribou would be seen running kilometers, just to turn around and return to the same location. Trying to escape this insect harassment meanwhile prevented the caribou from grazing to increase their fat storage. Changing sea ice conditions were a cause of concern for elder Isaak Klengenberg, who had to leave his outpost camp due to the later formation of sea ice, which prevented him from accessing it in the spring and fall. He mentioned that he used to see flocks of gulls gathering around frozen caribou in the ice; the gulls would feed off them. Elder Tommy Norberg mentioned that close by the islands north-east of Kugluktuk (Berens Islands), where the sea ice is often thinner near the edges, caribou were seen either drowned in the water or had died from freezing on the bedrock. He followed up with saying that this happen a number of years ago and that today, most island caribou don't cross in this area anymore.

*Photo 2: Elder Tommy Norberg showing where Dolphin-Union Caribou wintered south-east of Kugluktuk*

**Gjoa Haven**: James Qitsualik Taqaugak confirmed Jimmy Haniliak's observations of caribou crossing from Victoria Island to King William Island. He also expressed concern regarding predator increases and the potential impact of forest fires on wintering caribou.

In the past, the Inuit always kept their camps away from migration routes to avoid disturbing the caribou as they moved between summer and wintering grounds. James also spoke of how respect for using the caribou carcass has changed. In the past, cutting up a carcass was a very careful ordeal, making sure not to cut through sinew, while today people just used saws to butcher carcasses and these traditions are being lost.

**Predators:**

Many comments were received from all communities regarding the potential impacts of increased predator populations in the Arctic, mostly the perceived increase in wolves and grizzly bears. Observations from delegates on grizzly predation on calving grounds and increased observations of both predators on King William Island and Victoria Island were made. There was acknowledgement that predators have been interacting with caribou for millennia and they haven't been responsible for the extirpation of any caribou herds.

Some examples of previous predator control were made by delegates, including stories of killing wolf pups near calving ground and poisoning wolves along migration corridors. Poisoning can have serious detrimental effects on other scavengers and this wasn't the best form of predator management.

A suggestion to increase bounties on wolves in Nunavut was made, as it has been done in NWT and was supported by most communities. Increases in gas prices have negatively affected hunters and fewer people travel on the land due to the extra costs. Comments from delegates confirmed that there was no interest in mass slaughter, but rather would prefer a controlled management to keep numbers from increasing too quickly. The Inuit have always respected wolves and the role they play in the Arctic ecosystems. Examples of this were given by Philip Kadlun, who said when he was living on the land, they would sometimes find aborted wolf pups near dens at times of low caribou numbers.

There are also questions regarding the impact that industrial activities have in the NWT, forcing predators further north due to noise and mechanical disturbances.

It would be important to have a predator monitoring program in place in the region. Thus, even if the HTOs request a wolf bounty, it was made clear that the GN-DOE does not support such an initiative. However, DOE mentioned that there is no limitation on the number of wolves that can be harvested.

## 4.0 Session 2: What can we do to conserve the Dolphin and Union

### 4.2 Framework of the Management plan

Management plan group direction:

The management plan should incorporate equally scientific knowledge and traditional knowledge drawn from other existing caribou management plan, but be specific to the uniqueness of the Dolphin and Union caribou.

Management goal/vision:

A) To ensure a sustainable population of Dolphin and Union caribou and intact habitat, that offers harvesting opportunities for present and future generations, recognizing the cultural importance of Dolphin and Union caribou.

or

B) To ensure a sustainable population of Dolphin and Union caribou and intact habitat, that allows for human use of caribou and their habitat while respecting conservation concerns.

Objectives:

These are 5 recommended objectives for the management of Dolphin and Union caribou. These objectives should be applied across the NWT - Nunavut population.

1. Ensure there is adequate and intact habitat with minimal human disturbance (in particular, migratory sea-ice route) to maintain a healthy and sustainable population of Dolphin and Union caribou.

2. Ensure that harvest of Dolphin and Union caribou is sustainable.

3. Collect scientific, technical and traditional information on Dolphin and Union caribou ecology, key habitat, demographic indicators, and cumulative effects to inform sound management decisions.

4. Communicate and share information on an ongoing basis with co-management partners, communities, industry and the public to inform them about monitoring and managing dolphin-union caribou.

5. Adaptively co-manage Dolphin and Union caribou by using a grassroots (bottom up approach) and using the best traditional, scientific, and technical information available.

Approaches and actions to achieve these objectives:

Recommended approaches (numbered as X.X.) are grouped on the following pages under each objective. More specific actions (numbered as X.X.X) are grouped below under each approach.

**Objective #1:**

**Ensure there is adequate and intact habitat with minimal human disturbance (in particular an intact migratory sea-ice route) to maintain a healthy and sustainable population of Dolphin and Union caribou.**

1.1 Monitor and minimize human/industrial disturbance.
- 1.1.1 Monitor industrial shipping traffic.
- 1.1.2 Work with Transport Canada to regulate shipping and industry activities seasonally.
- 1.1.3 Work with tourism industry to regulate cruise ships as well as human traffic on land;
- 1.1.4 Establish seasonal limitations for industry shipping and cruise ships during calving and migration seasons.

1.1.5 Develop guidelines, standard advice, and best practices for shipping, tourism and industry;
1.1.6 If necessary, in response to caribou lifecycles and changes to habitat recommend that shipping, cruise ships and/or industrial activities be scaled back or temporarily discontinued.
1.1.7 Identify organizations (e.g., HTOs and communities) who could/would play a lead role in promoting standard advice and guidelines for industry.
1.1.8 Develop an oil spill response plan.

1.2 Monitor changes to habitat on an ongoing basis.
1.2.1 Track human-caused landscape changes, using both remote sensing and current disturbance data from industry.
1.2.2 Compile and manage spatial information on landscape change.

**Objective #2:**
**Ensure that harvest of Dolphin and Union caribou is sustainable.**
2.1 Obtain accurate harvest data through measuring harvest levels.
2.1.1. Educate people on the importance of reporting harvest.
2.1.2. Work with local Hunters & Trappers Committees/Associations, and local Wildlife Advisory Boards to collect accurate information on harvest levels of Aboriginal hunters.
2.1.3. Report estimated total harvest levels, including the number harvested and the sex ratio, to caribou management authorities.

2.2 Manage the harvest to ensure it is sustainable.
2.2.1. Investigate and define *sustainable harvest* levels.
2.2.2. Elders teach youth about wise harvesting practices that minimize negative impacts on caribou; includes no wasting of meat, avoidance of overharvesting, proper marksmanship, ability to distinguish types of caribou; avoidance of harvesting cows with calves.
2.2.3. Investigate the possibility of promoting alternative food sources as an alternative to harvesting of Dolphin and Union caribou.
2.2.4. Periodically review harvest levels and make management recommendations if necessary (e.g. temporary harvest limitations).

**Objective #3:**
**Collect scientific, technical and traditional information on Dolphin and Union caribou ecology, health, key habitat and population indicators, impacts of human activities, and cumulative effects to inform sound management decisions.**
3.1 Incorporate community and traditional knowledge on an ongoing basis.
3.1.1 Ensure that plans and activities for Dolphin and Union caribou management are informed by community and traditional knowledge through ongoing communication between co-management partners and through supporting community monitoring programs.

3.2 Identify knowledge gaps and establish high priority research questions.

3.2.1 Conduct research on Dolphin and Union caribou to determine health, condition and test for possible contaminants.

3.3 Improve our understanding of Dolphin and Union caribou distribution and relationships
 - 3.3.1 Identify geographic areas of importance to Dolphin and Union Caribou through research and traditional knowledge.
 - 3.3.2 Monitor changes in predator populations
 - 3.3.3 Promote research on relationships between Dolphin and Union caribou and predators (including new predators)
 - 3.3.4 Promote research on relationships between Dolphin and Union caribou and other species (e.g. ungulates, geese)

3.4 Estimate population trends in each region.
 - 3.4.1 Expand community monitoring programs that provide information on Dolphin and Union caribou health and condition, habitat vital rates, numbers, and population trends and predator changes.

3.5 Develop an approach to modelling cumulative effects.
 - 3.5.1 Assess and manage cumulative impacts on Dolphin and Union caribou population and habitat.

**Objective #4:**
**Communicate and share information on an ongoing basis with co-management partners, communities, industry and the public to inform them about monitoring and managing dolphin-union caribou.**

4.1 Encourage flow and exchange of information between parties, using various approaches, depending on group/demographic.
 - 4.1.1 Conduct “out on the land” trips, where more experienced hunters (elders if they’re able) take youth out on the land.
 - 4.1.2 Use social media and the internet to reach out to youth.
 - 4.1.3 Conduct school visits to educate youth about managing Dolphin and Union caribou
 - 4.1.4 Conduct community meetings to inform communities about managing Dolphin and Union caribou.

**Objective #5:**
**Adaptively co-manage Dolphin and Union caribou by using a grassroots, bottom up approach and using the best traditional, scientific and technical information available.**

5.1 Work with co-management partners, Aboriginal governments and organizations, local harvesting committees, and industry to share information and collaborate on management actions.
 - 5.1.1 Continue to work with wildlife management advisory boards, game councils and local HTOs on Dolphin and Union caribou monitoring, stewardship and management.
 - 5.1.2 Investigate the potential of having industry contribute information to research.

5.1.3 Continue engaging hunters, industry and public about Dolphin and Union caribou management.
5.1.4 Annually review new information on population and habitat, and adapt management practices accordingly.
5.1.5 If necessary, recommend alternative management actions (e.g., stricter habitat and/or harvest management) allowing for natural variation in numbers.
5.1.6 Annually report on management actions and progress made toward meeting objectives in management plan.

5.2 Co-ordinate research among different partners
5.2.1 Co-ordinate research activities with different research institutions to minimize impacts on Dolphin and Union caribou.
5.2.2 Ensure local involvement in research activities (planning, field research)
5.2.3 Potentially charge fees (higher fees if already in existence) to research institutions for conducting research.

5.3 Work with all levels of governments to manage populations of other species (particularly geese).
5.3.1 Approach other provincial governments to open hunting season earlier
5.3.2 Promote harvesting of geese through subsistence and sport hunts
5.3.3 Educate communities/ promote collection of eggs

5.4 Work with communities to reduce release of contaminants through various venues (see 4.1).

## 4.3 Threats to the Dolphin and Union caribou

During the meeting, the following threats were identified and then listed in priority. Approaches to address these threats were also identified by participants wherever possible. Each threat and approach has been linked to a specific objective in the framework.

**Threats:**

- Climate change (warmer weather, icing events, more severe storms)
- Drowning and dangerous sea-ice crossing
- Shipping – both industrial and cruise ships (ice-breaking-check specs of "ice-breaking" ie. Ice thickness)
  - invasive species, as a result of dumping of grey water)
  - Contaminants (eg. Oil spill causes destruction of shoreline and potential calving habitat)
- Human activities (conducting research)
- Industrial development
- Harvesting (wastage of meat and over- harvesting)

- Predation (wolves, bears)
- Disease (emerging or increase in disease and parasites
- Insects (increase in, and/or types)
- Relationship between other species (eg. musk-ox, geese) and caribou (predation, habitat degradation, competition for food)
- Impacts of salt on habitat
- Shipping of oil containers (oil spills)
- Tourism (eg. Cruise ships)

| | Threat | Approach that addresses threat | Integrated into Objective # Approach # |
|---|---|---|---|
| 1. | Climate Change (resulting in drowning and dangerous sea-ice crossing | | Obj. #1 |
| 2. | Shipping: breaking of sea-ice and tourism (tourists go on land)<br>- Also includes shipping of oil containers. | - Regulate shipping activities seasonally (eg. , migration)<br>Develop guidelines and best practices for shipping companies<br>- Monitor ship traffic<br>- Work with Transport Canada and industry to establish seasonal limitations<br>- Develop an oil spill response plan | Obj. #1<br>1.1.4<br>1.1.5<br><br>1.1.1<br>1.1.2<br>1.1.4<br><br>1.1.8 |
| 3. | Harvesting (wastage of meat and over-harvesting) | Obtain accurate information to estimate population<br>Approach: Manage harvest to ensure it is sustainable:<br>Actions:<br>- Obtain accurate harvest data (measure harvest levels)<br>Investigate and define "sustainable harvest levels<br>- Periodically review harvest levels and make harvest strategies and recommendations if necessary.<br>Community education<br>(Elders teaching youth:<br>- wise harvesting practices;<br>- "Out on the land" trips | Obj. #2<br><br>2.2<br><br><br>2.1<br><br>2.2.1<br><br>2.2.4<br><br><br><br>2.2.2<br><br>4.1.1 |

| | Threat | Approach that addresses threat | Integrated into Objective # Approach # |
|---|---|---|---|
| | | Consider alternative species to harvest | 2.2.3 |
| 4. | Industrial activities – mining (oil and gas exploration) | - Develop guidelines, standard advice, and best practices for shipping and industry; potentially have industry contribute to research<br>Minimize human/industrial disturbance<br>- Regulate activities seasonally (e.g. limit activities during calving and migration seasons)<br>- Identify organizations (e.g., HTOs and communities) who could play a lead role in promoting these guidelines.<br>- If necessary, in response to caribou lifecycles and landscape changes, recommend that development activities be scaled back or temporarily discontinued | 1.1.5<br>5.1.2<br>1.1<br>1.1.2<br>1.1.4<br>1.1.7<br>1.1.3 |
| 5. | Predation (wolves, bears) | - Monitor predator changes (change of predator species)<br>- Research predator-prey relationships among new predators<br>- Conduct and gather research on wolves (correlation between wolf population numbers and caribou pop numbers)<br>- Consider responsible wolf harvesting through:<br>Community education<br>Traditional harvesting | 3.3.2<br>3.4.1<br>3.3.3<br>3.4.1<br>3.3.3<br>3.4.1 |
| 6. | Human Activities including:<br>- Conducting research<br>Tourism,<br>Includes:<br>• Cruise ships<br>• Low-flying aircraft<br>• Air-borne pollutants<br>• Movement of tourists walking around in caribou habitat | - Coordinate research activities with different research groups to minimize impacts<br>- Identify knowledge gaps and establish high priority research questions<br>-Ensure local involvement in research activities (planning, field research)<br>- Charge fees for conducting research<br>- Have seasonal limitations on cruise ships & limitations to tourists walking in caribou habitat | 5.2.1<br>3.2<br>5.2.2<br>3.1.1<br>5.2.3<br>1.1.3<br>1.1.4<br>1.1.5 |

| | Threat | Approach that addresses threat | Integrated into Objective # Approach # |
|---|---|---|---|
| 7. | Disease | - Conduct research on caribou to determine health | 3.2.1<br>3.4.1 |
| 8. | - Presence of other species (eg. musk-ox, geese) causing habitat degradation and competition for food | -Examine relationship between other species and caribou<br>- Work with all levels of governments to manage numbers of geese<br>- Approach other provincial governments to open hunting season earlier<br>- Promote harvesting of geese through subsistence and sport hunts<br>- Educate communities/ promote collection of eggs | 3.3.4<br><br>5.3<br>3.1.1 |
| 9. | Contaminants<br>- includes impacts of salt on habitat | - Conduct research on caribou to determine health<br>- Decrease local community release of contaminants | 3.2.1<br>3.4.1<br>5.4<br>4.1 |
| 10 | Insects | - Conduct research on caribou to determine health<br>- Expand community monitoring programs that provide information on caribou health | 3.2.1<br><br>3.4.1<br>3.1.1 |
| 11 | Forest fires (smoke, air-borne pollutants) | - Conduct research on caribou to determine health<br>- Expand community monitoring programs that provide information on caribou health | 3.2.1<br><br>3.4.1<br>3.1.1 |
| **Knowledge Gaps** | | | |
| | Conduct research on health of caribou including monitoring of health | | 3.2.1<br>3.4.1<br>3.1.1 |
| | Research on predator-prey relationship | | 3.3.2<br>3.3.3<br>3.4.1 |
| | Research on impacts of past predator culling programs | | Use existing TK and academic info |

### 4.3 Sharing IQ/Traditional Ecological Knowledge and Local Knowledge

Elders had the opportunity to talk about what portions of the animal carcass were traditionally utilized and how each part of the caribou was used. Not only was the meat harvested, but also the organs in the chest cavity, liver, heart, digestive tract, and sinew were taken. Within the communities, successful hunters shared their catches not only with family or close relatives, but also with other community members in need. Since sharing is part of Inuit values, the workshop participants spoke of extending this cultural sharing to other communities in need, via a meat sharing distribution program.

## Going Forward

The draft management framework produced at this meeting will be distributed to all wildlife co-management partners for their review and input with their respective board(s) and/or organization(s). A second meeting of this group is tentatively planned for late 2015 in Cambridge Bay, where a request for youth delegation and elders should also take part.

## Appendix I: List of Participants

| Name | Community | Organization |
|---|---|---|
| Joshua Oliktoak | Ulukhaktok | Olohaktomuit Hunters and Trappers Committee |
| Joe Illasiak | Paulatuk | Paulatuk Hunters and Trappers Committee/Inuvialuit Game Council |
| Charles Pokiak | Tuktoyaktuk | Wildlife Management Advisory Committee (WMAC) |
| James Qitsualik Taqaugak | Gjoa Haven | Kitikmeot Regional Wildlife Board (KRWB) |
| Jimmy Haniliak | Cambridge Bay | Cambridge Bay Hunters and Trappers Organization |
| Philip Kadlun | Kugluktuk | Kugluktuk Hunters and Trappers Organization |
| Colin Adjun | Kugluktuk | Kugluktuk Hunters and Trappers Organization |
| Jorgen Bolt | Kugluktuk | Kugluktuk Hunters and Trappers Organization |
| Luigi Toretti | Kugluktuk | Kitikmeot Inuit Association (KIA) |
| Tannis Bolt | Kugluktuk | Kitikmeot Inuit Association (KIA) |
| Tommy Norberg | Kugluktuk | Kugluktuk Elder and Knowledge Holder |
| Isaac Klengenberg | Kugluktuk | Kugluktuk Elder and Knowledge Holder |
| David Lee | Quebec | Nunavut Tunngavik Inc. (NTI) |
| Lisa-Marie Leclerc | Kugluktuk | Government of Nunavut (DOE) |
| Myles Lamont | Kugluktuk | Government of Nunavut (DOE) |
| Mathieu Dumond | Kugluktuk | Government of Nunavut (DOE) |
| Lisa Worthington | Yellowknife | Government of NWT (GNWT) |
| Jan Adamczewski | Yellowknife | Government of NWT (GNWT) |
| Donna Bigelow | Yellowknife | Environment Canada (EC) |
| Amy Ganton | Yellowknife | Environment Canada (EC) |

## Appendix II: Agenda

**Dolphin and Union Caribou Joint Management Planning Meeting**

Ulu Visitor Center, Kugluktuk

March 25-27, 2015

***Goals of the Meeting:***

- *Review and discuss the proposed management planning process for the Dolphin and Union Caribou Management Plan*
- *Develop a management plan framework: species needs, threats, management objectives, and broad strategies and conservation measures*
- *Review of scientific background and current on-going research investigation*
- *Identify, review and discuss IQ and TEK information and how it can be incorporated into the management plan*
- *Seek a commitment from participants on how to engage/participate in the development of the Dolphin and Union Caribou Management Plan*

**Day 1:**

**Session 1: Joining different management processes and what do we know?**

| | |
|---|---|
| 8:30-9:00 | **Arrival and Coffee** |
| 9:00-9:10 | **Welcome**<br>**Opening Prayer**<br><br>**Opening Remarks**<br>**Introductions** |
| 9:10-12:00 | **Dolphin and Union herd Background**<br>-Previous aerial surveys (Kugluktuk and Cambridge Bay)<br>Update on research and monitoring program<br>Community Observations |
| | LUNCH |
| 13:00-15:00 | **Each jurisdiction explain their process- species at risk and management planning**<br><br>**Overview on how the joint process will work and the expected final product** |
| 15:00-15:30 | HEALTH BREAK |
| 15:30-17:00 | **Management goals and framework**<br>Process consideration<br>Goal, Objectives, Approaches |

**Day 2:**

## Session 2: What Can We Do to Conserve the Dolphin and Union?

| | |
|---|---|
| 8:30-9:00 | **Arrival and Coffee** |
| 9:00-9:10 | **Opening Remarks for Day 2**<br>**Overview of Day 1** |
| 9:10-12:00 | **Discussion group - Main concerns**<br>Concerns (threats) about the Dolphin and Union caribou |
| | **LUNCH** |
| 13:00-14:00 | **Discussion group - Main concerns**<br>Concerns (threats) about the Dolphin and Union caribou |
| 15:00-15:30 | **HEALTH BREAK** |
| 14:00-17:00 | **Management Practices**<br>-Current and future practices<br>-Group discussion |

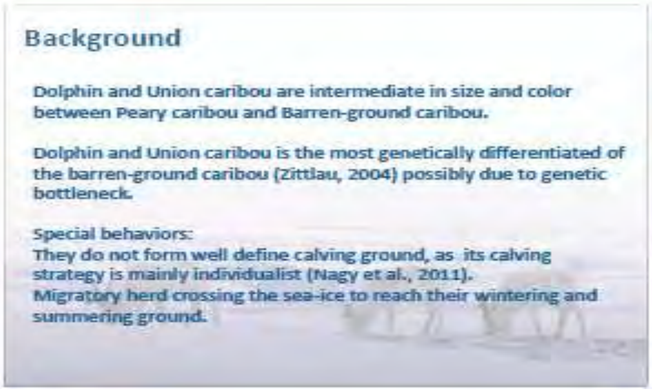
**Day 3:**

## Session 3: What Can We Do to Conserve the Dolphin and Union?

| | |
|---|---|
| 8:30-9:00 | **Arrival and Coffee** |
| 9:00-9:15 | **Opening Remarks for Day 3**<br>**Overview of Day 2** |
| 9:15 12:00 | **Discussion group – What can be done?**<br>Management recommendations - Framework<br>Address key stewardship and caribou management questions |
| | **LUNCH** |
| 13:00-16:00 | **Integrating IQ, TEK, and Local knowledge with Science for management action**<br>- Aboriginal management practices |
| 16:00-17:00 | **Next Step and Closing Remarks** |

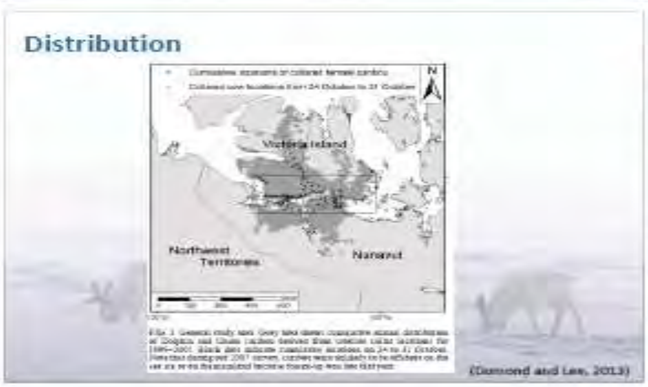
# Appendix III: Presentations





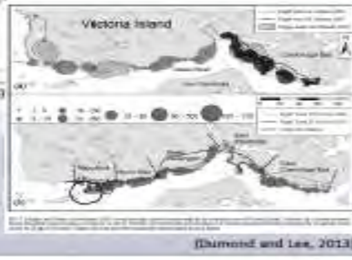






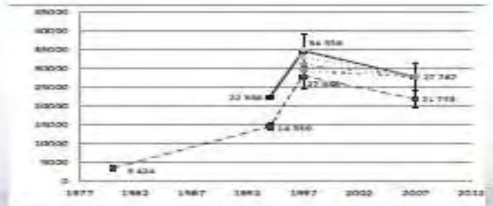

## Distribution

(Nishi and Gunn, 2004)




(Dumond and Lee, 2013)

## Population status




(Dumond and Lee, 2013)

## Population status

**Accurate long-term monitoring of this caribou herd is crucial to its management and conservation. We can only speculate about the factors responsible for the population dynamics observed for 1980-2007.**

## Goal and Objectives

**The main goal of this program is to closely monitor the population of the Dolphin and Union herd. Thus, this study will have four main objectives.**

1) Population estimate of the Dolphin and Union caribou herd
2) Fall migration pattern, highest natural mortality (UVA)
3) Habitat selection and distribution (mineral exploration, mining activities)
4) Health monitoring (contaminant, diseases, stress level)

## Study area


(Dumond and Lee, 2013)

## Anticipated Outcomes

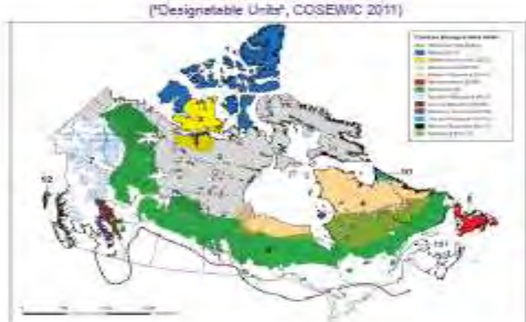
- To update the status of the herd, and inform management about sustainable harvest for this herd.
- Identify and monitor some of its stressors
- Land use impact mitigations, impacts of maritime traffic
- Habitat requirement
- Improved monitoring of the population, including collaring of individuals.

## Discussion

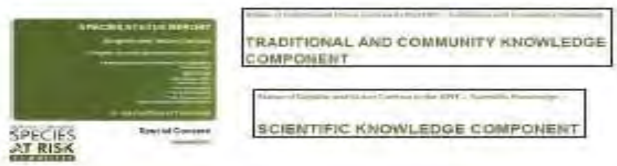
Dolphin-Union Caribou: Overview of Technical Information
March 2015 GNWT

Photo K. Poole

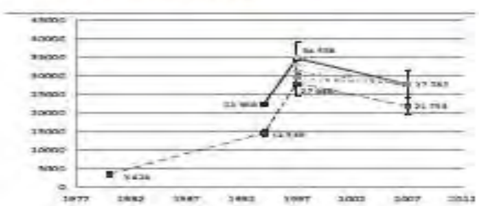
Kinds of Caribou in Canada
("Designatable Units", COSEWIC 2011)




Dolphin-Union Caribou: Status Report 2013 for NWT




Dolphin-Union Caribou: Population Trend 1980-2007
(From Dumond and Lee 2013)



Dolphin-Union Caribou: Population Trend Early 1900s to 2007
(From NWT SARC Report 2013)

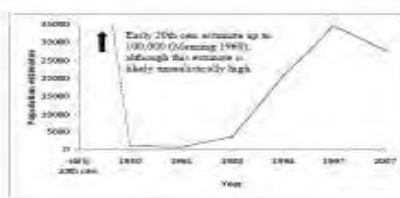
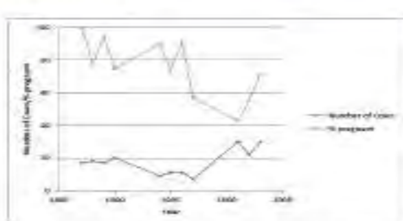



Figure 14. Depiction of approximate population estimates between the early 20th century and 2007 (Anderson 1922, Manning 1960, Banfield 1950, MacPherson 1961, Jakimchuk and Carruthers 1980, Nishi and Buckland 2000, Nishi and Gunn 2004, Dumond and Lee 2013).

Dolphin-Union Caribou: Pregnancy Rate 1980s to early 2000s
(From NWT SARC Report 2013)



Dolphin-Union Caribou:

Range Based on Collared Caribou & Observations

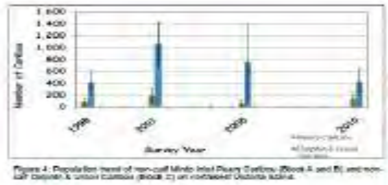
(From NWT SARC Report 2013)

Dolphin-Union Caribou:

Calving Locations from Collared Caribou 1987-2006

(From NWT SARC Report 2013)

Caribou Numbers on NW Victoria Island: Peary & Dolphin-Union (July-Aug)
(from Davison & Williams 2014)





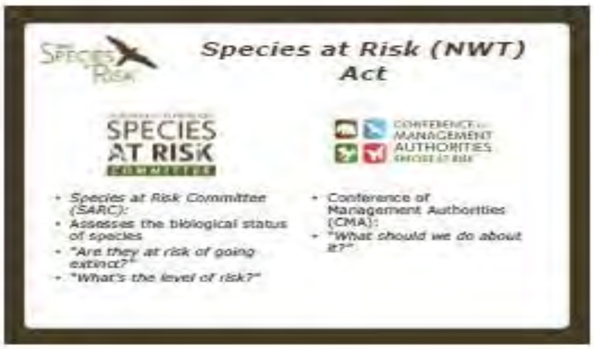

Dolphin-Union Caribou: Summary of Key Threats/Status:
(From SARC Report 2013)

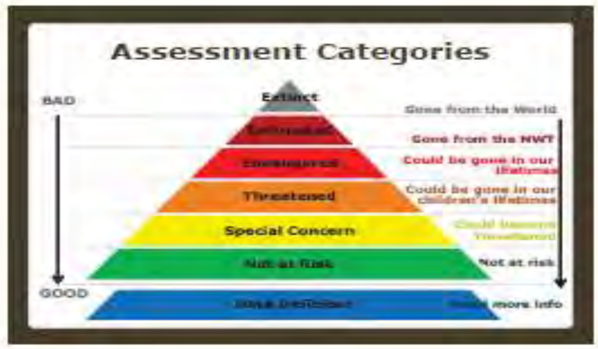
1. Declining trend 1997-2007
2. Population distinct from all others
3. Vulnerable to environmental change
4. Mine proposals Bathurst Inlet area
5. Ship traffic – possible effects on sea-ice
6. Warmer climate – shorter sea-ice season
7. Rain and ice on winter range
8. Harvest estimated 7-11%; may not be sustainable

Photo E. Tirada


Management Plans for
Species at Risk in the NWT
Dolphin Union Caribou
Management Plan Joint Meeting
Kugluktuk, Nunavut
March 25, 2015
Lisa Worthington
NWT Environment & Natural Resources

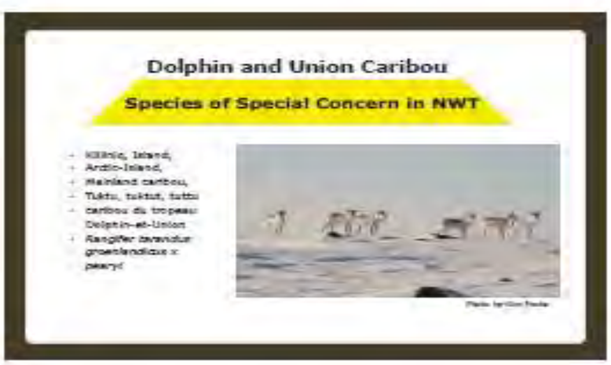

Species at Risk (NWT) Act
Purpose:
Find out which species are at risk in the NWT and do something about it.

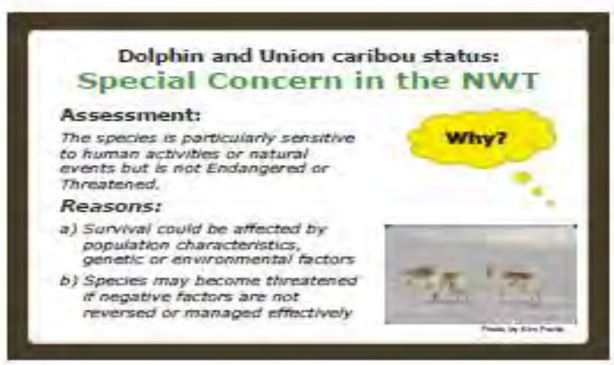

Species at Risk (NWT) Act
SPECIES AT RISK
CONFERENCE OF MANAGEMENT AUTHORITIES
Species at Risk Committee (SARC):
Assesses the biological status of species
"Are they at risk of going extinct?"
"What's the level of risk?"
Conference of Management Authorities (CMA):
"What should we do about it?"

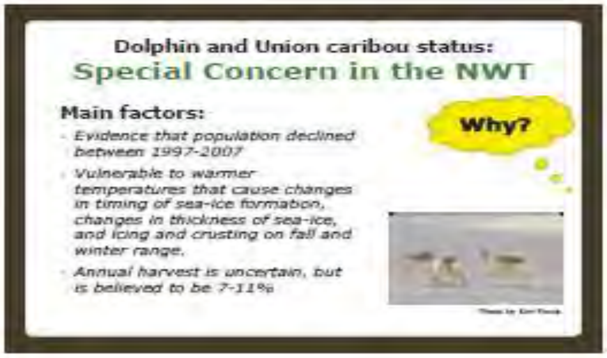

Assessment Categories
BAD
GOOD
Extinct
Gone from the World
Gone from the NWT
Could be gone in our lifetimes
Threatened
Could be gone in our children's lifetimes
Special Concern
Not at risk
more info

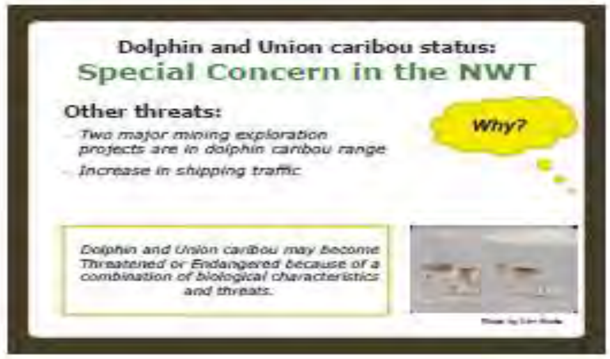

Adding Species to the
NWT List of Species at Risk

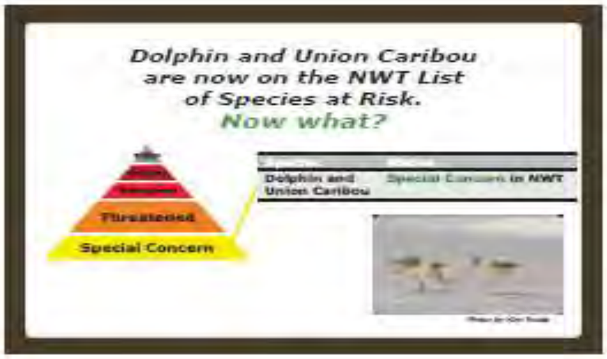

The process

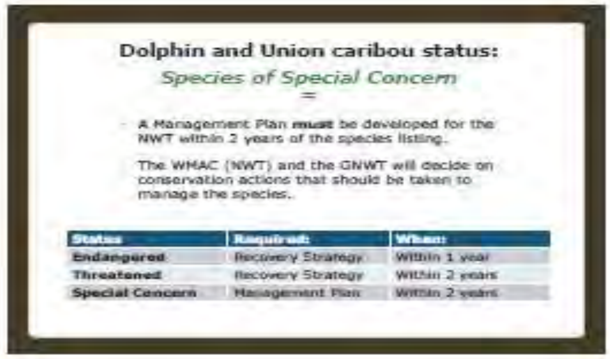

Dolphin and Union Caribou
Species of Special Concern in NWT
Arctic-Island,
Mainland caribou,
Tuktu, tuktut, tuttu
caribou du troupeau Dolphin-et-Union
Rangifer tarandus groenlandicus x pearyi


Dolphin and Union caribou status:
Special Concern in the NWT
Assessment:
The species is particularly sensitive to human activities or natural events but is not Endangered or Threatened.
Reasons:
a) Survival could be affected by population characteristics, genetic or environmental factors
b) Species may become threatened if negative factors are not reversed or managed effectively
Why?


Dolphin and Union caribou status:
Special Concern in the NWT
Main factors:
Evidence that population declined between 1997-2007
Vulnerable to warmer temperatures that cause changes in timing of sea-ice formation, changes in thickness of sea-ice, and icing and crusting on fall and winter range.
Annual harvest is uncertain, but is believed to be 7-11%
Why?


Dolphin and Union caribou status:
Special Concern in the NWT
Other threats:
Two major mining exploration projects are in dolphin caribou range
Increase in shipping traffic
Why?
Dolphin and Union caribou may become Threatened or Endangered because of a combination of biological characteristics and threats.


Dolphin and Union Caribou
are now on the NWT List
of Species at Risk.
Now what?
Threatened
Special Concern
Dolphin and Union Caribou
Special Concern in NWT


Dolphin and Union caribou status:
Species of Special Concern
=
A Management Plan must be developed for the NWT within 2 years of the species listing.
The WMAC (NWT) and the GNWT will decide on conservation actions that should be taken to manage the species.
Status | Required: | When:
Endangered | Recovery Strategy | Within 1 year
Threatened | Recovery Strategy | Within 2 years
Special Concern | Management Plan | Within 2 years


What will happen next?
This is where we are now


Management Planning for
NWT Species at Risk
Dolphin Union Caribou
Management Plan


Species at Risk
CONFERENCE of MANAGEMENT AUTHORITIES
Sections of a GNWT Management Plan
Part I:
Social Perspectives (spiritual and cultural importance)
Species Information (Status, Habitat and Biology)
Threats and Limiting Factors
Factors that may have a positive influence
Knowledge gaps
Part II:
Conservation and Recovery/Management of species
Management Goal
Management Approaches
Actions to achieve these approaches


Species at Risk
CONFERENCE of MANAGEMENT AUTHORITIES
Management Plan for the Polar Bear (Ursus maritimus)
in the Inuvialuit Settlement Region of NWT
Proposed Draft
May 2015
Species at Risk (NWT) Act
Management Plan and Recovery Strategy Series

SPECIES AT RISK

CONFERENCE OF MANAGEMENT AUTHORITIES

## Part II: Management Goal for ISR Polar Bear

**Management Goal:**
The management goal is to maintain healthy viable subpopulations of polar bears in the Inuvialuit Settlement Region (ISR) in the near term and in perpetuity, recognizing their cultural importance.

**Management Objectives:**
1. Reduce greenhouse gas emissions and help communities adapt to the impacts of climate change on polar bears.
2. Collect adequate scientific, traditional and technical information in a timely manner to facilitate management decisions.
3. Encourage wise use of polar bear subpopulations and polar bear products.
4. Adaptively co-manage polar bears and their habitat in accordance with all the best information available.
5. Minimize detrimental effects of human activities on polar bears and their habitat.
6. Communicate and share information on polar bears.

SPECIES AT RISK

CONFERENCE OF MANAGEMENT AUTHORITIES

## That's why we are here!

Part II:
- Overall Management Goal
- Management Objectives
- Approaches to achieve these objectives
- Actions to achieve these approaches

HTO's mission is to foster Inuit economic, social and cultural well-being through the implementation of the Nunavut Land Claims Agreement.

- Article 5 – Wildlife.
- Importance of implementing Article 5 to promote sustainable harvesting.
- Inuit Qaujimajatuqangit


## Land Claim Agreements

Article 5.1.2 (Principles):

a) Inuit are traditional and current users of wildlife

a) A long-term, healthy, renewable resource economy is both viable and desirable;

b) There is a need for an effective system of wildlife management that complements Inuit harvesting rights and priorities, and recognizes Inuit systems of wildlife management that contribute to the conservation of wildlife and protection of wildlife habitat.

c) There is a need for an effective role for Inuit in all aspects of wildlife management, including research; and

d) Government retains ultimate responsibility for wildlife management

Article 5.1.3 – Objectives:

(b) the creation of a wildlife system that:

(i) is governed by, and implements, principles of conservation,

(ii) fully acknowledges and reflects the primary role of Inuit in wildlife harvesting,

(iii) invites public participation and promotes public confidence particularly amongst Inuit, and

(iv) Enables and empowers the NWMB to make wildlife decisions pertaining thereto

Article 5.1.5 – Principles of conservation:

i. the maintenance of the natural balance of ecological systems within the Nunavut Settlement Area;

ii. the protection of wildlife habitat;

iii. the maintenance of vital, healthy, wildlife populations capable of sustaining harvesting needs as defined in this Article; and

iv. the restoration and revitalization of depleted populations of wildlife and wildlife habitat.

Nunavut Wildlife Management Board


- Institution of public government.
- Co-management board.
- establishing, modifying or removing total allowable harvests on wildlife harvesting.

## Management plans

The NWMB regularly reviews and approves management plans (5.2.34)

- Approve plans for management, classification, protection, restocking or propagation, cultivation or husbandry of particular wildlife, including endangered species
- Southhampton Island caribou management plan
- Kivalliq muskox management plan

In progress:

- Polar Bear management plan
- Peary caribou management plan
- Baffin Island caribou management plan

## Hunter and Trapper Organization

Article 5.7.1 - In addition to the functions given to the NWMB, the exercise of harvesting by Inuit shall be overseen by HTOs and RWOs.

The powers and functions of HTOs shall include the following:

(a) the regulation of harvesting practices and techniques among members, including the use of non-quota limitations;

(b) the allocation and enforcement of community basic needs levels and adjusted basic needs levels among members;

(c) the assignment to non-members, with or without valuable consideration and conditions, of any portion of community basic needs levels and adjusted basic needs levels; and

(d) generally, the management of harvesting among members.

## Regional Wildlife Organization

Article 5.7.6 The powers and functions of RWOs shall include:

(a) the regulation of harvesting practices and techniques among the members of HTOs in the region, including the use of non-quota limitations;

(b) the allocation and enforcement of regional basic needs levels and adjusted basic needs levels among HTOs in the region;

(c) the assignment to any person or body other than an HTO, with or without valuable consideration and conditions, of any portion of regional basic needs levels and adjusted basic needs levels; and

(d) generally, the management of harvesting among the members of HTOs in the region.

## Nunavut Wildlife Act

- Nunavut Wildlife Act recognizes and includes principles of Inuit Qaujimajatuqangit:
- Aajiiqatigiingniq/Pittiakatigiikiotik, which means that people who wish to resolve important matters or any differences of interest must treat each other with respect and discuss them in a meaningful way, keeping in mind that just because a person is silent does not necessarily mean he or she agrees;
- Avatimik Kamattiarniq/Amiginik Avatimik, which means that people are stewards of the environment and must treat all of nature holistically and with respect, because humans, wildlife and habitat are inter-connected and each person's actions and intentions towards everything else have consequences, for good or ill;



0951

# Federal *Species at Risk Act* (SARA) and Dolphin and Union Caribou Management Plan

## Recovery and conservation of species in Canada

- In the north, wildlife conservation/management is already practiced by the wildlife management boards, hunters and trappers committees/organizations, and governments
- The *Species at Risk Act* is another conservation tool for species that may be at risk of declining or disappearing
- Provides a nationally-consistent strategic framework for conservation of species across Canada
  - Species are not confined by provincial/territorial borders
  - Provides a national standard for consistency in protection
  - Management can be coordinated across the species' entire range

## Roles and Responsibilities: Federal Role

**Federal:**
- Environment Canada - *Species at Risk Act* (SARA)
- Parks Canada – *National Parks Act*
- The federal government is responsible for implementing the federal *Species at Risk Act* (SARA)

**Territorial:**
- Co-management of species
  - In general
  - As a SARA-listed species
- Territorial legislation (*Species at Risk (NWT) Act, NWT Wildlife Act, NU Wildlife Act*)

## *Species at Risk Act* (SARA)

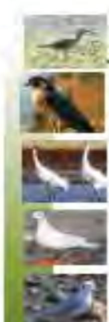
**Purpose**
- Prevent wildlife from becoming extirpated or extinct in Canada
- Provide for the recovery of extirpated, endangered or threatened species as a result of human activity
- Manage special concern species to prevent them from becoming further at risk

## The *Species at Risk Act* and the Wildlife Management Boards

- The *Species at Risk Act* requires consultation with the wildlife management boards before any decisions affecting Aboriginal people can be made
  - Listing of species
  - Application of prohibitions
  - Recovery strategies, action plans and management plans
  - Regulations for action plans and management plans
  - Critical habitat
  - Permits

## Essential role of Aboriginal Peoples

- The *Species at Risk Act* recognizes that the roles of Aboriginal peoples and Wildlife Management Boards established under land claims agreements in the conservation of wildlife in Canada are essential
- The *Act* requires:
  - Consideration of traditional knowledge in assessment, planning and implementation
  - Cooperation with directly affected Aboriginal organizations and Wildlife Management Boards when preparing recovery documents
  - Consultation with directly affected persons before making decisions that may impact them



## Species at Risk Act

**List**
- Official Listing

**Protect**
- Prohibitions
- Permits
- Project review

**Recover**
- Recovery strategies
- Action Plans
- Management Plans
- Critical Habitat

## Recovery and management planning


A recovery strategy identifies population & distribution objectives, threats, and to the extent possible, critical habitat for the species.


An action plan outlines the activities required to meet the objectives outlined in the recovery strategy.


A management plan identifies activities to conserve the species and its habitat.

## Dolphin and Union Caribou and the federal *Species at Risk Act* Process

Assessment → Listing → Recovery Planning → Implementation → Evaluation

- COSEWIC assessed as Threatened (2004)
- Reassessment underway – November 2015
- Management Plan due three years after listing: February 2014
- Backlog of recovery documents
- New date: 2016/2017

- Listed as Special Concern (2011)

- Species of Special Concern – a wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats.

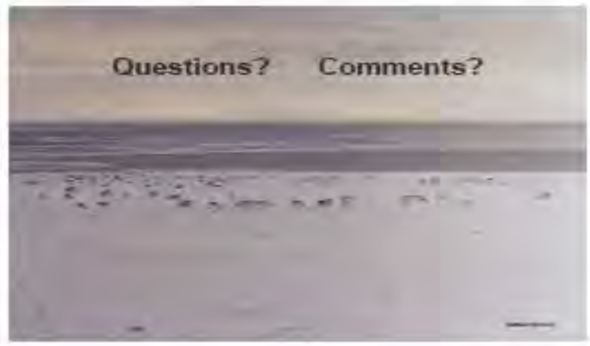
## What are the implications of Special Concern listing?

- Measures to ensure species does not become threatened or endangered.
- Management plan must be prepared within 3 years of the date of listing.
- Written in cooperation with Aboriginal organizations and Wildlife Management Boards.
- General prohibitions under SARA do not apply to species of Special Concern
- No critical habitat identification

## What Is a Management Plan?

A planning document that:

- Describes the species and its needs
- Lists the threats to the species and its habitat
- Sets management objectives
- Suggests broad strategies and conservation measures
- Describes ways to measure progress






0953

# Dolphin and Union Caribou Second Joint Meeting Report

Cambridge Bay, January 11 - 13, 2016

Department of Environment, Government of Nunavut
Iqaluit, Nunavut

0954

# Executive Summary

A workshop focusing on Dolphin and Union Caribou took place in Cambridge Bay between January 11 and 13, 2016. During this workshop, the Government of Nunavut, Department of Environment (DOE), Government of Northwest Territories (GNWT), Environment and Climate Change Canada (ECCC), NTI, and the Kitikmeot Wildlife Regional Board (KRWB) representatives conducted consultations with the Hunters and Trappers Organizations from Nunavut and Northwest Territories. The primary purpose of the workshop was to provide co-management partners with an update on progress on the draft Dolphin and Union Caribou Management Plan, and to seek further input and knowledge to help complete the draft plan.

The review of efforts on the management plan was followed by discussions on a pathway forward with the intent of developing a draft management plan suitable for community consultation. The meeting format was a series of presentations on herd status, reviews of the draft outline, framework, threats, and potential harvest management options, followed by questions and comments. The meeting was an open exchange of knowledge, both scientific and traditional and local.

Presentations on herd status and reports on research projects provided up to date knowledge for participants to start their discussions. The discussions on threats and actions to mitigate those threats will help further develop the management plan. A discussion on harvest management options will be used to define what recommended actions should be taken as caribou move through their natural population cycle. Finally a process and timeline were identified for the co-management partners to advance the management plan through each respective process.

This report attempts to summarize the comments made by participants during the workshop. A full record of the workshop is available in the minutes.

# Preface

This report represents the Dolphin and Union Caribou working group's best efforts to accurately capture and translate all of the information that was shared during workshop.

The views expressed herein do not necessarily reflect those of one specific organization, but rather, the best advice and opinions from the participants.

# Table of Contents

# 1.0 Summary Purpose

This summary is intended to collate and summarize comments, questions, concerns, and suggestions rose during the joint meeting held with representatives from the co-management partners from the Northwest Territories, Nunavut, and Environment and Climate Change Canada. The summary and notes herein only reflect what was shared during the meeting.

# 2.0 Purpose of the Workshop

The primary purpose of the workshop was to engage co-management partners from Nunavut, the Northwest Territories, and Environment and Climate Change Canada in an ongoing dialogue on Dolphin and Union caribou. It also allowed management partners to continue, based on the 2015 Kugluktuk meeting, directing the development of a multi-jurisdictional management plan for the Dolphin and Union caribou herd. Review of efforts to date was followed by discussions on a pathway forward with the intent of developing a draft management plan suitable for community consultation.

## 2.1 Format of Meetings

The meetings were held during three days (January 11, 12, and 13 2016) in Cambridge Bay at the Arctic Islands Lodge meeting room. Meetings were co-chaired by Joanna Wilson, Species at Risk Biologist with GNWT, and Mathieu Dumond, Regional Manager, DOE. The meeting format was a series of presentations on herd status, management process, reviews of the draft outline, framework and threats, and potential harvest management actions (presentations are in Appendix 2), followed by questions and comments. The meeting was an open exchange of knowledge, both scientific and traditional.

## 2.2 Meeting Participants

| Name | Community | Organization |
|---|---|---|
| Simon Qingnaqtug | Taloyoak | Kitikmeot Region Wildlife Board |
| Ema Qaqqutaq | Kugaaruk | Kitikmeot Region Wildlife Board |
| Jimmy Haniliak | Cambridge Bay | Cambridge Bay Hunters & Trappers Organization |
| John Lucas Jr. | Tuktoyaktuk | Wildlife Advisory Management Council (NWT) |
| Joe Ilisiak | Paulatuk | Inuvialuit Game Council/ Paulatuk HTC |
| Joshua Oliktoak | Ulukhaktuk | Inuvialuit Game Council/ Ulukhaktuk HTC |
| Larry Adjun | Kugluktuk | Kugluktuk Hunters & Trappers Organization |
| Joanna Wilson Co-Chair | Yellowknife | Government of Northwest Territories (GNWT) |
| Lisa Worthington | Yellowknife | Government of Northwest Territories (GNWT) |
| Tracy Davison | Inuvik | Government of Northwest Territories (GNWT) |
| Sam Kapolak | Bay Chimo | Bay Chimo Hunters & Trappers Organization |
| Bert Dean | Rankin Inlet | Nunavut Tunngavik Inc. (NTI) |
| Lisa-Marie Leclerc | Kugluktuk | Government of Nunavut (GN) |
| Drikus Gissing | Iqaluit | Government of Nunavut (GN) |
| Mathieu Dumond Co-Chair | Kugluktuk | Government of Nunavut (GN) |
| Amy Ganton | Yellowknife | Canadian Wildlife Service (CWS) |

## 3.0 Workshop Summary

The goals of the meeting were made clear to the participants prior to the meeting as well as at the start of it (See Appendix 1 Agenda). Participants actively engaged in many discussions that were preceded by a presentation. Participants raised many similar questions, concerns, and suggestions in addition to providing direct feedback to draft the management plan. The workshop maintained a positive tone throughout and many participants commented on the need to work together to find solutions to assure caribou conservation.

### 3.1 Review of Outcomes from the March 2015 workshop

A review of what was accomplished at the March 2015 workshop was provided as some participants were new to the process. The draft goals and objectives and the threats were revisited. A teleconference in October 2015 had already reviewed potential harvest management models to be discussed during this workshop.

#### 3.2.1 GN Knowledge Update and Background and Species Information

An update of the DOE April 2015 collaring and the October 2015 survey was provided. The analysis is not completed, but the preliminary results revealed 14,730 (CI= 11,475-17,986) in the visual stratum. A presentation on the biology of the species, the history of research and monitoring, and the current and historical use of the herd were provided as a review of what will be comprised in the future sections 3 and 4 of the management plan.

Participants focused discussion on the historical and current use of the herd including accuracy of the original Nunavut Harvest Study, which only grouped caribou harvest and did not differentiate between herds. Most co-member partners felt that the record was accurate for their respective communities; however more effort is required to determine current harvest rates. This was discussed in terms of potential HTO/HTC based community monitoring, efforts at the second Nunavut Harvest Study, and the requirement under Section 5.7.43 of the NLCA to provide information. Additional discussion on harvest included the situation when one herd becomes scarce; it often results in another herd being targeted for harvest. This has been the case when Peary caribou is low, and the Dolphin and Union caribou is targeted in Ulukhaktuk, and when Bluenose East herd becomes low, the Dolphin and Union caribou is targeted in Kugluktuk. Both communities have increased their harvest of Dolphin and Union caribou in response to decreases in access or availability of other herds.

General support of harvest monitoring, as well as increased cooperation with industry to incorporate voluntary best practices, and reduced flying during calving summarized participant concerns.

#### 3.2.2 Traditional Knowledge Research

The results of Traditional Knowledge collection were presented. The study took place in 2014 and 2015 in Cambridge Bay. Thirty individual interviews were conducted in the summer of 2014 and 7 group interviews in the winter of 2014. There were follow up interviews to validate the results of the 2014 interviews in the summer of 2015. The results provided excellent examples of quantification of oral knowledge depicting the caribou population recovering from a low in the 1960's to a peak in the late 1990's to the current decline being observed today using scientific methods.

In addition to describing population trend, key findings of scientific research conducted in October 2015, included: observation of poorer caribou body condition status since the decline, increased observations of caribou with abnormalities since the decline, and observation of diseases that might be new to the area.. The study participants' perceptions of factors that may have contributed to the decline of caribou in the area include; change in migratory routes (more to the east and west side), an increase in predators, deterioration of health status, human disturbance, and a change in climatic conditions that can have a direct or indirect effect on caribou populations.

Questions on the potential effects of climate change included an increase in new insects and new diseases. Although this was noted in the interviews, additional research is required. Additionally participants were interested to know if the interviews indicated an increasing muskoxen population and the potential impacts of increased competition between the two species. Although not an interview question, it was a recurring response.

Significant discussion was focused on the impacts of late season shipping that disrupts the fall migration and can lead to drowning. It also delays the caribou's staging time on the ice, leading to poor nutritional status. Potential mechanisms to try and implement a *no shipping* period during freeze up were discussed, but the situation is complex and managed by the federal government since international shipping takes place in these waters. More work needs to be directed to pursue the appropriate avenues with the federal government: in this case, Transport Canada. Voluntary agreements with industry to support no shipping during this period are already in place and could be pursued with additional companies.

Additional discussion focused on other community concerns from participants including; an increase in insect harassment associated with climate change and low flying aircraft and its impact (particularly on calving). Other concerns included increasing marine traffic (cruise ships and their passengers), an increase in grizzly bears, and the need for increased predator harvest to help caribou.

### 3.2.3 GNWT Traditional Knowledge Study

Traditional knowledge interviews were conducted in Ulukhaktuk from 2011 to 2013. The interviews highlighted threats to caribou and included human actions, such as low flying aircraft, development, predation, competition from muskox, and effects from climate change including more freezing rain, thin ice leading to drowning, and dryer weather negatively impacting vegetation.

### 3.2.4 Health and Disease

Samples taken from 25 Dolphin and Union caribou collared in April 2015 were blood, hair, and fecal samples for analysis. Feces were examined for parasites and results were mostly normal. One unusual finding is the existence of *Parelaphostrongylus andersoni*; this is the first report of this parasite found in Dolphin and Union caribou.

Lungworm was found in the feces. This worm was not historically found on Victoria Island, but as of 2010, it seems to have spread over the Island and appears to be increasing. The level at which this parasite is occurring in caribou does not appear to be a concern at this time.

The bacteria *Erysipelothrix rhusiopathiae* is present in Dolphin and Union caribou. It has caused die-offs in muskox. The prevalence of these bacteria should be monitored, as it may be a causal in the caribou decline. This is transferable to humans and therefore a human health concern.

Newly developed methods for determining stress levels from hair samples (cortisol levels) were performed. Preliminary results indicate that Dolphin and Union caribou had higher stress levels in spring 2015 compared to two other barren-ground herds and one woodland caribou herd. The study of stress is new and although it may be supportive of the decline it is too early to tell. However, it may become a useful tool to monitor stress level in caribou herds.

Concerns from participants on potential human health impacts from animals were discussed. Lungworm does not transmit to humans, but the bacteria *Erysipelothrix rhusiopathiae* does as well as Brucellosis. There are concerns over increasing snow goose populations and the potential for them to be a vector for new and increasing diseases. Birds and small animals can act as vectors, and can explain muskox die-off on Banks Island. Samples of 600 snow geese and rodent samples were taken, and it seems the bacteria were present in these animals

### 3.2.5 Toxicology

As part of the long term Northern Contaminants Monitoring Program caribou are tested for contaminants such as mercury, cadmium, radioactivity, brominated, and fluorinated compounds. The majority of these contaminants are transported through air currents from elsewhere and deposited on vegetation and ingested by caribou. Levels at this time do not pose a threat to human health from consuming caribou. Long-term monitoring is important to monitor the concentration of these contaminants in the animal.

Most questions were on human health impacts from consumption of caribou. However current standards indicate that the thresholds are below any level of consumption for meat.

## 3.3 Overview of Draft Table of Contents

The current version of the draft Table of Contents was reviewed for accuracy and completeness. Although many of the sections are yet to be drafted, participants felt that the current content of the management plan adequately covers all the information needs.

## 3.4 Threats and the COSEWIC Threat Assessment

After a review of the threats drafted for the management plan, participants concluded that the draft accurately reflects what was discussed at the first joint meeting in March 2015. Additional discussion on threats focused on the need for more research to address the impacts of climate change including: how climate change may impact forage quality and quantity, the time of green up in the spring, increase in new insects and diseases. Several participants identified a need to improve education on caribou both by the schools and within the family. There was one participant who felt a quota should be implemented to ensure the declines are not as severe as what is being experienced in Baffin Island. However another participant countered that this should be through HTOs/HTCs as opposed to through the formal decision-making process.

A presentation on the requirements under the *Species at Risk Act* for management plans and how the Threat Assessment Calculator is used to address those requirements was given. The threats calculator is a tool to enumerate and quantify each threat; to rank what threats are a big issues and what may only be a potential threat. The focus is on direct threats that either cause decline, (such as mortality or removal of habitat), or affect reproduction. Threats are scored and tracked, so they are not considered twice, which would skew the overall rating of the threats. The calculator is a complex, but useful tool. A teleconference is to be scheduled as a follow up to complete this agenda item.

## 3.5 The Management Framework

The management framework consists of the goal of the management plan (still in draft form) and the objectives to reach that goal. There are additional approaches identified to achieve each objective. This approach will ensure that objectives are met and through meeting the objectives, the goal(s) will be met.

Discussions on the current version of the management framework indicated that this section was mostly completed. These groups suggested to include current actions that involve working with industry to establish voluntary agreements on shipping and flying. They also suggested coordinating monitoring with industry, examining what mechanisms can move shipping concerns forward, the role that marine protected areas might play in protecting the sea ice component of the migration route, and specific actions to contact federal departments regarding the impacts of ice breaking activities.

## 3.6 Harvest Management Options

Three different options were presented as potential models for harvest management; these included the Bluenose Model, the Porcupine Model, and the Southampton Island Model. They are all similar in that they described actions related to distinct sections of a caribou population cycle. For example, if the herd is at its peak and stable, the herd would be assessed as green; a herd that is showing a decline would be assessed as yellow; and a herd at low would be assessed as red. Each of these would have prescribed management recommendations reflecting the respective conservation issues. A herd in the green would have few harvest restrictions, while a herd in yellow may see the removal of sport hunts, while a herd in red may see strict harvest limitations.

Considerable discussions resulted from these options. An exercise was performed to determine what thresholds should trigger each of these categories, and what the recommendations should be. The results (photos in appendix 2) will be used to inform the propose harvest management framework in the next draft management plan. Suggested thresholds for herd triggers between levels green, yellow and red are: 24,000 to 40,000 is high (green); 8,000 to 24,000 is medium (yellow); and below 8,000 is low (red). Within these ranges the population can be increasing, decreasing or stable. A point form summary of participant thoughts on appropriate recommendations during the various stages of the herd cycle follow below.

**Herd is at Peak-Green Level**

- Provide harvester and youth education when population is high, don't wait for the population to decline
- No Harvest restrictions on beneficiaries,
- Support reporting at the HTO/HTC level (community-based monitoring.),
- Ensure any changes are phased in,
- Allow community to determine if action should be taken,
- Commercial harvest may be a tool to bring down an overpopulation (i.e. Southampton Island caribou),
- Predator control, encourage harvest of predators by paying for samples.

**Herd is in Yellow-Declining**

- Increased monitoring and sharing of information,
- Harvest Management,

- Sample kits (help ID decline),
- Stop commercial/sport hunts,
- Restrict industry activities on land,
- NQL-bull only,
- Education; how to hunt alternate wildlife, use elders,
- Increase communications between stakeholders,
- Create a working group of stakeholders or commission,
- Periodic review of the state of knowledge

**Herd is in Yellow-Increasing**

- Easing of industry restrictions,
- Easing of harvest restrictions,
- Education,
- Return to baseline monitoring,
- Easing of Non-Quota Limitations (NQLs).

**Herd is in Red**

- Increase monitoring, more frequent surveys,
- Setting TAH,
- Harvest from other caribou herds (if appropriate),
- Education; tell people to stop harvest and explain why there are restrictions,
- Harvest seasons.

## 3.7 Summary of Issues and Actions

The discussions where open and diverse, and some general themes were consistent throughout. Although a quantitative summary was not conducted, it is possible to summarize the key themes that were recurrent throughout the discussions, these are summarized below.

### 3.7.1 Summary of Key Concerns

- Predation from wolves and grizzly bears and their impacts on caribou number, particularly during calving,
- The number of flights, particularly low level flights during calving,
- The effects of climate change particularly on increasing insect harassment and potential impacts on forage quantity and quality,
- Increased shipping during the fall migration and potential for drowning,

### 3.7.2 Summary of Key Actions

- Work with industry to voluntarily implement best management practices,
- Pursue avenues for stopping shipping during the key migration; fall and spring,
- Increase education for harvesters in terms of caribou harvesting and how to harvest other species,
- Improve harvest monitoring,
- HTOs/HTCs to implement community-based quotas and monitoring were appropriate,
- Increased predator harvest through incentives and/or increased sport hunts.

## 4.0 Next Steps

The following text defines the proposed next steps and timeline to see the draft management plan through the respective territorial and federal processes.

**2016-2018 Timelines for Dolphin and Union caribou management plan**

*As presented at joint management planning meeting, Cambridge Bay, January 13, 2016*

- Finish drafting plan using input from this Cambridge Bay meeting (GN, GNWT & EC technical staff & managers)
- Teleconference organized by EC to work on COSEWIC threat assessment table (end of January)
- Draft plan and accompanying presentation to be provided to WMAC(NWT) for March 13-15, 2016 meeting - this would be the version to go out for community consultations
- April 2016
    - Consultation meetings held in individual communities, with HTC/HTOs
    - Review of draft by GNWT, GN, PC, WMAC (NWT), KRWB, NTI, KIA, IGC ("first jurisdictional review") and by EC headquarters ("first compliance review")
- GN, GNWT & EC technical staff & managers to edit the plan based on all those comments – edits to be done jointly
- September 2016
    - Revised draft plan reviewed by GNWT, GN, PC, WMAC (NWT), KRWB, NTI, KIA, IGC ("second jurisdictional review", asking for support to post on SARA registry)
- GN, GNWT & EC technical staff to edit the plan based on all those comments – edits to be done jointly
- By mid-January 2017, EC to send proposed draft plan for translation into French – proposed draft ready for posting on SARA registry
- March 31, 2017 (hard deadline)
    - Draft plan posted as 'proposed' on the SARA public registry for 60 day public review
    - Draft plan posted by GNWT for public review
    - All partners including HTO/HTCs to be notified of opportunity to comment
    - If posted on March 31, comment period would end May 30
- GN, GNWT & EC technical staff & managers to edit the plan based on all those comments – edits to be done jointly
- Final management plan completed by August 2017
- Package submitted to NWMB by mid-August 2017 (may be joint submission by GN & EC)
- NWMB to consider the management plan at September 2017 meeting, followed by their hearings if needed
- Plan submitted to WMAC (NWT) for approval at their September 2017 meeting
- GN, GNWT & EC to seek Minister approval of the plan
- Response from NWMB by December 2017 – whether or not they approve the plan
- NWT Conference of Management Authorities consensus agreement by December 2017
- Management plan completed, approved and made public by March 31, 2018

Abbreviations:
ECCC = Environment and Climate Change Canada
GN = Government of Nunavut
GNWT = Government of the Northwest Territories
HTC = Hunters and Trappers Committee
HTO = Hunters and Trappers Organization
IGC = Inuvialuit Game Council
KIA = Kitikmeot Inuit Association
KRWB = Kitikmeot Regional Wildlife Board
NTI = Nunavut Tunngavik Inc
NWMB = Nunavut Wildlife Management Board
PC = Parks Canada
WMAC (NWT) = Wildlife Management Advisory Council (Northwest Territories)

# Appendix 1 - Agenda

**Dolphin and Union Caribou Joint Management Plan Workshop**

**Cambridge Bay, Nunavut**
**January 10 – 13th, 2016**

**Meeting Information**

Goals of the Meeting:

- Integrate community perspectives (IQ/TEK) with scientific knowledge throughout the meeting

- Review and discuss the first draft of the Dolphin and Union Caribou Management Plan

- Review and collect feedback on key sections of management plan: species needs, threats, management objectives and approaches, including inclusion of IQ/TEK information.

- Discuss options for harvest management model and corresponding actions

- Review new knowledge and current research

Schedule:

- Arrival in Cambridge Bay: Sunday, January 10th in the afternoon. Grocery store may be

closed by 5:00 so get groceries (if needed) before coming to the meeting room.

- Meeting:

  - Sunday – lunch served in meeting room (catered), meeting 3:00 pm to 4:30 pm
  - Monday & Tuesday - 9:00 am to 5:00 pm with health breaks and lunch (catered)
  - Wednesday – 9:00 to 4:00 pm with health breaks and lunch (catered)

- Breakfast and dinners will be on your own. Green Row is open for dinner 5:00-7:00 p.m. and Arctic Islands Lodge is open for dinner from 5:00-6:45 p.m. Breakfast is available at the Green Row.

- Departure from Cambridge Bay: Wednesday, January 13th in the evening (6:00 pm flight)

Meeting Location: Arctic Islands Lodge, medium boardroom

Accommodation: Green Row Executive Suites (transportation will be provided to and from the airport

# Dolphin and Union Caribou Joint Management Plan Workshop

### Cambridge Bay, Nunavut
### January 10 – 13th, 2016

# Agenda

**Sunday January 10th, 3:00 p.m. – 4:30 p.m.**

| | |
|---|---|
| 1. Welcome | Co-chairs – Joanna Wilson and Mathieu Dumond |
| 2. Opening Prayer | |
| 3. Opening Remarks | Co-chairs |
| 4. Introductions | All participants |
| 5. Outcomes/Expectations for meeting | All participants |
| 6. Review of Outcomes from March 2015 meeting in Kugluktuk | Lisa Worthington |

**Monday January 11th, 8:45 a.m. – 12:00 p.m.**

| | |
|---|---|
| 7. Knowledge and Research Update | |
| 7.1. GN update | Lisa-Marie Leclerc |
| 7.2. GNWT update | Tracy Davison<br>Matilde Tomaselli |
| 7.3. Traditional Knowledge Research | Tracy Davison |
| 7.4. NWT Traditional Knowledge Study (tentative) | Susan Kutz |
| 7.5. Health and Disease | Mary Gamberg |

**Monday January 11th, 1:00 p.m. – 5:00 p.m.**

| | |
|---|---|
| 8. Review of Draft Management Plan - Background Information on Dolphin and Union caribou | All participants (lead presenter below) |
| 8.1 Overview of draft table of contents | Lisa Worthington |
| 8.2 Background & Species Information<br>- Historical & social perspectives<br>- Use of the herd<br>- Population and Distribution | Lisa-Marie Leclerc |

| | |
|---|---|
| 9. Review of Draft Management Plan – Threats to Dolphin and Union caribou<br><br>9.1. Threats in draft management plan | All participants (lead presenter below)<br><br>Lisa Worthington (with technical support from Lisa-Marie Leclerc and Tracy Davison) |

**Tuesday January 12th, 8:45 a.m. – 12:00 p.m.**

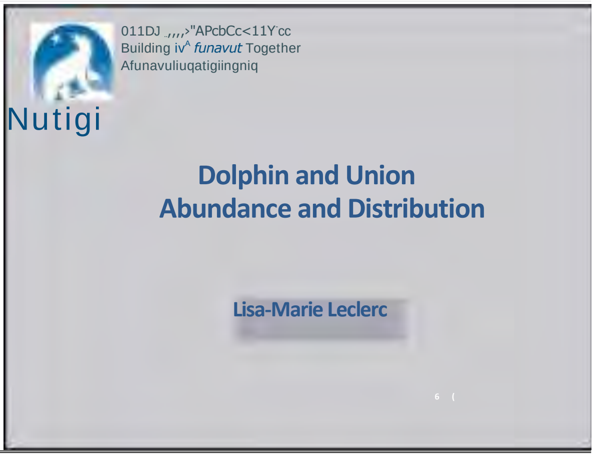
| | |
|---|---|
| 9. Review of Draft Management Plan – Threats to Dolphin and Union caribou (*continued*)<br><br>9.2. Threat assessment by COSEWIC | All participants (lead presenter below)<br><br>Amy Ganton / Justina Ray |
| 10. Review of Draft Management Plan – Management Framework<br><br>10.1. How the framework links to management plan<br>10.2. Management goal/vision & objectives | All participants (lead presenter below)<br><br>Lisa Worthington<br>Lisa Worthington |

**Tuesday January 12th, 1:00 p.m. – 5:00 p.m.**

| | |
|---|---|
| 10. Review of Draft Management Plan – Management Framework (*continued*)<br><br>10.3. Recommended management approaches & actions to achieve objectives | All participants (lead presenter below)<br><br>Lisa Worthington |

**Wednesday January 13th, 8:45 a.m. – 4:00 p.m. (all day)**

| | |
|---|---|
| 11. Options for Consideration of Harvest Management<br>11.1. Decision on harvest management models<br>11.2. Management recommendations | All participants (led by Lisa-Marie Leclerc) |
| 12. Next Steps | Co-chairs |
| 13. Closing Remarks | All participants |
| 14. Closing Prayer | |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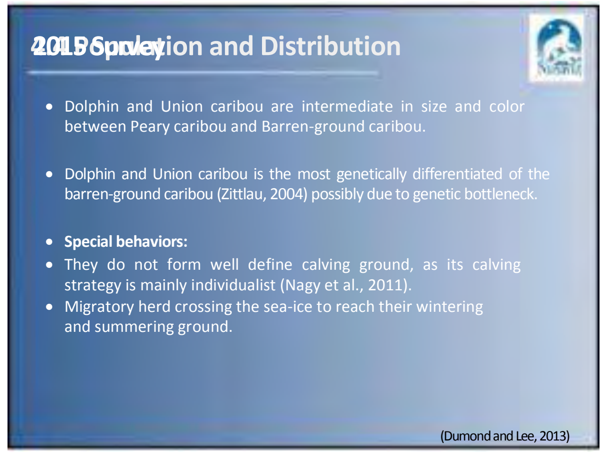
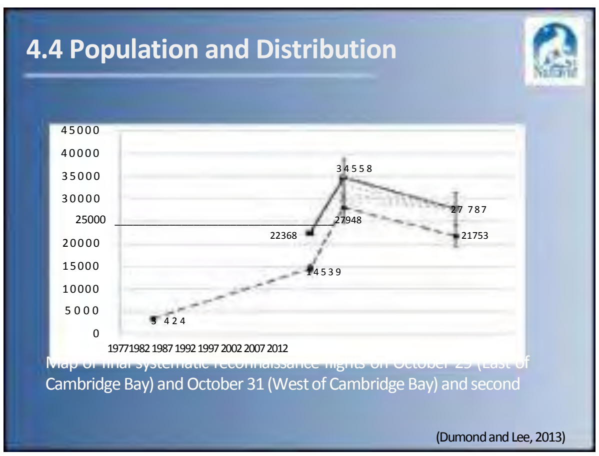
Dolphin and Union
Abundance and Distribution
Lisa-Marie Leclerc


4.4 Population and Distribution
Dolphin and Union caribou are intermediate in size and color between Peary caribou and Barren-ground caribou.
Dolphin and Union caribou is the most genetically differentiated of the barren-ground caribou (Zittlau, 2004) possibly due to genetic bottleneck.
Special behaviors:
They do not form well define calving ground, as its calving strategy is mainly individualist (Nagy et al., 2011).
Migratory herd crossing the sea-ice to reach their wintering and summering ground.
(Dumond and Lee, 2013)


4.4 Population and Distribution
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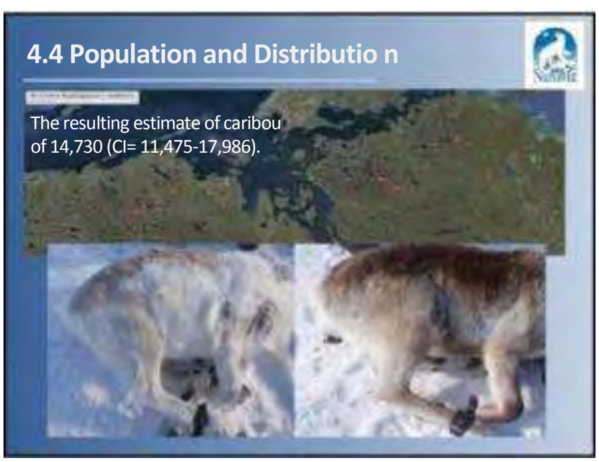
Cambridge Bay) and October 31 (West of Cambridge Bay) and second
(Dumond and Lee, 2013)


4.4 Population and Distribution


4.4 Population and Distributio n
The resulting estimate of caribou
of 14,730 (CI= 11,475-17,986).


2015 Survey

## Ulukhaktok Traditional Knowledge Interviews 2011-2013

# Threats

## Humans Activities

- Five people mentioned human activities as a threat.

"When they do exploration they always fly around and when they see animal they turn around, fly low and take pictures. That's when the caribou start running away." – PIN02

"Any place where there are machines or planes start travelling every day or every second day and that they could easily move from that spot. Because from they come in start making noise they spook them off. Interrupt whatever they're doing."– PIN07

"When they work on the land, like, they're drilling, the smell of smoke, the sound of the drills, the sounds of vehicles, maybe people, the smells of those drives the caribou away and that's a threat to caribou. So they go somewhere else to where it can be at peace." – PIN11

## Predators

- Everyone Mentioned Predators as a threat to Caribou.
- They kill caribou, kill calves and also some are
- Both Wolves and Grizzly Bears
- People also concerned about their own safety because of increase in Wolves and Grizzly Bears

"Even now the wolves are still following the caribou. Everywhere they go they follow caribou. Not only the wolves, even so the Grizzly Bears are killing them. Right now there's more Grizzly Bears that have been spotted." –PIN07

"All because of the wolf, the wolf make eight pups and caribou make one pup. One caribou calf. That's a big difference there. So like I said, that's how come it's really hard to see a female caribou with a calf. Females have lots of milk because it's already been chased by the wolves and it's really easy to be spooked now. " –PIN07

"Yeah, the population of the wolves have really increased because long ago there used to be hardly any wolves. " – PIN02

"Used to never see Grizzlies when we were younger. Just few years now start seeing them more every year." – PIN02

"I never, never seen one when I was growing up anywhere. Grizzlies. I don't know why they're moving to our island. " - PIN08


## Competition - Muskox

- When talking about competition 9 people mentioned muskox. The reason they compete varied:
  - 7 people thought they might eat the same, 2 people thought they didn't.
  - 4 people thought caribou didn't like to be around the same place as muskox, with two of those people thinking the smell caribou didn't like.
  - It was observed that in the past when there was lots of caribou, there was no muskox

"They eat the same food. They just don't hang around together. " PIN03

"The caribou don't want to feed where the muskox feed because it's too strong for them, the smell, where they feed. But they eat the same food, that's why. " –PIN07

"He said caribou has a different diet with the seasons. But the muskox diet never changes. When they open up their gut to check the contents are always the same. They never change. They eat these big leaves off the ground. " – PIN04

## Plant Growth

- Three people talked about plant growth as a concern for caribou

"The poor growth of the plants they eat." – PIN02 "the weather is changing and the land is also changing and so if there's hardly any rain and the weather doesn't go the way for the plants then there's nothing for them to eat." – Pin01

"Late spring early summer when people first started getting caribou their meat was tough, they had no fat, and it was due to the way the plants grew. Freezing, they'd start shooting out then freeze, shoot out and freeze, and that wasn't good for them. That is why the caribou was very skinny this year." – Pin10

## Thin Ice

- Four people mentioned hearing about or seeing caribou going through thin ice, mostly in the fall time during freeze up.

" You know when they go through the ice and drown. That's another one." –PIN01

"It doesn't freeze fast anymore and the ice doesn't get solid fast like it used to. When it used to freeze we used to just start walking on it the next day. On the ocean." - Pin07

## Freezing Rain

- Eight people mentioned Freezing Rain – or Rain on snow making a layer of ice on the ground.

- Some people recorded that it happened in the past. Other People noticed it happing more now than in the past, but one person notices it happing the same as in the past.

"Got snow now and then rain and then freeze again then it's going to be hard for them for feeding."– Pin07

"They can't paw through the ice when it's thick." – PIN10

"Caribou, no matter what weather, they will graze but when the snow gets covered over with ice they find a lot of dead caribou. Because they can't go pawing through that ice that's on top of the snow." – PIN04

"If you got a lot of storm. You know, some years winter time it could storm for many days. If there's too much storm and it wells up a little bit then they get cold and iced up and all that, they get cold and they get stuck to the place where they're sleeping, where they're laying down. From the climate or whatever the weather changes fast sometimes. We've seen a couple of those do like that. Just laying there, dead from bad weather and all that. Sometimes it takes a long time to get nice out. Must be probably not the healthy ones, that's why." –PIN07

"Yeah, when it's too much wind and cold weather and stuff like that, I guess, you know. Big storm. Got to be a big storm when they die like that. I could notice, I look at them, no blood, nothing, not even the blood every one of them they just freeze like that staying down." PIN08

Caribou can die from weather events like freezing rain but they also have ways to deal with winter weather in the Arctic and extreme conditions.

- Caribou stay still during a storm , they will also move to different areas if the snow is bad or there is ice in an area.

- Three people mentioned they will fatten up for winter.

They know the weather, they know the seas, so they know when to come to these high areas where they can get out of the storm. – PIN04

"Winter time I think they just lay down, hunker down and wait for the weather." - PIN03

He said in the fall time if we get snow and then rain the caribou leave that area and go somewhere else. They don't hang around in that area where they would have stayed. Due to weather, ice conditions on top of the snow, they will not stay. - Pin06

Like in the winter, like all animals they what you call try and eat as much as they can for the winter months so that they grow a layer of fat to keep them warm so that on days like this they know that they can't be roaming around hunting and that. - PIN01

She said in the winter there was one time when she noticed and first when she seen it there was an area, a grazing area. Her, really deep snow, the caribou just kept pawing at the ground until they could reach to the ground, to the growth under. - PIN10

## Health

Sickness isn't very common, some participants had never seen illness in caribou other participants saw the occasional sickness. Most common observation was issues with joints, or legs.

Caribou do get skinny during winter, but they get fat again in the spring and summer.

"Just a couple since I started hunting. One that gets way left behind, that they have a cyst or something in their legs. Liquid. They run for a while and then they can't run anymore. " - PIN03

When she was hunting she used to travel and she used to never hear of caribou getting sick. – PIN11

## How know Caribou are doing well?

**Three people commented on how to tell if caribou are doing well.**

**Things people look for is :**

- **If hunters are successful**
- **If the land/plants grown good**
- **See caribou coming in the spring.**

## Changes in the number Caribou

**Almost everyone saw changes in number of caribou over their life.**

**There were times when there were less caribou in the past, in the 1970's and 1980's there were a lot of caribou then seem to decrease.**

Reasons for the change was similar to the threats however it is also a natural cycle for animals.

Some people also talked about how caribou have moved away, and they will come back

It might deplete because there's so many things that come into consideration like the weather and the plants that grow and things that happen to the Earth and all those things that you mentioned come into what you call play on the survival of the caribou. – PIN01

## Conservation

- **Most people mentioned changing harvesting – taking less or not taking Peary Caribou (smaller caribou). One participant mentioned getting muskox instead of caribou and another mentioned not hunting cows with calves.**

## Habitat

Caribou like low areas, where it is damp and there is good plant growth. Most participants said this is where you would find them in summer but 2 participate also said you could find them here in winter.

Two participants also mentioned that caribou like shores in the summertime.

In winter most participates though caribou choice areas with less snow; high areas.

Two participants mentioned rocks; one thought they used rocks to get away from wolves.

## What Caribou Eat

- Things caribou eat include:
  - Tuktut niqait
  - Lichen
  - Arctic Sorrel
  - Grass
  - Berries

To me their stomach is very green in the summer. –PIN06

**Local Knowledge about Caribou in the Ikaluktutiak area : research updates**

*Matilde Tomaselli, Susan Kutz, Sylvia Checkley*

2

## Study design

- SUMMER, 2014 30 INDIVIDUAL

Identified with help of KIA and HTO

23 Beneficiaries

5 Residents

Specific questions - muskox population

Open questions - emergence of other themes

3

## Study design

- WINTER, 2014 7 SMALL GROUP INTERVIEWS

Total of 19 participants

11 from individual interviews

Group according to: age, hunting experience, hunting area of preference

Specific participatory activities

probe observations from the individual interviews

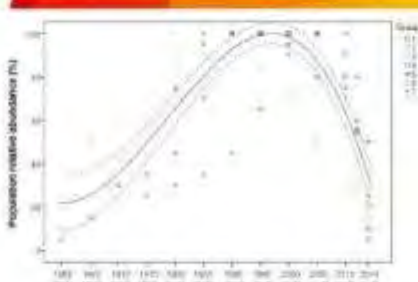
4

## Study design

- **SUMMER, 2015** VALIDATION OF THE REULTS

After data analyses
Presentation of results
Feedback from participants
n= 31/38

5



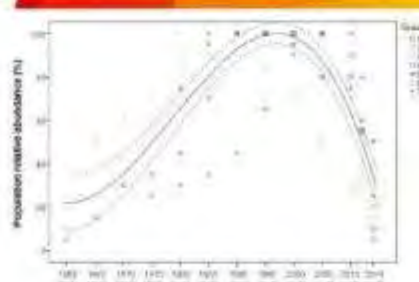
*((Back then (in the 60s) there were not too many muskox and even caribou))*

*((In the 70s, 80s the caribou were further away from the community))*

*((The caribou started to come by the community 10, 15 years ago. Every spring and every fall hundreds of caribou were crossing the ice. Then 4, 5 years ago they started to decline and now there are not even*

6

## Caribou population trend

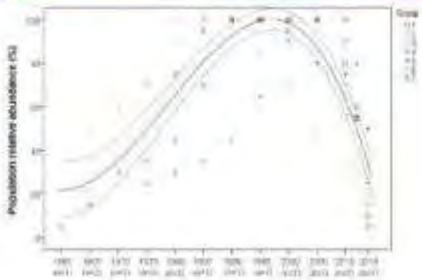


*...but since three years ago Idon't see as many caribou. I think their migration pattern has changed»*

*«Caribou have changed their migration route, so that they are bypassing town by more kilometers in the past two years. Icouldn't say that they are going to a different area, but I have certainly heard that there are lots of caribou crossing over the west side of Kent Peninsula and even in Queen Maud Gulf...»*

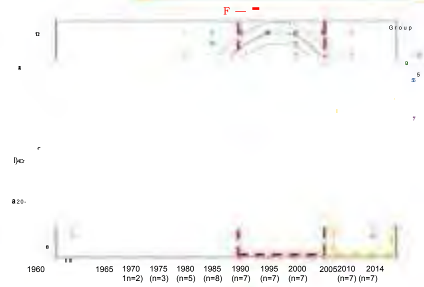
7

## Caribou population trend




- Caribou started migrating in the vicinity of Ikaluktutiak from the mid 1980s
- The decline started around 2005 but more evident since 2010
- Now people see about 80% less caribou (IQR 75%-90%) of what they were used to see back in the 1990s

## Caribou population trend



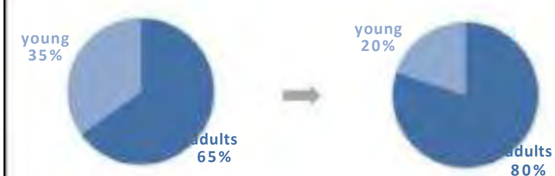

9

*Proportional piling* used to generate numbers and quantify people's perceptions

10

## Caribou population

1990s - mid-2000s PRESENT TIME



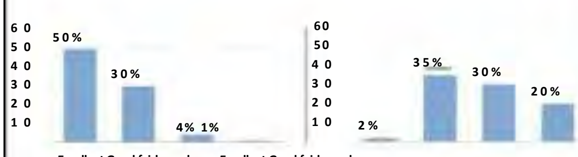

Young= yearling + calves

- Overall decrease of the young age class between the pre-declining period and presenttime

11

## Caribou population

PRE-DECLINING PERIOD DECLINING PERIOD

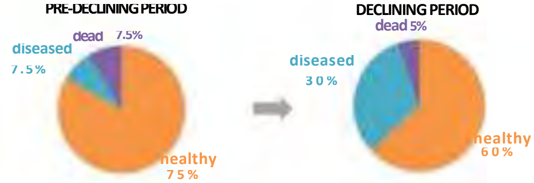



- Observation of caribou in poorer body condition status from the pre-declining to the declining period

12

## Caribou population

PRE-DECLINING PERIOD DECLINING PERIOD

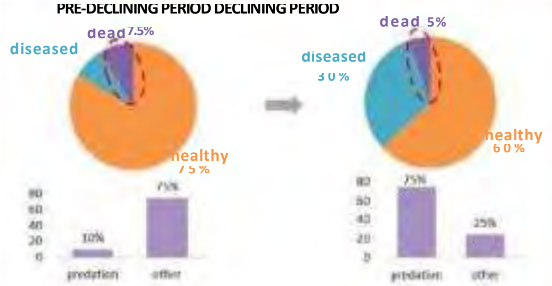



- Increased observations of diseased animals
- Dead animals: comparable between the two periods

13

## Caribou population

PRE-DECLINING PERIOD DECLINING PERIOD




- Since the decline, increased perception of predation among the cause of death; however the overall mortality is comparable between the two periods

14

## Diseases - lesions and syndromes list, relative proportion (%), and trend

ALREADY NOTICED PRIOR THE DECLINE

40% Warbles larvae

15% White cysts in meat/heart

5% Swollen joints, limping animals

5% Sand paper disease


NEWLY OBSERVED (after mid-2000s)

< 1% Bleeding scabs on the nose area – orf like lesions
<1% Pale meat and yellow color of subcutaneous tissue

15

## Diseases - lesions and syndromes

ALREADY NOTICED PRIOR THE DECLINE

| | | |
|---|---|---|
| 40% | Warbles larvae | |
| 15% | White cysts in meat/heart | Increasing trend noticed since mid-2000s |
| 5% | Swollen joints, limping animals | |
| 5% < 1 % | Sand paper disease Infected testicles * | |

NEWLY OBSERVED (after mid-2000s)

<1% Bleeding scabs on the nose area –orf like lesions
<1% Pale meat and yellow color of subcutaneous tissue

16

- Observation of major caribou population decline in the Ikaluktutiak area since mid-2000s but more evident since 2010
  - 80% (IQR 75%-90%) decline of caribou population compared to the 1990s
  - Decrease of young age class (yearling and calves) form 35%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- Observation of poorer caribou body condition status since the decline
- Increased observations of caribou with abnormalities since the decline
  - Increasing trend of some lesions/syndromes
  - Observation of diseases that might be new to the area (e.g. orf like
- Unchanged perception of overall caribou mortality between the pre-declining and declining period
- Participants' perceptions of factors that may have contributed to the decline of caribou in the area
  - Change in migratory routes (more to the east and west side)
  - Increase in predators
  - Deterioration of health status
  - Human disturbance
  - Change in climatic conditions that can have a diect or indirect effect on caribou populations

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## Acknowledgements

Community of Ikaluktutiak

Kitikmeot Inuit Association

Charlie Evalik, Stanley Anablak, Paul Emingak, Julia Ogina,

Fred Pedersen, Joey Evalik, Sarah Jancke and Michelle Buchan

Ekaluktutiak Hunters and Trappers Organization

CHARS

Jimmy Haniliak, Alice Maghagak, Brenda Sitatak

January 10,

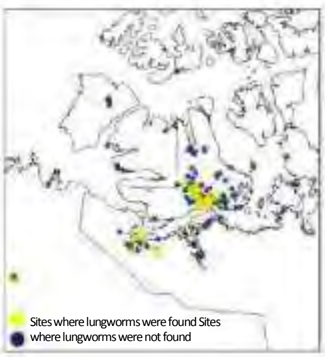
Summary report of the preliminary results of health analyses for caribou collared in the Kitikmeot, April 2015

Susan Kutz with Pratap Kafle Angeline McIntyre and ArS,Carlsson

96NzgAYRic

## Feces examined for Parasites

Distribution of lungworm, *Varestrongylus eleguneniensis,* based on muskox fecal samples




## Blood samples: Tested for ***Erysipelothrix rhusiopathiae***

- Bacteria that is associated with muskox die---offs on Banks and Victoria Islands
- Can infect caribou and many other species, including people
- Only 'discovered' recently, but probably has been around fora longer time
- Very preliminary results: 5

**Blood testing for *Brucella* and other diseases underway**

## Preliminary results: Stress levels determined from hair

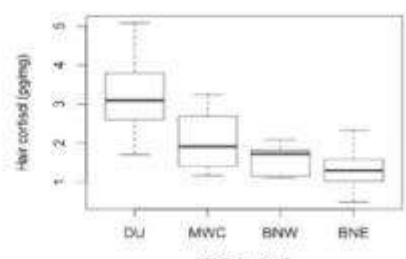



**Figure 1.** Dolphin Union caribou (DU, n=25) have significantly higher **hair cortisol** levels compared to Mountain Woodland caribou (MWC, n= 19), Bluenose West caribou (BNW, n=10) and Bluenose East caribou (BNE, 29).

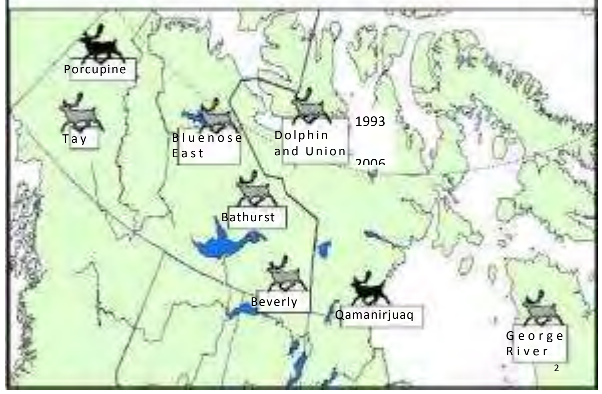

Supporters, funders and partners
UNIVERSITY OF CALGARY
Northwest Territories
CHARS
Morris Animal Foundation
Ekaluktutiak Hunters and Trappers Association
KugluktukAngoniatit Association
Sachs Harbour Hunters and Trappers Committee
Paulatuk Hunter and Trappers Committee
Nunavut Harvesters Association
University of Glasgow
Canada
KILLAM
Parks Canada
ArcticNet

## Contaminants in Arctic Caribou

Mary Gamberg
Whitehorse, Yukon

1

## NCP Arctic Caribou Sampling Program




2

## Potential Contaminant Issues in Arctic Caribou

- Cadmium
- Mercury

- Fluorinated compounds
- Brominated compounds

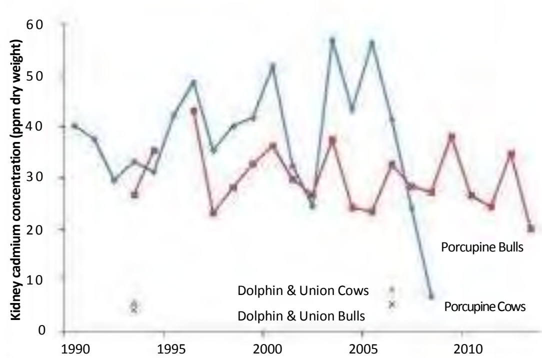
- Radioactivity

3

## How do contaminants get into the caribou?

4

## Kidney Cadmium in Arctic Caribou

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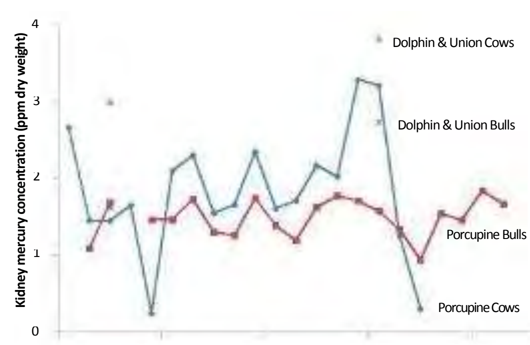
## Kidney Mercury in Arctic Caribou

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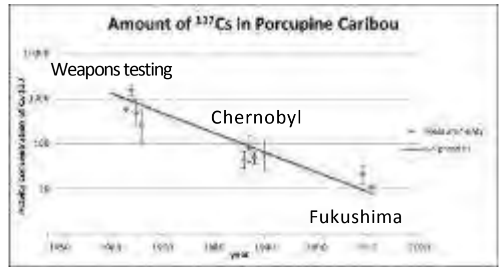
## 'New' Contaminants

Brominated flame retardants (PBDEs)

Fluorinated compounds (TeflonTM)

7

## Effect of Fukushima Nuclear Accident



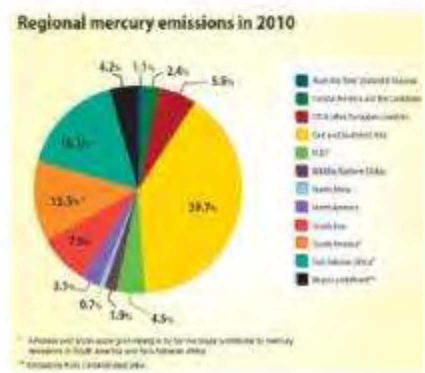

Geometric means (+SD) of the activity concentrations in the Porcupine caribou (MacDonald et al. ,2007 except for the last two data points which are from this study.

## Health Assessment

| CARIBOU | Kidneys | Livers | Meat |
|---|---|---|---|
| Porcupine | 24 | 12 | All You Want |

9

## Why do we continue to monitor caribou?




10

## What do we know about mercury in caribou?

- In the fall, mercury is higher in cows than in bulls
- In the spring, mercury may be lower in cows than in bulls
- Mercury is generally higher in spring caribou than fall
- Mushrooms may provide a pulse of mercury in the fall

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## Why do mercury levels fluctuate over years?

- Rain
- Snow
- Wind
- Temperature
- Migration patterns
- Time of green-up

- Industrial emissions
- Volcanoes
- Forest Fires

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# What Can We Do?

Monitoring Programs

Provide information on contaminants to individuals and communities

Provide evidence for Territorial, National and International legislation

13

International Legislation

**Stockholm Convention**

- 2004
- Limits production of persistent organic pollutants (DDT, PCBs)
- 179 countries signed
- 152 countries ratified

**Minimata Convention**

- 2013
- Limits emissions of mercury
- 128 countries signed
- 20 countries ratified
- Not ratified by

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Thank You!

**to**
**All the Hunters who Contributed to this Program!**

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# Draft Table of Contents:
# Dolphin & Union Caribou Joint Management Plan

5.2.3 Threat #2…etc

5.3 Factors that may have a positive influence

5.4 Knowledge Gaps

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6.2 Management Objectives (List)

6.3 Current Management Actions

6.4 Managing based on Herd Status (Level)

6.5 Approaches to Achieve Objectives (Descriptions)

6.6 Management Actions and Implementation Schedule (Table)

6.7 Socioeconomic and Environmental Effects of Management

7. MEASURING PROGRESS

8. NEXT STEPS

9. REFERENCES

bDrLDJ ,,> `APcbC`c<il'ac
Building i *Vunavut* Together
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le *Nunattut* ensemble

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## Background & Species Information

Lisa-Marie Leclerc

## Sections

3. Background

3.1 Historical perspective

3.2 Social perspective es

History of subsistence and commercial harvesting

History of harvest management

4. Species information

4.1 Species status

4.2 Species desc ription and biology

Life cycle and reproduction

Natural mortality and surviva

Diet

## 3.1-2 Historical and social perspectives

- Since mankind has colonised the barren-land, his subsistence was based on caribou availability.
- Caribou:
  - At the based of the Northern Aboriginal Cultures
  - Has social and economical impacts.

## 3.3 Use of the herd

3.3.1 Communities that harvest the species

- Dolphin and Union cross two jurisdictions
- Winter: Paulatuk, Kugluktuk, Bay Chimo, Bathurst Inlet

## 3.3 Use of the herd

3.3.2 History of subsistence and commercial harvesting

- Availability in function of the herd distribution and movement.

- Up to 1994 , 289 tags was allocated for caribou commercial harvest in

- Inuvialuit Harvest study (88-97): 681 to 441

- Nunavut Harvest study: Kuglukuk 1..575 Cambridge Bay, 811, Bathurst

Small Harvest Study 1January 1994- May 1995 and October 1995-

June 1996.

- Kugluktuk : 90% of barren-ground caribou and 10% DU

## 3.3 Use of the herd

3.3.3 History of harvest management

- No TAH set on the Dolphin an Union Caribou : harvest caribou to the full level of his or her economic, social, and cultural needs.

## 4. Species information

4.1 Species Status

NWT: Special Concern (2013, 2015)

4.2 Species description and biology

**Dolphin and Union caribou are intermediate in size and color between Peary caribou and Barren-ground caribou.**

**Dolphin and Union caribou is the most genetically differentiated of the barren-ground caribou (Zittlau, 2004) possibly due to genetic bottleneck.**

**They do not form well define calving ground, as its calving strategy is mainly individualist (Nagy et al., 2011).**

## 4. Species information

4.2.1 Life cycles and reproduction

- Calves at 3 years of age

4.2.2 Natural mortality and survival

- Knowledge gaps

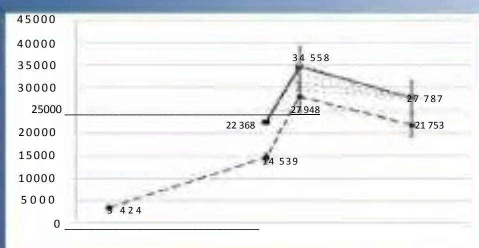
4.2.3 Diet

- Mid-July: grasses and green willows

4.3 Habitat Needs

- Victoria Island, Mainland, sea-ice

## 4.4 Population and Distribution




(Dumond and Lee, 2013)

## 4.4 Population and Distribution

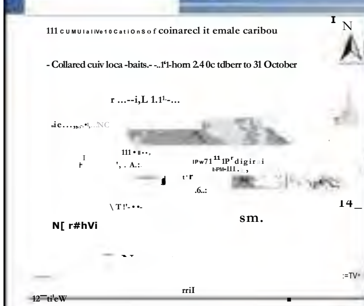



FIG. 1. ... study area. Grey area shows cumulative annual distribution of Dolphin and Union caribou derived from satellite collar locations for 1999-2005. Black dots indicate cumulative locations on 24 to 31 October. Note that during our 2007 survey, caribou were likely to be offshore on the sea ice or on the mainland because freeze-up ... that year.

(Dumond and Lee, 2013)

## 4.4 Population and Distribution

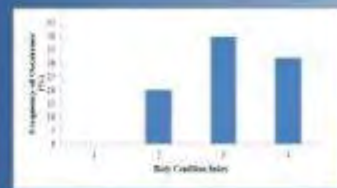
## 4.4 Population and Distribution

- April 6, 7 and 8, 2015
- 25 "caribou"

## 4. 4 Population and Distributio n

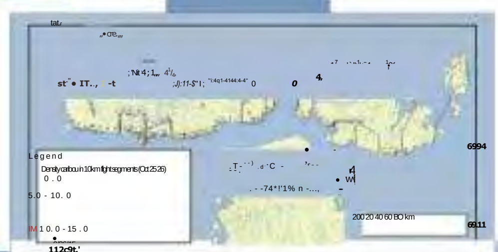
## 4. 4 Population and Distribution

- Body condition was assed according to CAR MA's *Rangifer* Health & Body Condition Monitoring Protocol Level II, section 3.
- The body index condition is scud to healthy caribou as health female caribou were targeted for this program. Healthy animal will have a better chance to resist disease, harsh winter conditions and predation and stay alive for the duration of the study.



## 2015 Survey

## 2015 S vey



issance flights on Oct
d October 27 (West of C

## 2015 Survey

## 2015 Survey

Map of final systematic reconnaissance flights on October 29 (East of Cambridge Bay) and October 31 (West of Cambridge Bay) and second

# Dolphin and Union Caribou Management Plan Threats

Photo by Mathieu Dumond

Lisa Worthington

Environment & Natural Resources

## Dolphin and Union Caribou

- Killiniq, Island,
- Arctic-Island,
- Mainland caribou,
- Tuktu, tuktut, tuttu
- caribou du tropeau Dolphin-et-Union
- *Rangifer tarandus groenlandicus x pearyi*

Photo by Kim Poole

## Dolphin & Union Caribou Limiting Factors

**Limiting Factors**

* Non-human factors that limit the abundance and
* Make a species more vulnerable
* Eg. age at first reproduction, prey abundance

**Threats**

* Caused by human beings
* Contribute to the population

## Dolphin & Union Caribou Limiting Factors

* **Parasites and disease**
* **Predation**
  - Wolves, grizzly bears

Photo by Kim Poole

## Dolphin & Union Caribou Threats

**Climate Change**

Warmer temperatures cause:

* Later fall freeze-up and earlier spring thaw = longer staging time before migration.
* Insect harassment
* Warm weather = New parasites and diseases

* **Impact on vegetation = increase in high quality forage

Photo by Kim Poole

## Dolphin & Union Caribou Threats

**Industrial Activities and other Human Disturbance**

* Tourism activities
* Aircraft
* Mining projects

Photo by Kim Poole

## Dolphin & Union Caribou Threats

**Presence of other species**

- Muskox
- Geese
- Other herbivores (e.g. hare, lemmings)

Photo by Kim Poole

## Dolphin & Union Caribou Threats

**Harvesting beyond a self-sustaining level**

- NWT: there is no mechanism to collect harvest data.

+

- Nunavut: harvest reporting is not mandatory.

=

- When a population declines, a consistent rate of harvest could become a threat.

Photo by Kim Poole

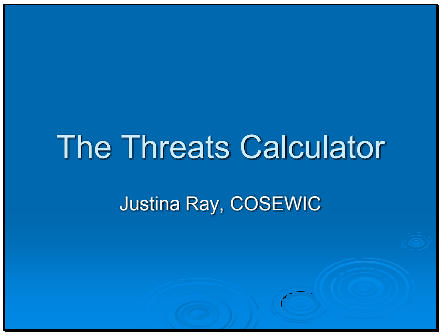
## Dolphin & Union Caribou Threats

**Other threats:**

- Contaminants (includes impact of salt on habitat)

Photo by Kim Poole

Slide 1

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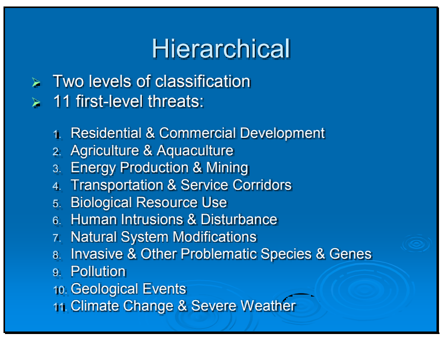


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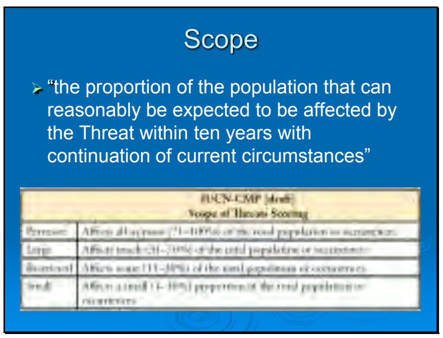
Slide 4

Slide 5

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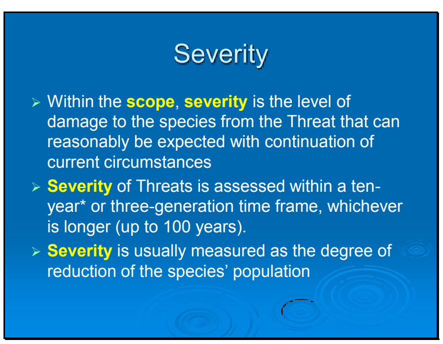

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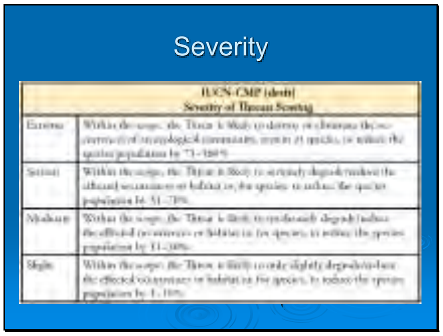


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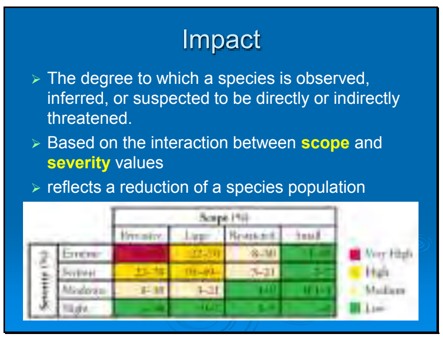


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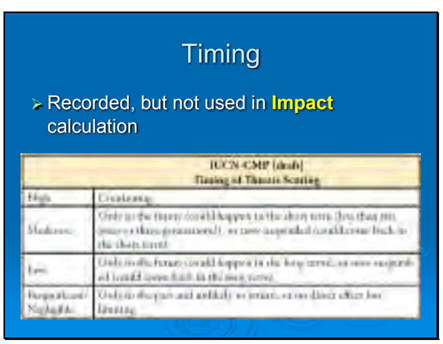


# DOLPHIN AND UNION CARIBOU MANAGEMENT FRAMEWORK

## Outline of draft goal, objectives, approaches and actions
## Based on Group Discussion in Kugluktuk: March 25 – 27, 2015

**MANAGEMENT GOAL/VISION:**

The long term persistence of healthy Dolphin and Union caribou recognizing their cultural importance.

To support a healthy and viable population of Dolphin and Union Caribou that moves freely between mainland and Victoria Island, and offers harvesting opportunities for present and future generations.
OR:

To support a healthy and viable population of Dolphin and Union Caribou that moves freely between mainland and Victoria Island, that allows for human use of caribou and their habitat while respecting conservation concerns..

To keep Dolphin and Union caribou from becoming threatened or endangered.

**OBJECTIVES:**
These are five objectives for the management of Dolphin and Union caribou. These objectives apply broadly across the herd's range in NWT and Nunavut.

1. Adaptively co-manage Dolphin and Union caribou by using a grassroots, community-based approach and the best traditional, community, scientific and technical information available.

2. Communicate and exchange information on an ongoing basis between co-management partners, communities, industry and the public with regard to monitoring and managing Dolphin and Union caribou.

3. Collect information on Dolphin and Union caribou using TK and IQ, community monitoring and scientific methods to inform sound management decisions.

4. Promote minimal human disturbance to habitat (particularly sea-ice crossings) to maintain a healthy, migratory population of Dolphin and Union caribou.

5. Ensure management actions including harvest are based on herd status.

**APPROACHES TO ACHIEVE THESE OBJECTIVES:**
Recommended approaches (numbered as X.X.) are grouped on the following pages under each objective. More specific actions (numbered as X.X.X) are grouped below under each approach but will not be included in management plan (for implementation plan).

**Objective #1:**
**Adaptively co-manage Dolphin and Union caribou by using a grassroots, community-based approach and the best traditional, community, scientific and technical information available.**

1.1 Work with co-management partners, Aboriginal governments and organizations, local harvesting committees, and industry to share information and collaborate on management actions.
1.2 Co-ordinate research among different co-management partners and research institutions.
1.3 Assess and manage cumulative impacts on Dolphin and Union caribou population and habitat.

**Objective #2:**
**Communicate and exchange information on an ongoing basis between co-management partners, communities, industry and the public with regard to monitoring and managing Dolphin and Union Caribou.**

2.1 Encourage flow and exchange of information between parties, using various approaches, depending on group/demographic.

**Objective #3:**
**Collect information on Dolphin and Union caribou using TK and IQ, community monitoring and scientific methods to inform sound management decisions.**

3.1 Improve our understanding of Dolphin and Union caribou health, distribution, key habitat and population indicators, impacts of human activities, cumulative effects and relationships.
3.2 Monitor Dolphin and Union caribou population.

**Objective #4:**
**Promote minimal human disturbance to habitat (particularly sea-ice crossings) to maintain a healthy, migratory population of Dolphin and Union caribou.**

4.1 Monitor human and industrial disturbance.
4.2 Minimize human and industrial disturbance.
4.3 Monitor changes to habitat on an ongoing basis.
4.4 Work with all levels of governments to manage populations of other species that affect Dolphin and Union caribou habitat (e.g., overabundant geese).

**Objective #5:**

**Ensure management actions including harvest are based on herd status.**

**Ensure long term harvest of Dolphin and Union caribou can be supported by the population.**

5.1 Obtain accurate harvest data.
5.2 Access herd status based on information collected.
5.3 If necessary, manage harvesting activities within acceptable limits to ensure that harvesting opportunities are available in the future by respectfully harvesting today.

**MORE DETAILS – List Actions**

**APPROACHES AND ACTIONS TO ACHIEVE THESE OBJECTIVES:**

**Objective #1:**
**Adaptively co-manage Dolphin and Union caribou by using a grassroots, community-based approach and the best traditional, community, scientific and technical information available.**

1.1 Work with co-management partners, Aboriginal governments and organizations, local harvesting committees, and industry to share information and collaborate on management actions.
  - 1.1.1 Incorporate community and traditional knowledge and ensure that plans and actions for Dolphin and Union caribou management are informed by this knowledge.
  - 1.1.2 Continue to work with wildlife management advisory boards, game councils and local HTO/HTAs on Dolphin and Union caribou monitoring, stewardship and management.
  - 1.1.3 Work with industry on best practices and mitigation, monitoring and research.
  - 1.1.4 Continue engaging hunters, industry and public about Dolphin and Union caribou management.
  - 1.1.5 Annually review new information on demographics and habitat, and adapt management practices accordingly.
  - 1.1.6 If necessary, recommend alternative management actions (e.g., stricter habitat and/or harvest management) allowing for natural variation in numbers.
  - 1.1.7 Annually report on management actions and progress made toward meeting objectives in management plan.

1.2 Co-ordinate research among different co-management partners and research institutions.
  - 1.2.1 Identify knowledge gaps and establish high priority research questions.
  - 1.2.2 Co-ordinate research activities with different research institutions and promote high priority research.
  - 1.2.3 Ensure local involvement in research activities (planning, field research).

**Objective #2:**

**Communicate and exchange information on an ongoing basis between co-management partners, communities, industry and the public with regard to monitoring and managing Dolphin and Union Caribou.**

2.1 Encourage flow and exchange of information between parties, using various approaches, depending on group/demographic.
- 2.1.1 Conduct "out on the land" trips, where experienced hunters (elders if they're able) take youth out on the land.
- 2.1.2 Use social media and the internet to reach out to youth.
- 2.1.3 Conduct school visits to educate youth about managing Dolphin and Union caribou.
- 2.1.4 Conduct community meetings to exchange information with communities about management of Dolphin and Union caribou.
- 2.1.5 Investigate the potential of having industry contribute information to research and monitoring.
- 2.1.6 Ensure ongoing communication between co-management partners and through supporting community monitoring programs.

**Objective #3:**
**Collect information on Dolphin and Union caribou using TK and IQ, community monitoring and scientific methods to inform sound management decisions.**

3.1 Improve our understanding of Dolphin and Union caribou health, distribution, key habitat, relationships and cumulative effects.
- 3.1.1 Identify geographic areas of importance to Dolphin and Union Caribou through research and community/traditional knowledge.
- 3.1.2 Monitor changes in predator abundance through community-based monitoring.
- 3.1.3 Promote research on relationships between Dolphin and Union caribou and predators (including relatively new predators such as the grizzly bear on Victoria Island).
- 3.1.4 Promote research on relationships between Dolphin and Union caribou and other species (e.g. other ungulates, geese).
- 3.1.5 Promote research on Dolphin and Union caribou population, habitat, vital rates, and health and condition, including possible contaminants.

3.2 Monitor Dolphin and Union caribou population and periodically assess herd status.
- 3.2.1 Expand community monitoring programs that provide information on Dolphin and Union caribou condition, population trends, and predators.
- 3.2.2 Periodically estimate population size and trend.
- 3.2.3 Assess herd status annually, based on framework.

3.3 Assess cumulative impacts on Dolphin and Union caribou population and habitat.
- 1.3.1 Develop an approach to modelling cumulative effects.

**Objective #4:**
**Promote minimal disturbance to habitat (particularly sea-ice crossings) to maintain a healthy, migratory population of Dolphin and Union caribou.**

4.1 Monitor and minimize human and industrial disturbance.

- 4.1.2 Develop guidelines, standard advice, and best practices for shipping, tourism and industry that can be regulated and evaluated;
- 4.1.3 Identify organizations (e.g., HTOs and communities) who could/would play a lead role in promoting standard advice and guidelines for shipping, tourism and industry.
- 4.1.4 Work with Transport Canada, tourism operators and other industry to regulate shipping and industry activities (e.g., establishing seasonal limitations for industry shipping and cruise ships during migration season and adjusting these in response to caribou status, if necessary).
- 4.1.5 Develop guidelines for oil spill response related to caribou.

4.2 Monitor changes to habitat on an ongoing basis.

- 4.2.1 Track human-caused landscape changes.
- 4.2.2 Monitor industrial activity including shipping traffic.
- 4.2.3 Track changes to sea ice and potential impacts to Dolphin and Union caribou.
- 4.2.4 Monitor and evaluate compliance with (or implementation of) guidelines, standard advice, and best practices mentioned in 4.1.2.
- 4.2.5 Work with communities to reduce release of contaminants through various venues (see 2.1.4).

4.3 Work with all levels of governments to manage populations of other species that affect Dolphin and Union caribou habitat (e.g., overabundant geese).

- 4.3.1 Promote traditional harvesting of overabundant species through subsistence and sport hunts.
- 4.3.2 Approach other governments to open hunting season earlier for geese.
- 4.3.3 Promote collection of eggs within communities.

**Objective #5:**
**Ensure management actions including harvest are based on herd status.**

5.1 Obtain accurate harvest data.

- 5.1.1. Educate people on the importance of reporting harvest.
- 5.1.2. Work with local Hunters & Trappers Committees/Organizations and regional Wildlife Advisory Boards to collect accurate information on harvest levels.
- 5.1.3. Report estimated total harvest levels, including the number harvested and the sex ratio, to caribou management authorities and co-management partners.

5.2 Assess herd status based on information collected.

5.3 If necessary, manage harvesting activities within acceptable limits to ensure that harvesting opportunities are available in the future by respectfully harvesting today.

5.2.1. Investigate and consider defining *acceptable harvest* levels appropriate for different population size and trend in the herd.

5.2.2. Elders teach youth about wise harvesting practices that minimize negative impacts on caribou; includes no wasting of meat, harvesting only what is needed, proper marksmanship, ability to distinguish types of caribou; avoiding harvest of cows with calves.

5.2.3. Investigate the possibility of promoting alternative food sources through harvest of other species.

5.2.4. Annually review harvest levels and make management recommendations if necessary (e.g. temporary harvest limitations).

## FOUR OPTIONS FOR DOLPHIN & UNION CARIBOU MANAGEMENT GOAL

1. The long term persistence of healthy Dolphin and Union caribou recognizing their cultural importance.

2. To support a healthy and viable population of Dolphin and Union Caribou that moves freely between mainland and Victoria Island, and offers harvesting opportunities for present and future generations.

3. To support a healthy and viable population of Dolphin and Union Caribou that moves freely between the mainland and Victoria Island, and allows for human use of caribou and their habitat while respecting conservation concerns.

4. To keep Dolphin and Union caribou from becoming threatened or endangered.

From the Bluenose Management Plan

### *9.2 When Do We Take Action*

Our actions to help the caribou herds will be determined in part by the herd size, and whether it is increasing or decreasing. Management decisions will also be influenced by other information from harvesters and scientists such as recruitment, bull-to-cow ratio, body condition and health.

In this Management Plan there are four levels of herd status and management actions. These are colour-coded yellow, green, orange, and red.[14] Management actions are based on defined phases of the population cycle. The herd status provides a trigger for specific management actions.

**Yellow:** The population level is intermediate and increasing

**Green:** The population level is high

| | | |
|---|---|---|
| | **Orange:** | The population level is intermediate and decreasing |
| | **Red:** | The population level is low |

A representation of these thresholds is provided with corresponding colours in **Figure 8.**

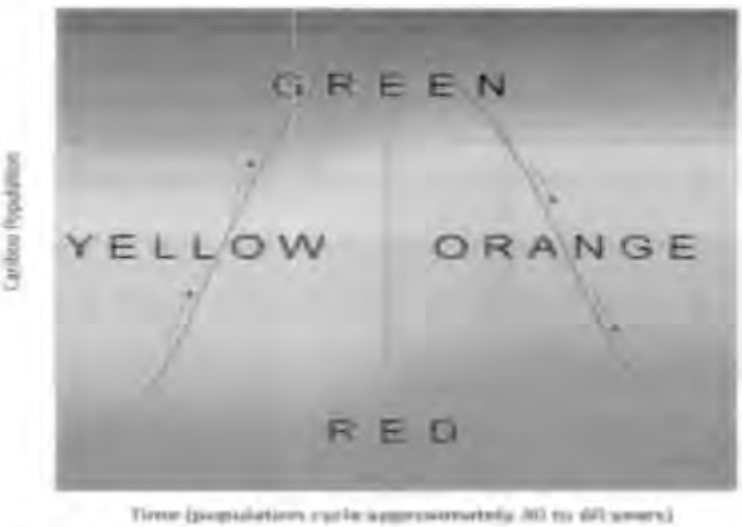



Figure 8: Caribou population status as colour zones.

Thresholds to help guide management actions were determined with input received from community and technical experts in a consensus-based process (**Table 2**). ACCWM members combined available science (historical high and low populations) with traditional knowledge and experience. Slight differences in thresholds between herds reflect the results from community engagements. The historic high, as measured by surveys, for each of the three herds, and the change over time, are shown in **Figures 4-6** of this report and described in more detail in the ***Scientific Report***. Sufficient information was not available from results of modelling simulations to help set thresholds. However, this could be a helpful tool to provide further evaluation or adjustments in future planning. In addition, ENR has recently developed a "Rule of Thumb Approach" that describes a framework for barren-ground caribou harvest recommendations based on herd risk status. This approach relies on indicators – such as population size and trend – to help estimate the potential risk to a herd under different management scenarios; it is included with the ***Scientific Report***.

The thresholds in **Table 2** are approximate and will be used to help guide management decisions and actions based on herd status. As explained earlier, estimated herd size is not the only indicator used to set a herd status into one of the four colour zones. Herd status decisions will use estimates of the overall number of caribou, whether a herd is growing in size or is declining (trend), and other monitoring indicators to assist in interpretation. In practise this means that although an estimate for a herd may cross or be very near a threshold, the determination of herd status will take into account all available information – it is not only the threshold value that is used to determine the colour zone. For example, a recommendation could be made to set a herd in a colour zone before a population estimate reaches a threshold value, or a decision could be made to keep a herd in a colour zone despite an estimate placing it just outside the threshold, if this is the best action based on all indicators considered together and according to the principles stated in this Management Plan.

Table 2: Thresholds for the status of the Cape Bathurst, Bluenose-West, and Bluenose-East Caribou Herds.

| HERD | Historic High As measured by surveys | Threshold Between green & yellow/orange | Threshold Between red & yellow/orange |
|---|---|---|---|
| Cape Bathurst Herd | [illegible] | 12,000 | 4,000 |
| Bluenose West Herd | [illegible] | 56,000 | 15,000 |
| Bluenose East Herd | [illegible] | 60,000 | 20,000 |

Table 3: Summary of management actions.[16]

<table>
<tr><th colspan="5">Management Actions Based on Herd Status/Colour Zone</th></tr>
<tr><th>Management Action</th><th>The population level is intermediate and increasing</th><th>The population level is high</th><th>The population level is intermediate and decreasing</th><th>The population level is low</th></tr>
<tr><td>Education</td><td colspan="4">Recommend education programs for all status levels. Ideas for educational themes include:<br>• Promoting total use of harvested caribou, and proper butchering and storage methods;<br>• Limiting wounding loss;<br>• Letting the leaders pass;<br>• Promoting community hunts with experienced hunters;<br>• Use of alternate species; and<br>• Increased sharing of traditional foods.</td></tr>
<tr><td>Habitat</td><td colspan="4">• Identify and recommend protection for key habitat areas;<br>• Review results of monitoring, including cumulative effects, to ensure enough habitat is available and caribou are able to move between areas of good habitat;<br>• Recommend important habitat as a 'value at risk' for forest fire management.</td></tr>
<tr><td>Land use activities</td><td>• Review results of cumulative effects monitoring programs;<br>• Provide advice on mitigation of industrial impacts to proponents and regulators.</td><td>• Review results of cumulative effects monitoring programs;<br>• Provide advice on mitigation of the impacts of exploration and development activities to proponents and regulators.</td><td>• Review results of cumulative effects monitoring programs;<br>• Provide advice on mitigation of industrial impacts to proponents and regulators;<br>• Provide active and accessible communication and recommend education programs for all including proponents and airlines;<br>• Recommend increased enforcement of land use regulations, including community monitors.</td><td>• Work directly with proponents and regulators of exploration and development activities to advise on mitigation measures;<br>• Review results of cumulative effects monitoring programs;<br>• Provide active and accessible communication and recommend education programs for all including proponents and airlines;<br>• Recommend increased enforcement of land use regulations, including community monitors.</td></tr>
</table>

[16] These management actions are in addition to the research and monitoring actions described in section 8.0 and summarized in Table 1.

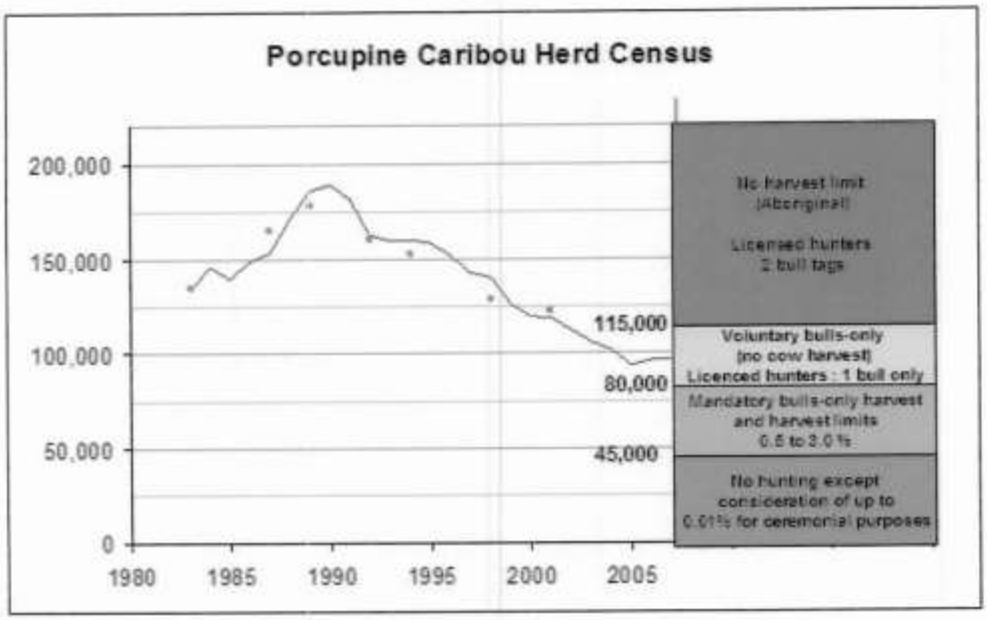
| Management Actions Based on Herd Status/Colour Zone | | | | |
|---|---|---|---|---|
| **Management Action** | **The population level is intermediate and increasing** | **The population level is high** | **The population level is intermediate and decreasing** | **The population level is low** |
| **Predators** | • Continue research programs to monitor predator condition (e.g., carcass collection and community monitoring programs). | • Continue research programs to monitor predator condition (e.g., carcass collection and community monitoring programs). | • Review results of research programs that monitor predator abundance and predation rates;<br>• Consider recommending options for predator management. | • Review results of research programs that monitor predator abundance and predation rates;<br>• Consider recommending options for predator management. |
| **Harvest** | • Recommend easing limits on subsistence and then resident harvests ;<br>• Consider recommending outfitter and commercial harvests at discretion of the ACCWM. | • Support harvest by beneficiaries of a Land Claim and members of an Aboriginal people, with rights to harvest wildlife in the Region;<br>• Recommend that if subsistence needs are met resident harvest should be permitted (with limits);<br>• Potentially recommend resident (non-beneficiary), non-resident, sport hunts, and/or commercial harvests. | • Recommend a mandatory limit on subsistence harvest based on a TAH accepted by the ACCWM;<br>• Prioritize the collection of harvest information;<br>• Recommend no resident, outfitter or commercial harvest;<br>• Recommend a majority-bulls harvest, emphasizing younger and smaller bulls and not the large breeders and leaders;<br>• Recommend harvest of alternate species and encourage increased sharing, trade and barter of traditional foods, such as the use of community freezers;<br>• Recommend increased enforcement including community monitors. | • Recommend harvest of alternate species and meat replacement programs, and encourage increased sharing, trade and barter of traditional foods;<br>• Prioritize the collection of harvest information;<br>• Review of mandatory limit for subsistence harvest for further reduction;<br>• Recommend increased enforcement including community monitors;<br>• Resident, commercial, or outfitter harvest remain closed. |

From the Porcupine Caribou Management Plan

## B. Colour Chart

At the Inuvik workshop it was agreed to use a colour chart for showing what the harvest should be in relation to how big the herd is. Such colour charts are already used for fire management and salmon management, and so many people understand what they mean and how to use them.

### Harvest Management Colour Chart




Red dots are estimates of the number of caribou from counts during the photocensus.
Blue line is the trend in population size predicted by the Caribou Calculator using available data each year.

**All hunters in all colour zones must report their harvest at all times. Rigorous and verifiable harvest monitoring will be an important information source for ongoing herd management.**

**Green** 'Take what you need' — This means no aboriginal harvest restrictions; in other words, nothing special would be done, and people could hunt for what they need. Of course, respect for the caribou would always be emphasized. Licensed hunters would receive a maximum of two bull tags.

**Yellow** 'Voluntary Bulls only' — Bulls-only harvest, with the understanding that the goal is to have no cows harvested — governments will use tools like education initiatives, legislation, regulations, and/or bylaws to work cooperatively to achieve this 100% bulls-only target. Licensed hunter harvest would be reduced to one bull tag. The Parties are committed to achieving 100% bulls-only harvest. If this target is not effectively met, the Parties will commit to review the measures, including the potential application of a mandatory bulls-only harvest.

**Orange** 'Mandatory bulls only and harvest limits' — This means that the Parties would take steps to ensure hunters took only bulls and the total harvest and the related sub-allocations are collectively within the annual allowable harvest.

**Red** 'No hunting' — This means all hunting would cease except for the opportunity of a very small (0.0%-0.1%) bull-only subsistence-ceremonial aboriginal harvest.

**Herd Management**

The Management Plan recommends three approaches to overall monitoring and management of the population that accounts for natural long term population fluctuations (Table 3).

*Level – 1: Core Management (Stable or increasing trend/high population)*

Level 1 core management actions apply at all times during the population cycle and represents the minimum level of population management activities that need to be conducted. Core management actions are used to detect a decline in productivity and abundance.

*Level – 2: Enhanced Management (Declining trend)*

Level 2 is implemented when there is an indication that the population is declining. The management actions are designed to detect changes at a finer scale. At this level a total allowable harvest may have to be applied and/or modified.

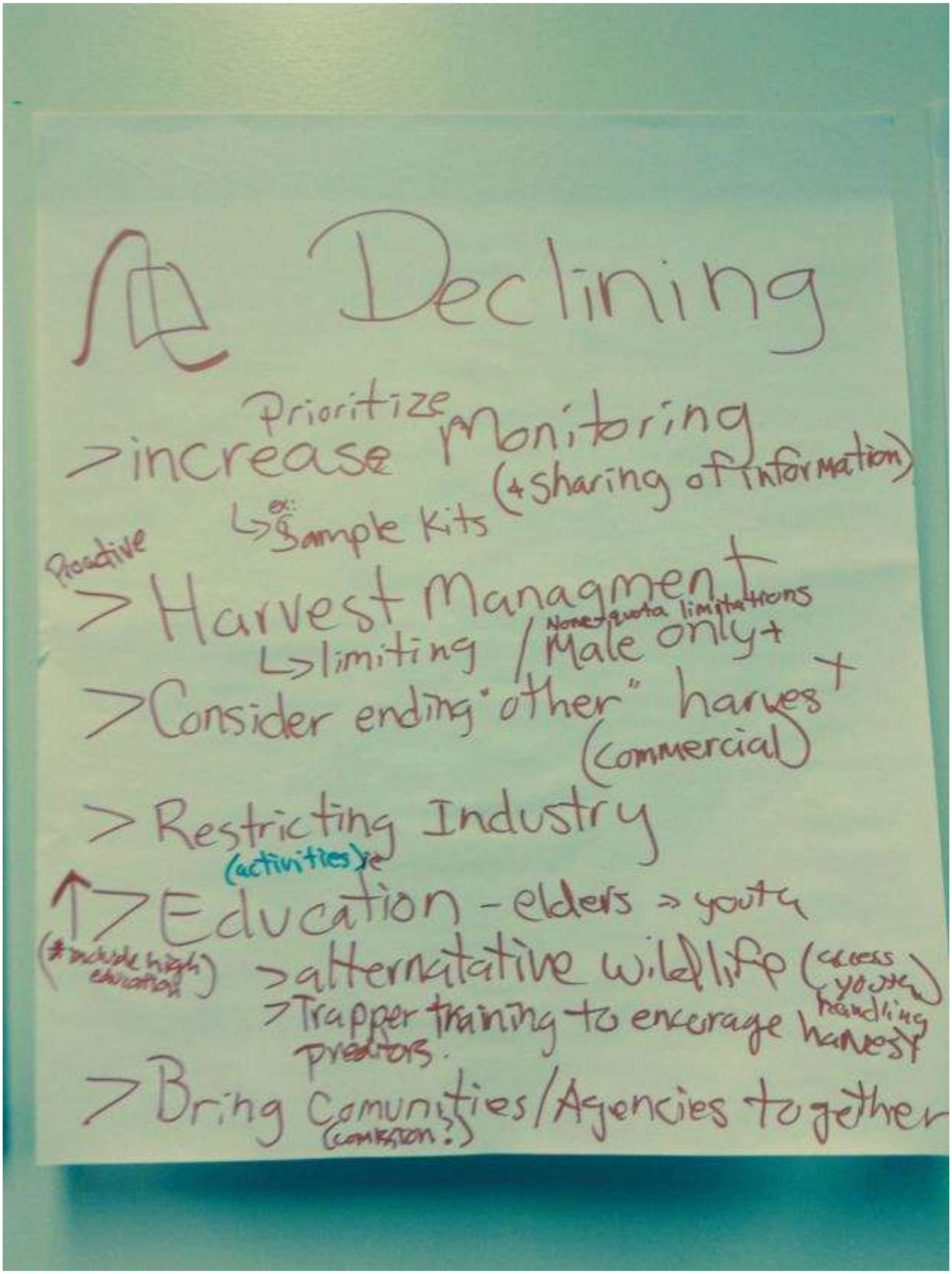
*Level – 3: Critical Threshold Management (Population level below Basic Needs Level)*

Level 3 is implemented when there are not enough caribou to meet the basic needs level. Management actions for level 3 will remain the same for those at level 2, but would involve more intensive harvest management. At this level it is expected that non-quota limitations will be introduced and a Total Allowable Harvest will have to be set below the Basic Needs Level.

A ⇒ High/Stable

- **#1 Education - youth
(including other wildlife)
- Encourage harvest of Predators
(\$\$ + Education)
- No Harvest Restrictions
on Benificiaries
- Harvest Monitoring
(comunity Based monitoring)
- Comunity Based
Mgm
- Consider other
harvest
based on comunity
landclaim

Commercial - Meat Plant
Sport hunting
Resident hunting
Comunity (comercial) harvest



# Declining

> ~~increase~~ Prioritize Monitoring (+sharing of information)
↳ ex: Sample Kits

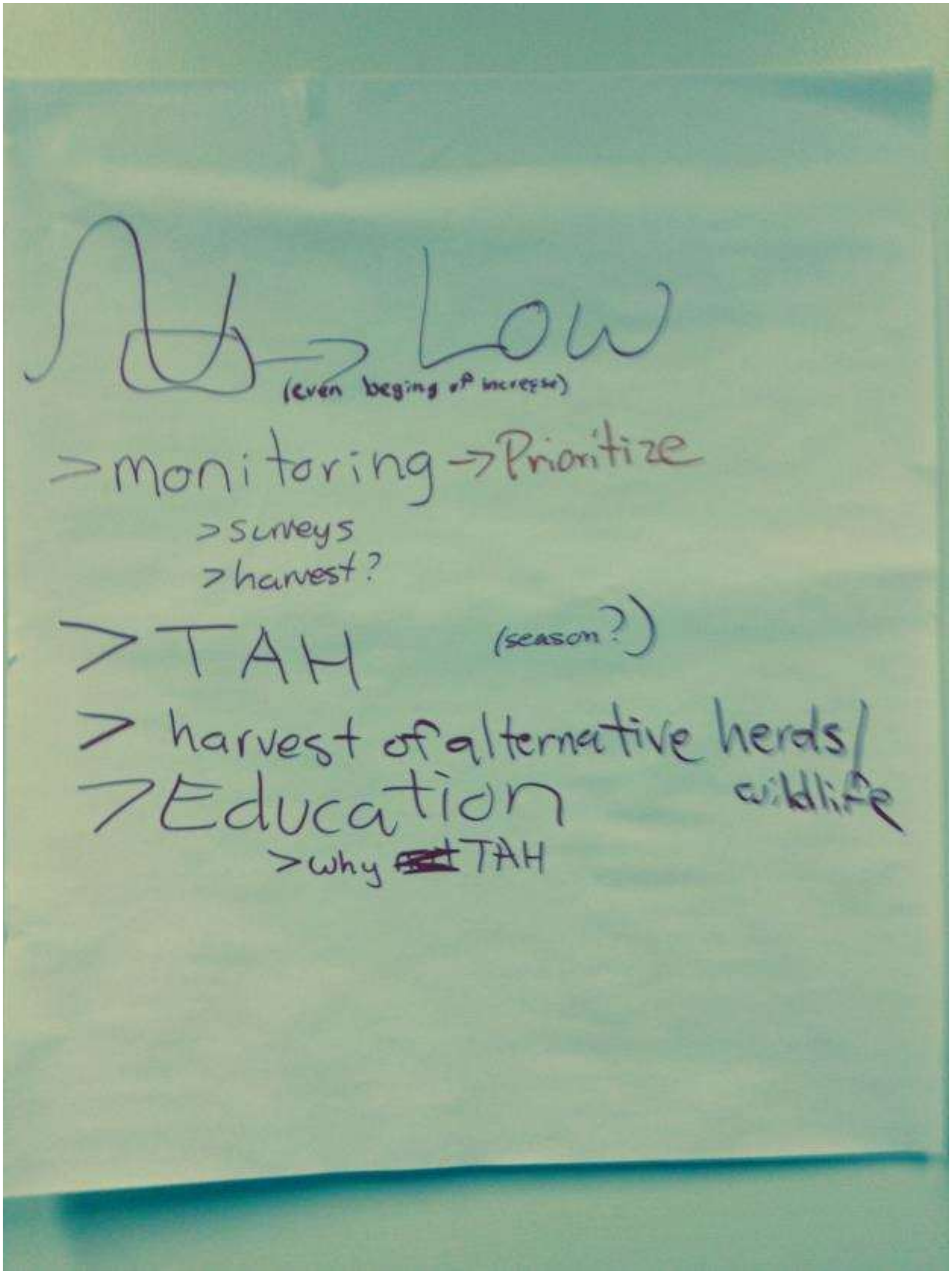
Proactive > Harvest Managment
↳ limiting / None quota limitations / Male only +

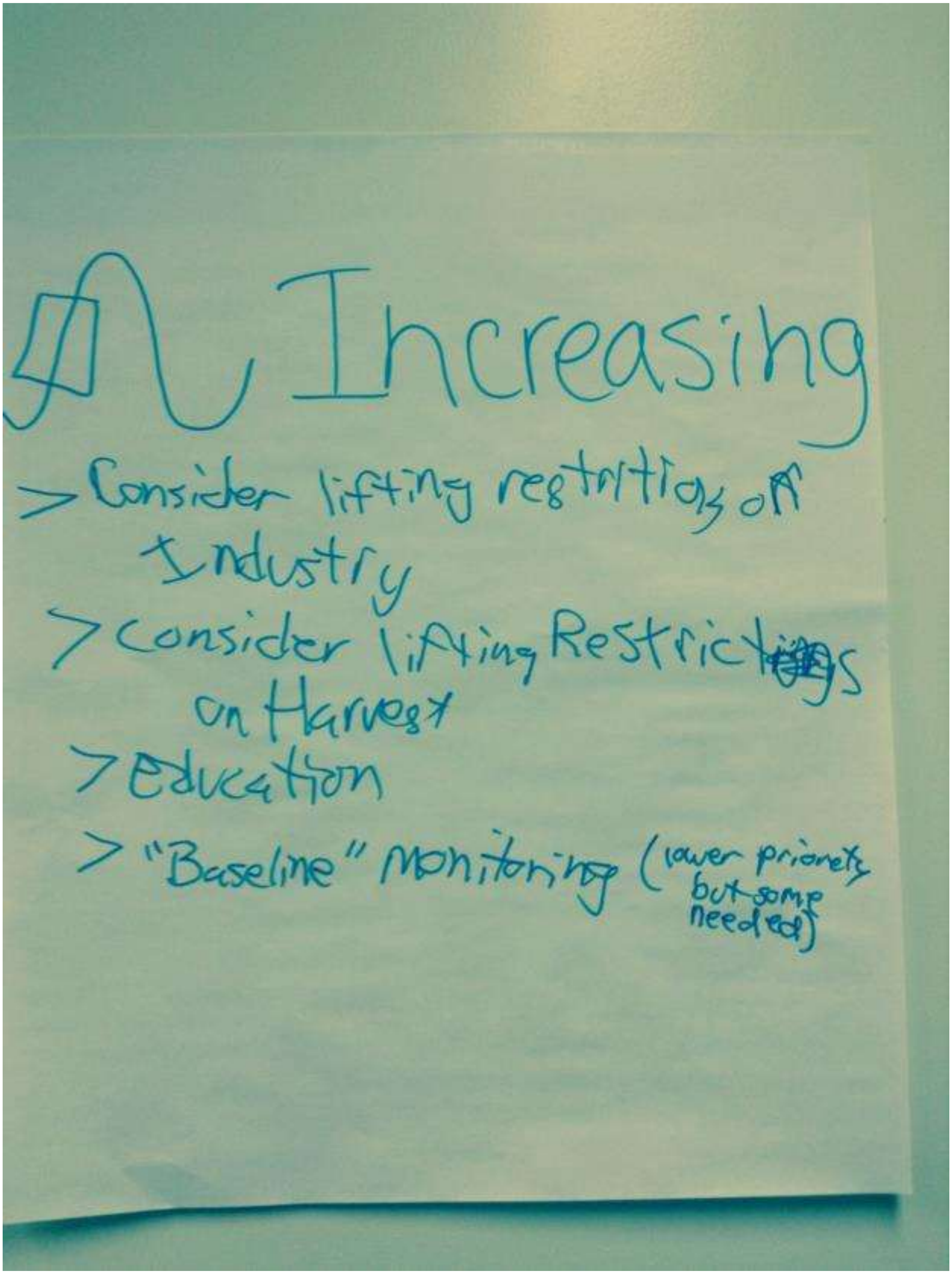
> Consider ending "other" harvest (commercial)

> Restricting Industry (activities)

↑ > Education - elders → youth (* include high education)
> alternatative wildlife (access youth)
> Trapper training to encorage handling harvest predators.

> Bring Comunities/Agencies together (combination?)


Low
(even beging of increase)
>monitoring -> Prioritize
>surveys
>harvest?
>TAH (season?)
> harvest of alternative herds/wildlife
>Education
>why TAH



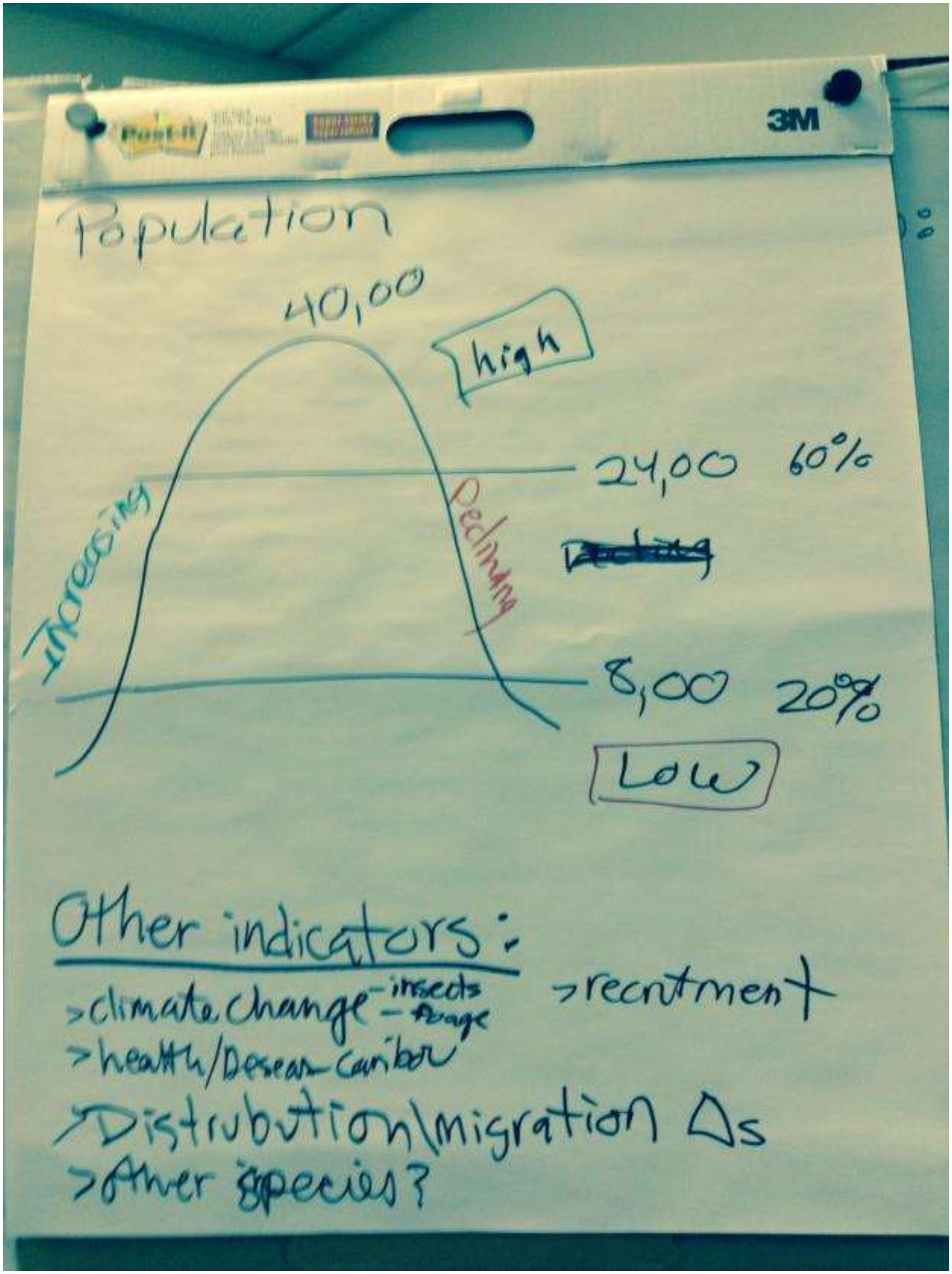
Increasing

> Consider lifting restrictions on Industry

> consider lifting Restrictions on Harvest

> education

> "Baseline" monitoring (lower priority but some needed)


Post-it
3M
Population
40,00
high
24,00 60%
Increasing
Declining
8,00 20%
Low
Other indicators:
>climate change - insects - forage
>health/Desease caribou
>recrutment
>Distrubution\migration Δs
>other species?

Environment and Climate Change Canada | Environnement et Changement climatique Canada

**Please send this form to 867-873-6776**
**Or email to:**
ec.sarnt-lepnt.ec@canada.ca
**by May 29, 2017**

# Barren-ground Caribou (Dolphin and Union population) POSITION on the Proposed Management Plan

**The following questions are intended to assist you in providing comments. They are not limiting and any other comments you may have are welcome.**

**Questionnaire filled out by:**
**Amanda Dumond**
(Print name / title)

**Organization:**
**Kugluktuk Angoniatit Association**

**Date questionnaire completed**
___May 29th, 2017______________________

**Do you have enough information to make a decision on your position/opinion on the support of the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan?**

☐ Yes ☐ No

*If you need more information, someone will contact you to see how best to provide this information*

**What is your organization's position on the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan?**

☐ Support the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

☐ Do not support the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

☐ Indifferent to the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

**What are your reasons for this position?**



Canada

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ec.sarnt-lepnt.ec@canada.ca
**by May 29, 2017**

## Do you have any additional comments?

Just to let you know, this document was given to the board members weeks ago, but we haven't had a meeting quorum to discuss this. To date, I have not had any comments regarding this document.

I am not at liberty to answer for the board, so I leave the sections above blank.

Larry and I were talking about this earlier and we would like it mentioned somewhere around page 67, that the Kugluktuk HTO had made a motion to suspend all caribou commercial and sports hunts (for all herds). Also, the local outfitter had voluntarily quit all sports hunts around Contwayto Lake. These actions show how proactive this board is, and how important it is for us to manage our wildlife.

Amanda

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Please send this form to 867-873-677
Or email to:
ec.sarnt-lepnt.ec@canada.ca
by May 29, 2017

# Barren-ground Caribou (Dolphin and Union population)
# POSITION on the Proposed Management Plan

**The following questions are intended to assist you in providing comments. They are not limiting and any other comments you may have are welcome.**

**Questionnaire filled out by:**
**Bobby Greenley, Chairman** Bobby Greenley
(Print name / title)

**Organization:**
**Ekaluktutiak Hunter's and Trapper's Organization (EHTO)**

**Date questionnaire completed**
23-MAY-2017

**Do you have enough information to make a decision on your position/opinion on the support of the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan?**

☒ Yes ☐ No *If you need more information, someone will contact you to see how best to provide this information*

**What is your organization's position on the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan?**

☐ Support the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

☐ Do not support the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

☒ Indifferent to the proposed Barren-ground Caribou (Dolphin and Union population) Management Plan

**What are your reasons for this position?**

- The EHTO feel there was not enough follow-up/feedback to base a decision of support/non-support to the Management Plan for D/U caribou herd.
- The EHTO feel that a member of the co-management group (GN-DOE or others) should have presented this document to the Board and community to explain the conditions and outcomes of support/non-support.
- The EHTO Board and its members must emphasize clearly that they do not in any way support any discussion of applying a TAH or Zones to the D/U caribou herd.

Canada

Environment and Climate Change Canada / Environnement et Changement climatique Canada

**Please send this form to 867-873-677**
**Or email to:**
ec.sarnt-lepnt.ec@canada.ca
by May 29, 2017

## Do you have any additional comments?

- As indicated in the Draft document, the most recent population size and survey cannot be accepted by the EHTO. During a survey in 2016, a member of the EHTO who was helping to conduct the survey was told not to include numbers of caribou that were not within the transect lines of the survey, yet they were within the D/U range and most likely a part of the poulation.
- The EHTO has approved its own management initiatives by lowering the number of commercial/sports hunts allowed for this herd and presented this to the NWMB.
- The EHTO Board and its members will continually voice the concern of increased predators which have become more commonly sighted which were uncommon to the area on Victoria Island.
- Recent surveys conducted by the GN-DOE have not been presented effectively in a timely fashion to the EHTO and the community members, to base a decision of support/no-support to the Management plan.
- Objective #2 of the Management Plan must be better implemented for co-management partners (EHTO) and especially for the harvesters of the D/U herd, to accept recommendations or decisions to the Management plan.

## Major modifications following the various reviews

Minor editorial changes were made throughout the document, and only larger changes are discussed below.

**Management Plan for the Dolphin and Union Caribou (*Rangifer tarandus groenlandicus x pearyi*) in the Northwest Territories and Nunavut**

Preface
- No large changes.

Acceptance Statement
- No changes, as the statements will be made at a later date.

Acknowledgements
- Names of individuals that provided comments during the First Jurisdictional Technical Review were added.

Executive Summary
- Clarification was added to the comparison of Dolphin and Union Caribou to other sub-species and populations.
- Information about the 2015 population estimate was added.
- Information about adaptive management added.

Acronyms
- Acronym table was added for reference.

Table of Contents
- Added a List of Figures, and a List of Tables.

1. Introduction
- Section was shortened to avoid repetition in other areas and to make the text more succinct.

2. Plan Development
2.1 Purpose and Principles
- Section was shortened to avoid repetition and to make the text more succinct.

2.2 Planning Partners
- Suggestions added to clarify the roles of planning partners / legislation added.

2.3 Management Planning Process
- Section was shortened slightly to avoid repetition and to make the text more succinct.

2.4 Inuit Qaujimajatuqangit and Traditional Knowledge
- No large changes.

3. Historical and Social Perspective
- Section was shortened slightly to avoid repetition and to make the text more succinct.

3.1 Communities that Harvest Dolphin and Union Caribou
- Section was shortened slightly to avoid repetition and to make the text more succinct.

3.2 Use of the Herd and History of Harvest Management
- Additional information about past harvest reporting was included.

4. Species Information

4.1 Species Status Assessment
- The COSEWIC and SARC status assessments were moved from Appendix B to this section.
- Text was added to clarify the difference between how COSEWIC/SARA classify Dolphin and Union Caribou (*Rangifer tarandus groenlandicus*) compared to how the GNWT/GN classify the population (*Rangifer tarandus groenlandicus x pearyi*).

4.2 Species Description and Biology
- Clarifying information about how to distinguish Dolphin and Union Caribou from other sub-species and populations was added.
- Section was shortened slightly to avoid repetition and to make the text more succinct.

4.2.1 Life Cycle and Reproduction
- Information about the timing of life cycle events was added.

4.2.2 Natural Mortality and Survival
- No large changes.

4.2.3 Diet
- No large changes.

4.2.4 Habitat Needs
- Section was shortened slightly to avoid repetition and to make the text more succinct.
- Figures were modified to include place-names mentioned in the section and document overall. The placement of figures within the text was also changed for better flow of the document, and one figure was added to show fall migrations.
- Information about the timing of crossings

4.3 Population and Distribution

- Restructured this section by creating Table 2 to make the text more succinct regarding population and distribution information.
- Information about the 2015 population estimate was added.

5. Threats and Limiting Factors

5.1 Threat Assessment

- The threats table provided in Appendix D was moved to this section so major threats to the species can be quickly assessed.

5.2 Description of Threats

Changes to Sea Ice Affecting Migration

- Moved the discussion of cumulative impacts of climate change (sea-ice related issues) and shipping traffic after reviewing each of these threats separately. It is now more clear to the reader what each of the threats is before reviewing their cumulative impact.

Predation and Competition

- No large changes.

Harvest

- Added text explaining the change of rank between 2014 and 2016 threat assessment.

Parasites, Diseases and Insect Harassment

- No large changes.

Other Habitat Changes due to Climate Change

- This section was moved below to avoid confusion with the first section of the Threats addressing changes to sea ice.

Icing Events

- No large changes.

Mining

- No large changes.

Roads

- No large changes.

Flights

- No large changes.

Other Threats

- Summarized the threats of this category in a paragraph and moved detailed information to the Appendix C.

5.3 Knowledge Gaps

- An additional knowledge gap was added: Potential impact of future development on Dolphin and Union caribou.
- Prioritized Knowledge gaps.

6. Management

6.1 Management Goal

- Rewording of the goal to make it clearer.

6.2 Management Objectives

- No large changes.

6.3 Approaches to Management of the Dolphin and Union Caribou

- This section was moved before the Approaches to Achieve Objectives to facilitate reading.
- Added a ‘Threats and/or knowledge gaps addressed’ column to link back to the initial reason for concern and how we are addressing that concern.
- Management Plan Goal row: moved this information in its own section at the end of the document called “7. Measuring Progress”.

6.4 Approaches to Achieve Objectives

- Updated Objective 1, Objective 2 and Objective 3 to reduce redundancy and make it more clear how these 3 objectives are distinct from one another.

6.5 Current Management and Other Positive Influences

- This section was moved to the Management section to facilitate reading.

6.6 Managing Based on Population Status (Level)

- Replaced term ‘herd’ with ‘population’.

Determining Population Status

- No large changes.

Management Actions Recommended

- No large changes.

7. Measuring Progress

- New section added: to define and measure progress toward achieving the management goal.

8. Next Steps

- No large changes.

9. References

- No large changes.

Appendix A: Dolphin and Union Caribou Management Framework

- No large changes.

Appendix B: Assessments of Dolphin and Union Caribou

- Appendix B was removed as the status assessments were placed in the body of the document.

Appendix C: Effects on the Environment and Other Species

- No large changes.

Appendix D: IUCN Threat Classification Table and Threat Calculator Results for Dolphin and Union Caribou

- No large changes.

# SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD July 2017

**FOR**

**Information: X** **Decision:**

**Issue:** Department of Fisheries and Oceans Canada Updates

**Updates:**

***Marine Mammals:***

1) Narwhal:
   - The 2017/18 narwhal tags (including carryover tags) and information packages have been distributed to all communities

2) Walrus:
   - A total of 17 Walrus Sport Hunt licences have been issued for this season.
   - Four licences for Hall Beach; 11 for Coral Harbour and two for Iqaluit.

3) Cumberland Sound Beluga:
   - The Arial Survey crew arrived in Pangnirtung on July 25th and the survey is scheduled to run until August 20th.
   - A sampling contract was also created between the HTO and DFO to collect biological samples in an effort to obtain genetic evidence of the second group of whales, which is thought to enter Cumberland Sound

***Arctic Char:***

1) Pangnirtung Fishery
   - An exploratory license was issued to the HTO on May 3, 2017
   - Anticipated Start date of the summer fishery is the beginning of August

2) Pond Inlet Emerging Arctic Char Fishery:
   - The Pond Inlet Exploratory Arctic Char Fishery was licensed on July 28, 2017. Fishing was planned to start mid-July.
   - DFO Fisheries Technician will be participating with this year's summer sampling

***Greenland Halibut (Turbot):***

1) Cumberland Sound Turbot Fishery

- Turbot fishing began on February 3, and the final landing at the fish plant was on May 16. 449 tonnes (t) was harvested by 60 fishers. This is more fish than was harvested in the 2015 or 2016 ice Turbot fisheries.
- The licence for the 2017 Cumberland Sound small vessel Turbot fishery was issued on July 28, 2017. The licence is for 50.605t of Turbot, which is the remainder of the 500t Total Allowable Harvest after the ice fishery. As of July 28 there is one vessel on the licence.

2) Offshore Fishery:

- Baffin Fisheries Coalition fished some of their Division 0B Greenland Halibut quota in January 2017; apart from this, fishing in Division 0B began in late May for trawlers and mid-June for gillnetters. As of July 28 fishing had not begun in Division 0A.
- The 0B Competitive fishery for the Division 0B 900t Fixed Gear Quota opened on June 28 and closed on July 8. The reported catch was 860t. This number is preliminary and may change once landings reports are received by DFO. Based on previous years, the number is expected to increase slightly.

***Northern Shrimp:***

- For Nunavut fishing industry in shrimp fishing areas adjacent to Nunavut: fishing in Management Units Davis Strait East and West began in late June; fishing in Shrimp Fishing Area 1 began in late July; and as of July 28 fishing had not begun in Management Units Nunavut East and West.

**Prepared by:** Central and Arctic Region – Fisheries and Oceans Canada

**Date:** June 28, 2017

# SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD September 2017

**FOR**

**Information: X** **Decision:**

**Issue:** Oceans Protection Plan – Nunavut Pilot Site.
.

**BACKGROUND:**

In November 2016, the Prime Minister announced the $1.5 billion, five-year national Oceans Protection Plan (OPP). The plan brings together a large number of diverse initiatives designed to enhance the protection of Canada's oceans and waterways, increase safety and improve the marine environment. Its impacts will be felt by Canadians, not just on the coasts, but across the country and has implications for all of Canada's regions.

The OPP will balance significant investments in cutting-edge science to understand and protect our marine environment; design, enhance and deploy the most effective world-leading technologies and systems to enhance our spill prevention and environmental response abilities and create a state-of-the-art marine safety regime.

The Federal Government has made cooperation between Federal Government departments a key component of the implementation of OPP. The plan must also bolster public confidence by advancing reconciliation with Indigenous peoples through genuine partnerships. Government departments will work closely with Provinces, Territories, industry, environmental organizations, indigenous peoples, coastal communities and the public.

**COASTAL ENVIRONMENTAL BASELINE PROGRAM:**

Fisheries and Oceans Canada (DFO) – Central and Arctic Region has been tasked with recommending one pilot site within Nunavut to collect baseline data to characterize the ecosystem. This Coastal Environmental Baseline Program will support an Assessment of the Cumulative Impacts of Marine Shipping (led by Transport Canada). The objective of this program is to respond to concerns regarding the lack of baseline environmental information in areas of current/projected high vessel traffic activities and coastal development. The study duration for this pilot site will be 3-4 years.

Community support and capacity are essential to ensure the success of this initiative. Furthermore, a large amount of the funding for this initiative will be in the form of grants and contributions that would be provided to our partners (e.g. community organizations, Universities, etc.) to enable them to participate in and contribute to this program.

**PILOT SITE CANDIDATES:**

DFO will be discussing pilot site candidates with our Nunavut co-management partners.

**Prepared by:** Central and Arctic Region – Fisheries and Oceans Canada

**Date:** Aug. 1, 2017

# <u>SUBMISSION TO THE NUNAVUT WILDLIFE MANAGEMENT BOARD</u>

**<u>FOR</u>**

**Information: X** **Decision:**

**Issue:** Brief update on DFO Science Program in Nunavut, Sept 2017.

**Background:**
In the past, Fisheries and Oceans Canada (DFO) Science provided an update on the Emerging Fisheries Program and other Science programs currently operating in Nunavut e.g. Narwhal Aerial Survey, Offshore Trawling Survey.

**Current Situation:**
Currently, DFO Science is in the process of planning and executing field work for the 2017 season. This is a very busy time with many people travelling to remote locations in Nunavut. At this time DFO Science personnel are on the ground working closely with local communities and Hunters and Trappers Organization to collaboratively collect the best data possible.

<u>The current NWMB funded projects are</u>:

Cumberland Sound bowhead and beluga photo-id, genetic mark-recapture, and assessment of the use of UAS for aerial surveys.
- This project is currently underway.

Eclipse Sound Narwhal Telemetry Study, Floe Edge 2017
- This project occurred in the spring/early summer and was a good learning experience, no whales were tagged.

Eclipse Sound Narwhal Tagging Study 2017
- This project is currently underway and three (3) whales have been tagged as of August 4.

Aerial Survey of Cumberland Sound beluga whales.
- This project is currently underway.

Seasonal patterns of growth in anadromous and resident Arctic Char
- This project is scheduled to begin in early August

Pond Inlet Arctic Char Fishery Enhancement Research Program
- This project is scheduled to begin in early August

Community-based fisheries monitoring in Qikiqtarjuaq Fishing Areas
- This project is scheduled to begin in the fall 2017 for three (3) waterbodies.

Sylvia Grinnell Arctic Char (Salvelinus alpinus): Stock, Creel Survey and Didson Sonar Assessments

- This project is currently underway and going well with half our samples collected and many Creel Surveys completed.  The Didson is scheduled to be deployed in mid-August until the end of August.

Intra-System Assessment of Genetic Population Structure, Migration and Habitat Use Among Spawning Arctic Char (Salvelinus alpinus) from the Cambridge Bay Region, NU: Year 2.

- This project is currently underway.

In the coming months we will have full updates for the NWMB regarding our field work.

**Consultations:**
DFO Central & Arctic Region and Eastern Arctic Area

**Prepared by:** Z. Martin, Aquatic Science Biologist, DFO Iqaluit and Dr. R. Young, Division Manager, DFO Winnipeg.

**Date:** July 29, 2017

## SUBMISSION TO THE

## NUNAVUT WILDLIFE MANAGEMENT BOARD

## FOR

**Information: X** **Decision:**

**Issue:** ***Fisheries Act*** **closures in Eastern Arctic**

**Background:**

Canada has committed to increasing the proportion of marine and coastal areas that are protected to 5% by 2017. To achieve this target, "other effective area-based conservation measures" are being evaluated for their role in marine conservation. These include areas closed to fishing which conserve biodiversity.

For 2017, the focus of fishing closures is the protection of sensitive benthic areas. Significant concentrations of corals, sponges, and sea pens have been identified in the Eastern Arctic (Figure 1) which provide important habitat for many species. Many coral, sponge, and sea pen species are vulnerable to physical damage and sediment smothering because they cannot move, break easily, are long lived, and grow very slowly.

On June 5, 2017, Fisheries and Oceans Canada (DFO) presented to the Board a proposed Hatton Basin fishing closure as well as adjustments to the Narwhal Overwintering and Coldwater Coral Zone fishing closure. These closures, if approved, will contribute 42,459 km$^2$ and 7,382km$^2$ respectively to Canada's Marine Conservation Targets (MCTs) (Figure 2).

As noted in the June presentation, the multi-stakeholder Marine Conservation Working Group (Working Group) formed under the auspices of the multi-stakeholder Eastern Arctic Groundfish Stakeholder Advisory Committee (EAGSAC) was also evaluating a proposal tabled January 19 at the EAGSAC meeting in Iqaluit, Nunavut. The Working Group finalized a proposal for a fishing closure to bottom contact gear in Davis Strait (Figure 3) to conserve habitat for corals, sponges, sea pens. The annual average value of Greenland Halibut fisheries in Div. 0A/0B and shrimp fisheries in SFA 1/DS is $78M; the annual average value of the Greenland Halibut and shrimp fisheries in the proposed closure is $20K. The proposed closure was presented to EAGSAC on July 21, 2017 and EAGSAC members supported the proposal. This fishing closure would contribute 17,298km$^2$ to Canada's MCTs for 2017. It is DFO's intent to consider all comments, seek Ministerial approval this fall, and implement approved fishing closure for the 2018 fishing season.

Once again, DFO appreciates the extensive output of the Working Group and the hard work and cooperation of its members.

**Consultation:**

Although the Working Group and EAGSAC are the primary stakeholder consultation mechanisms (including representatives from co-management organizations, groundfish and shrimp fishing industry, territorial/ provincial governments, and environmental organizations), other fora have also been used to engage interested groups. Table 1 lists the main stakeholder meetings. All stakeholders generally support a fishing closure in this area. Broad concerns have been expressed regarding timelines, equitable distribution of marine protected areas among Canadian bioregions, cumulative impact of marine protected areas on future commercial fishery development, rules for other ocean activities within fishing closures, etc. However no specific concerns regarding the proposed Davis Strait fishing closure have been expressed. A summary of comments heard is found in Appendix 1.

DFO will also seek comments from the Nunavik Marine Region Wildlife Board.

**Recommendation:**

The Board provide comments to DFO on the proposed Davis Strait fishing closure. Comments are requested before October 10, 2017.

**Prepared by:** DFO, Central & Arctic Region, Fisheries Management

**Date:** August 3, 2017

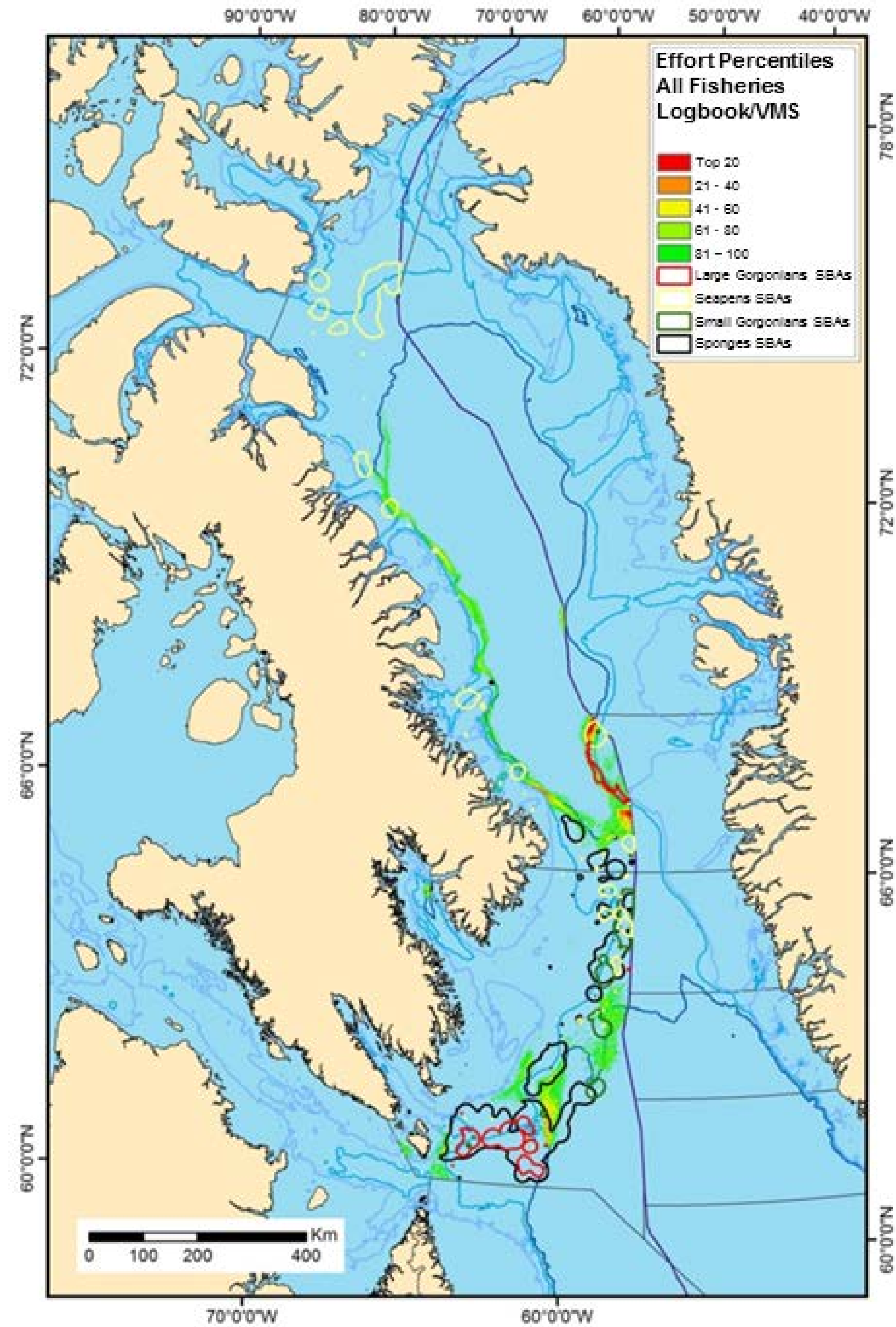



Figure 1. Significant concentrations of corals, sponges, and sea pens in the Eastern Arctic overlaid with fishing footprint.

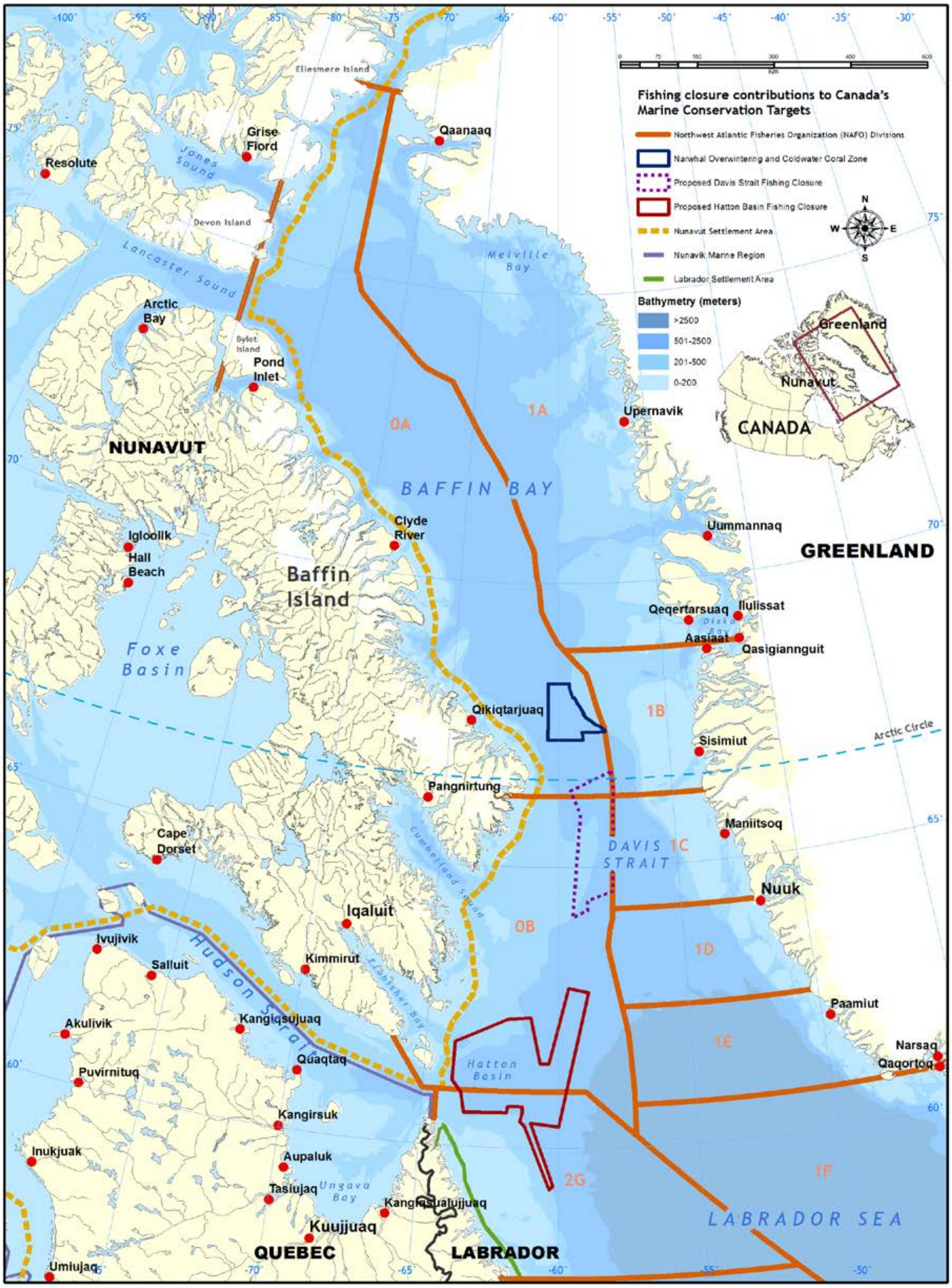



Figure 2. Potential contribution to Canada's Marine Conservation Targets from proposed Eastern Arctic fishing closures.

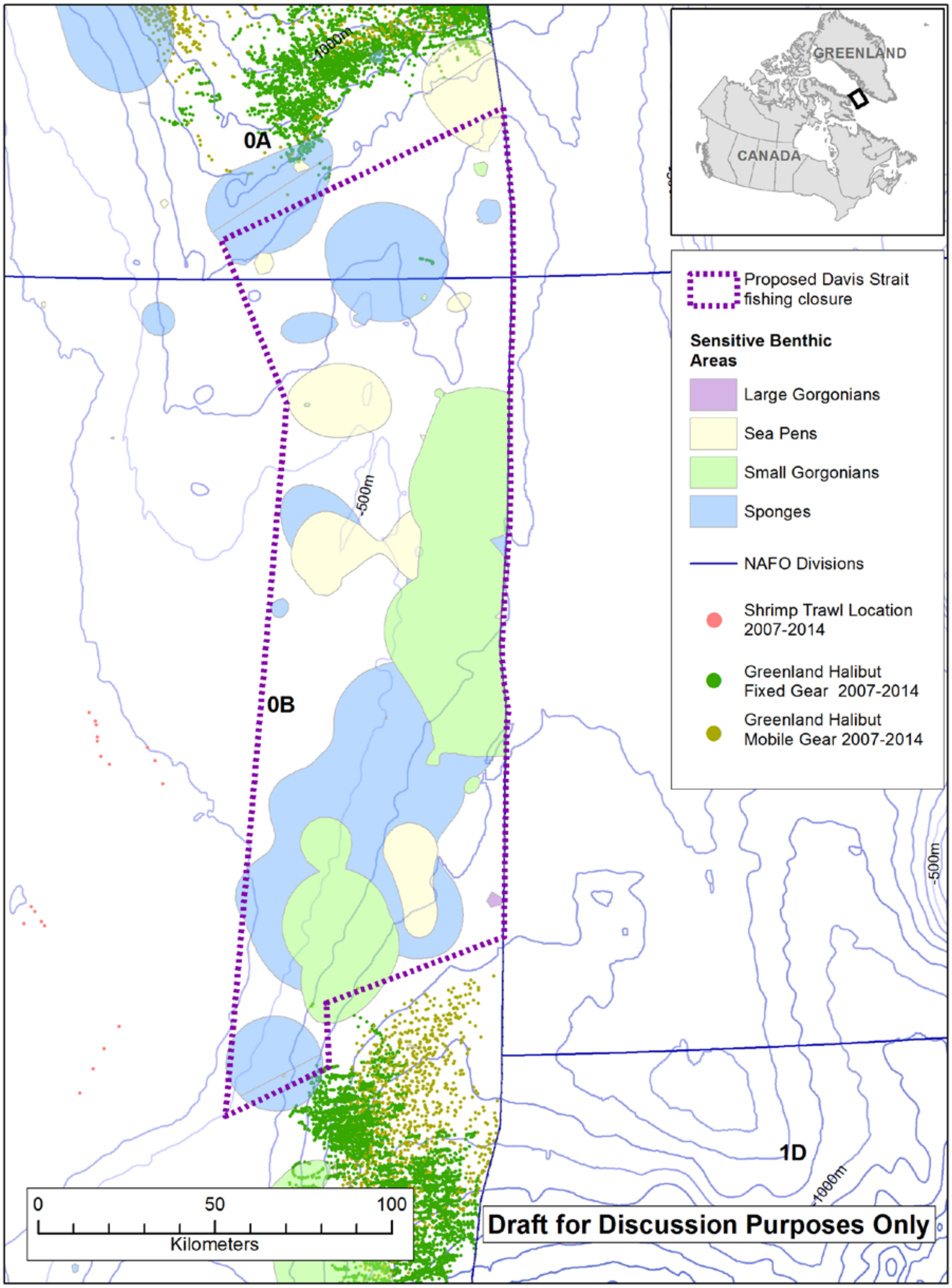



Figure 3. Proposed area in Davis Strait closed to all bottom contact fishing gear to conserve sensitive benthic areas.

Table 1. Consultations related to proposed Davis Strait fishing closure.

| Date | Engagement event | Participants |
| --- | --- | --- |
| 18-Jan-17 | Eastern Arctic Groundfish Stakeholder Advisory Committee (EAGSAC) meeting | Provinces/Territories, Indigenous partners, Industry, Environmental Organizations |
| 1-Mar-17 | Nunavik Marine Region Wildlife Board meeting | Indigenous partner |
| 07-Mar-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| 07-Mar-17 | Nunavut Wildlife Management Board meeting | Indigenous partners |
| 09-Mar-17 | Northern Shrimp Advisory Committee (NSAC) meeting | Industry, Indigenous partners, Provinces/Territories |
| 10-Mar-17 | C&A/NL consultations with shrimp harvesters/NSAC members | Provinces/Territories, Indigenous partners, Industry, Environmental Organizations |
| 19-Mar-17 | Boston Seafood Show Marine Conservation Target Roundtable | Provinces/Territories, Indigenous partners, Industry, Environmental Organizations |
| 27-Mar-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| 07-Apr-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| 19-Apr-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| 27-Apr-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| 02-May-17 | World Wildlife Canada, Canadian Parks and Wilderness Society, Ecology Action Centre, Oceans North, David Suzuki Foundation, Western Legal Defence Fund | Senior officials from each environmental organization |
| 04-May-17 | Government of Newfoundland and Labrador, Department of Fisheries and Land Resources | Senior officials |
| 05-May-17 | Government of Nunavut, Department of Environment, Fisheries and Sealing Division | Senior official |
| 30/31-May-17 | Canada-Nunavut Fisheries and Marine Mammal Cooperation Committee meeting | Gov’t of Nunavut, Nunavut Wildlife Management Board staff, Nunavut Tunngavik Inc. |
| 31-May-17 | Canada-Nunavut meeting | Gov’t of Nunavut senior officials |
| 01-Jun-17 | Canada- Nunavut Wildlife Management Board meeting | Nunavut Wildlife Management Board staff |

| | | |
|---|---|---|
| 05-Jun-17 | Nunavut Wildlife Management Board meeting | Indigenous partner |
| 08-Jun-17 | Nunavik Marine Region Wildlife Board meeting | Indigenous partner |
| 20-June-17 | Government of Newfoundland, Department of Fisheries and Land Resources | Provincial Government |
| 23-June-17 | Fish Food and Allied Workers | Industry |
| 26-Jun-17 | EAGSAC Marine Conservation Working Group | Indigenous partners, Industry, Environmental Organizations |
| June 26-17 | World Wildlife Canada , Ecology Action Centre, Canadian Parks and Wilderness Society | Environmental Organizations |
| 28-Jun-17 | Nunatsiavut Government | Senior officials |
| 29-Jun-17 | Torngat Joint Fisheries Board Secretariat | Indigenous partner |
| 21-Jul-17 | EAGSAC meeting | Provinces/Territories, Indigenous partners, Industry, Environmental Organizations |

Appendix 1. Summary of comments heard from stakeholders during consultations on proposed Eastern Arctic fisheries closures relevant to proposed Davis Strait closure.

- Support the goal of marine conservation including protection of sensitive benthic areas.
- Support the governance structure established by Fisheries & Oceans Canada (DFO) to identify and develop boundaries for proposed fishing closures in Baffin Bay/Davis Strait. In particular, the Marine Conservation Working Group, composed of representatives with diverse perspectives, is efficient and productive.
- Thought timeline for 2017 Marine Conservation Targets too compressed which could result in inadequate consultation, mistakes, and damage to stakeholder relationships.
- Requested clarification on marine conservation tools (i.e. Fisheries Act closures, Marine Protected Areas, National Marine Conservation Areas, National Wildlife Areas, Migratory Bird Sanctuaries, National Parks) and consultation processes for those which affect fishing.
- Wanted to ensure equitable distribution of fisheries closures and marine protected areas among Canadian bioregions.
- Wanted to ensure meaningful protection to valued ecosystem components. In particular, where fishing is a threat to identified Ecologically and Biologically Significant Areas, environmental organizations want fishing closures established with conservation objectives to ensure protection of all the components which make the area significant.
- Wanted balance between conservation and economic impact to both current and future fishing activities. Industry leaned to minimizing economic impact and environmental organizations leaned to maximizing conservation.
- Questioned time period used to determine the fishing footprint which underpinned the socio/economic analysis and boundary negotiations. Industry would like all historical fishing activity to be included whereas environmental organizations would like only the last 10 years to be included.
- Requested clarification on the review process for fishing closures which contribute to Marine Conservation Targets and the ability to revaluate and revise in the future.
- Varying views on further implementation by DFO of its “Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas”. Industry concerned with impact to current and future fishing opportunities. Environmental organizations concerned implementation of the Policy will stall after 2017.
- Concern regarding cumulative impact of fisheries closures and marine protected areas on future commercial fishery development, especially in the Eastern Arctic.
- Significant concern that fish harvesters are carrying the burden for Marine Conservation Targets.
- Lack of clear rules on other ocean activities which potentially could negatively impact the conservation objectives of the fishing closure (e.g. dredging, transport, ballast water discharge, oil and gas, marine mining, spill risks, marine cables, tourism, etc.).
- Highlighted the need for adequate monitoring and enforcement of fishing closures.
- Concern regarding actions, or lack thereof, by other countries to protect shared ecosystem components valued by Canadians

# *Fisheries Act* closures in the Eastern Arctic

Nunavut Wildlife Management Board meeting

Iqaluit, NU

September 11, 2017

# Outline

- Background
  - o Marine Conservation Targets initiative
  - o Corals, sponges and sea pens present in eastern Arctic
  - o Identification of sensitive benthic areas
  - o Development of fishing closure proposals
- Proposed Davis Strait fishing closure
- Consultations
- Next steps

# Background

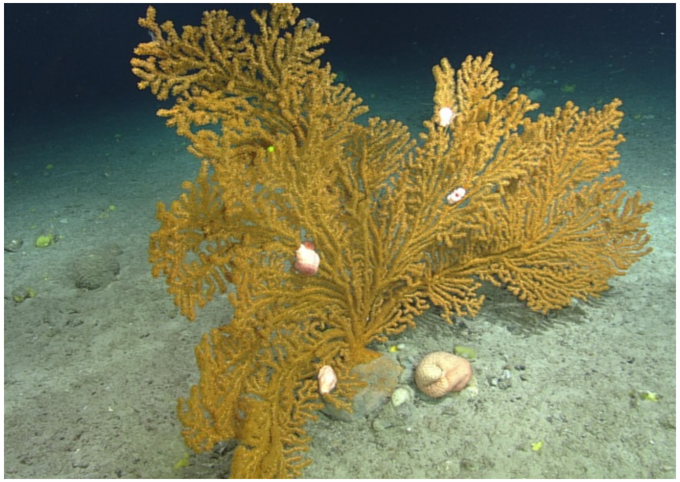
- Canada has committed to increasing the proportion of marine and coastal areas that are protected to 5% by 2017.
- Areas closed to fishing which conserve biodiversity will contribute to this target.
- For 2017, the focus of fishing closures is the protection of sensitive benthic areas.
- Significant concentrations of corals, sponges, and sea pens have been identified in the eastern Arctic which provide important habitat for many species.
- Many types of corals, sponges, and sea pens are vulnerable to physical damage and sediment smothering because they cannot move, break easily, are long lived, and grow very slowly.

# Corals, Sponges, Sea Pens found in Eastern Arctic

Sponge

Sea Pen

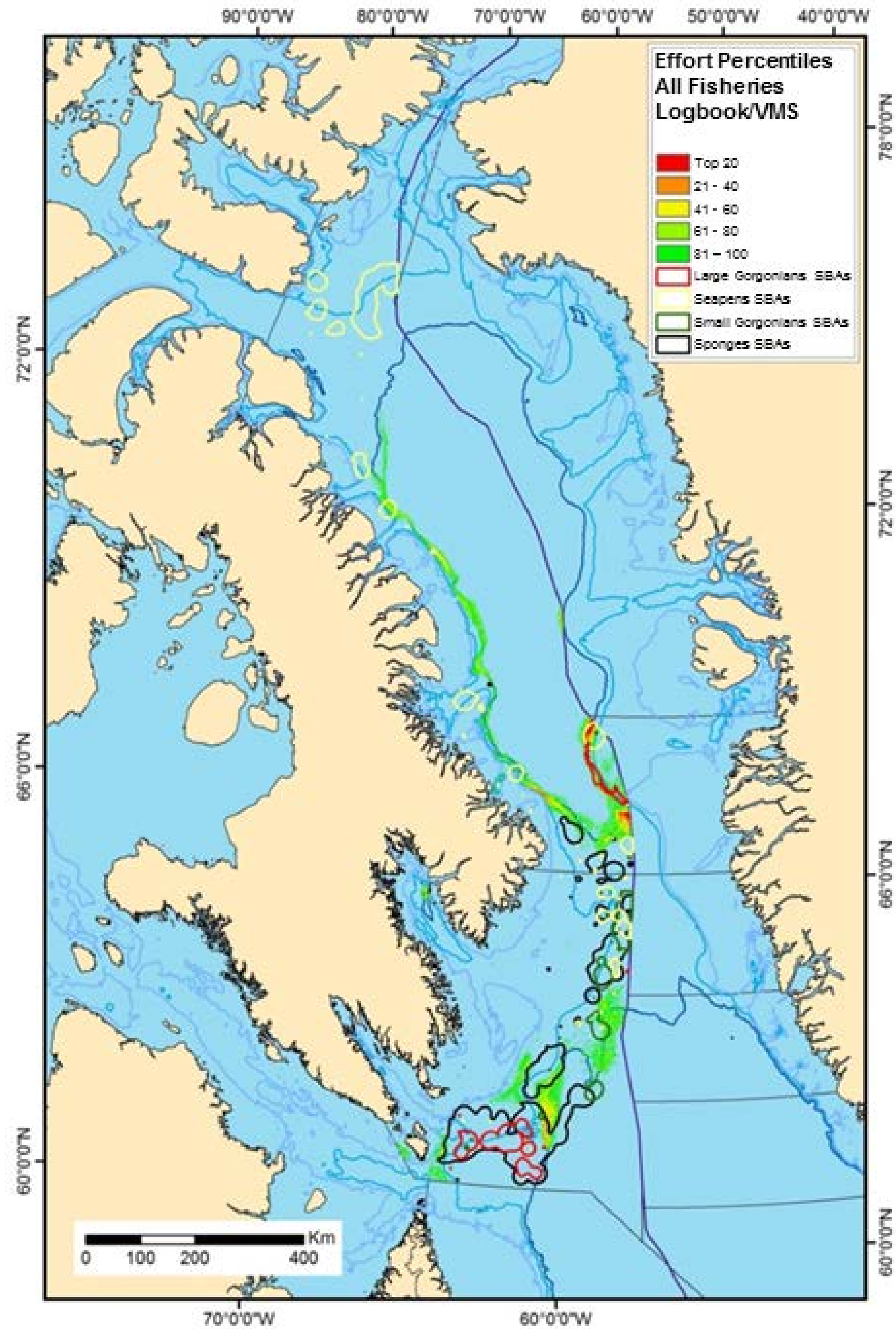
Small Gorgonian Coral



Large Gorgonian Coral

# Sensitive Benthic Areas

- Significant concentrations identified by modeling, ground truthed with data from video/camera surveys, captures by research and fishing vessels
- Overlaid with shrimp and Greenland Halibut fishing footprints.



# Protection

- On January 19, 2017, the Eastern Arctic Groundfish Stakeholder Advisory Committee (EAGSAC) established a Marine Conservation Working Group (MC WG).
- Tasked to review current closures and identify potential areas for new groundfish and/or shrimp fishing closures that would assist with conservation needs and future economic viability of the fisheries.

DFO appreciates the extensive output of the MC WG and the hard work and cooperation of its members.

Fisheries and Oceans Canada | Pêches et Océans Canada

# Proposed closures

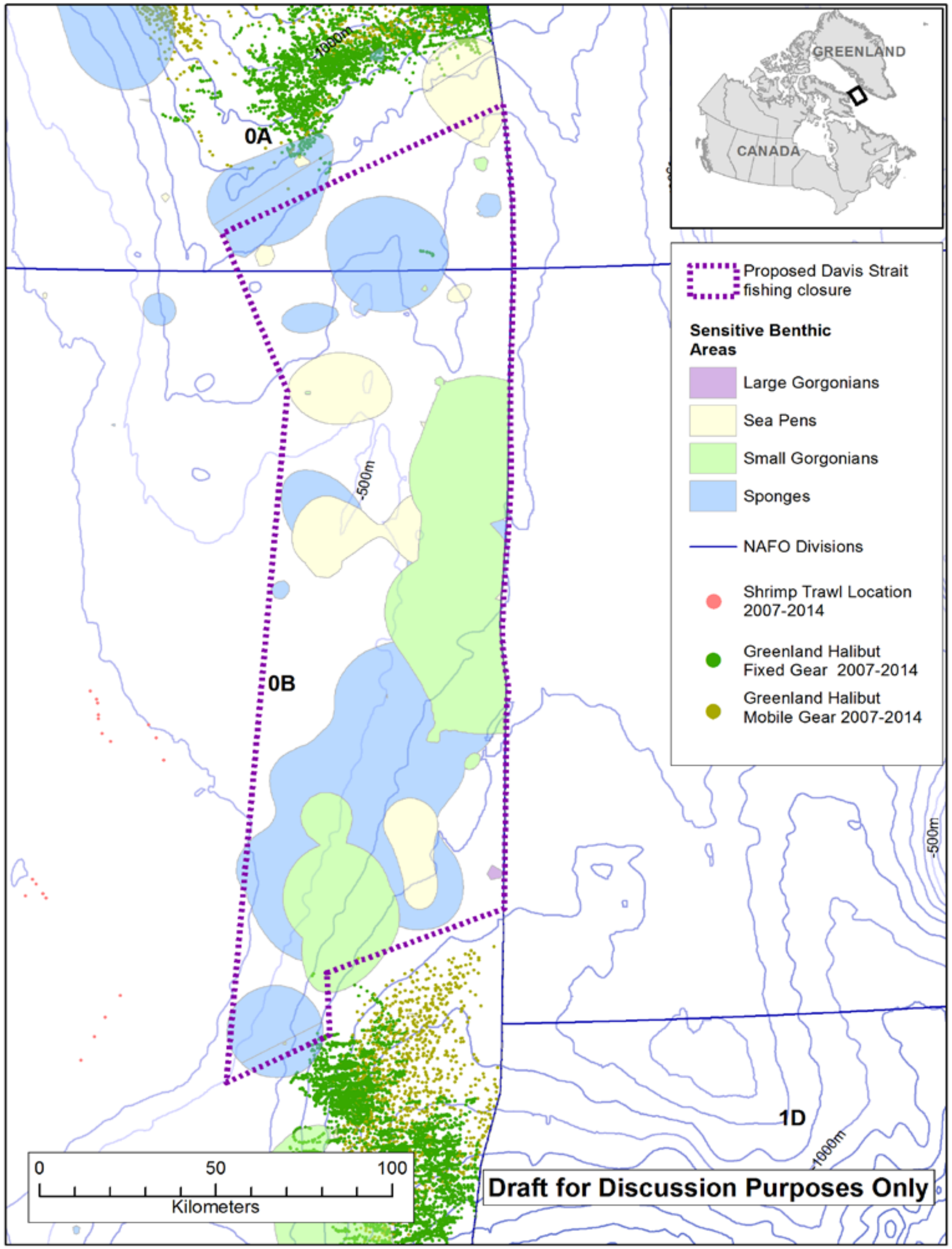
MC WG has developed the following:

- Proposed Hatton Basin fishing closure (presented to Boards June 2017);
- Proposed adjustments to Narwhal Overwintering and Coldwater Coral Zone fishing closure (presented to Boards June 2017);
- Proposed Davis Strait fishing closure, endorsed by EAGSAC

Fisheries and Oceans Canada | Pêches et Océans Canada

# Davis Strait fishing closure

- Objective to conserve sensitive benthic areas
- 17,298 km$^2$
  - o Div. 0A 2,487 km$^2$
  - o Div. 0B 14,810 km$^2$
- Annual avg value of fisheries in Div. 0A/0B, SFA 1/DS is \$78M; in proposed closure \$20K.



# Consultations

- The primary venue for consultation has been the multi-stakeholder MC WG (6 meetings).
- Since Dec. 2016, DFO has sought the views of other stakeholders, including representatives from co-management organizations, groundfish and shrimp fishing industry, territorial/ provincial governments, and environmental organizations, on Eastern Arctic fishing closure recommendations. Highlights:
  - EAGSAC (multi-stakeholder Subarea 0 groundfish fishery interests)
  - Northern Shrimp Advisory Committee and other interested shrimp fishery stakeholders
  - Gov'ts of Newfoundland & Labrador, Nunatsiavut, Nunavut
  - Nunavik Marine Region Wildlife Board, Torngat Joint Fisheries Board, Nunavut Wildlife Management Board
  - Environmental Organizations

# Summary of Comments

- Support marine conservation.
- Support governance structure established to identify and develop proposed fishing closures in Baffin Bay/Davis Strait/Hatton Basin.
- Timeline for 2017 MCTs too compressed.
- Clarification on marine conservation tools (i.e. Fisheries Act closures, Marine Protected Areas, National Marine Conservation Areas, National Wildlife Areas, Migratory Bird Sanctuaries, National Parks) and consultation processes for those which affect fishing.
- Equitable distribution of fisheries closures and marine protected areas among Canadian bioregions.
- Equitable distribution of conservation burden among marine industries.
- Meaningful protection to valued ecosystem components.

# Summary of Comments (cont.)

- Balance between conservation and economic impact to both current and future fishing activities.
- Time period used to determine the fishing footprint which underpinned the socio/economic analysis and boundary negotiations.
- Process to revaluate and revise fishing closures in the future.
- Further implementation of DFO's Sensitive Benthic Areas Policy.
- Cumulative impact of fisheries closures and marine protected areas on future commercial fishery development.
- Rules on other ocean activities which potentially could negatively impact the conservation objectives of fishing closures.
- Adequate monitoring and enforcement of fishing closures.
- Actions, or lack thereof, by other countries to protect shared ecosystem components valued by Canadians.

# Next Steps

- In September, seek comments from Nunavut Wildlife Management Board and Nunavik Marine Region Wildlife Board on proposed Davis Strait fishing closure. Advice requested by October 10.
- Consider all comments and seek Ministerial approval this fall.
- Implement fishing closure for 2018 fishing season.



# Comments/Questions

# SUBMISSION TO THE

# NUNAVUT WILDLIFE MANAGEMENT BOARD

# FOR

**Information:** **Decision: X**

**Issue: Clyde River HTO Request to increase the Arctic char commercial quota for Sam Ford Fiord to 9000kg**

**Background:**

The Clyde River Hunters and Trappers Organization (HTO) has requested an increase for the Arctic Char commercial quota of Sam Ford Fiord from 4500 kg to 9000kg. The commercial arctic char quota identified in Schedule V of the NWT Fishery Regulations for Sam Ford fiord is 3600kg. Based on science advice provided by the Department of Fisheries and Oceans (DFO) in 1995, the quota was varied to 4500 kg. In 1999, the Clyde River HTO requested the Nunavut Wildlife Management Board (NWMB) increase the commercial arctic char quota to 6800 kg. DFO advised that an increase to 6800kg would be a high risk option for overfishing the stock (see attached 1999 DFO submission to the NWMB). DFO identified a medium risk option (increase to 5500 kg) and a low risk option (remaining at 4500 kg). The NWMB approved an increase of 5500kg, and the fishery was opened under Variation Order at that quota in 1999/2000. Since that time, the waterbody has been opened under Variation Order at quotas ranging from 3600kg-5500kg (Table 1).

| Year | Quota (kg) | Reported Harvested Quota (kg) |
|---|---|---|
| 2016/2017 | 4500 | 4,500.00 |
| 2015/2016 | 4500 | No Info |
| 2014/2015 | 4500 | No Info |
| 2013/2014 | 4500 | No Info |
| 2012/2013 | 4500 | 851.81 |
| 2011/2012 | 4500 | 198.64 |
| 2010/2011 | 4500 | No Info |
| 2009/2010 | 4500 | No Info |
| 2008/2009 | 4500 | No Info |
| 2007/2008 | 4500 | 631.82 |
| 2006/2007 | 4500 | 1,455.00 |
| 2005/2006 | 3600 | 1,518.63 |
| 2004/2005 | 3600 | No Info |
| 2003/2004 | 3600 | 3,203.36 |
| 2002/2003 | 3600 | 4,256.06 |

| | | | |
|---|---|---|---|
| 2001/2002 | 5500 | 3,791.13 | |
| 2000/2001 | 5500 | 4,248.80 | |
| 1999/2000 | 5500 | 18,817.51 | Probable Data Error |
| 98/99 | 4500 | 3,448.13 | |
| 97/98 | 4500 | 3,708 | |
| 96/97 | 4500 | 2,108 | |
| 95/96 | 4500 | 4,356 | |
| 94/95 | 4500 | 6,182 | |
| 93/94 | 3600 | 4,220 | |
| 92/93 | 3600 | 3,600 | |
| 91/92 | 3600 | 400 | |
| 90/91 | 3600 | 228 | |
| 89/90 | 3600 | 227 | |
| 88/89 | 3600 | 625 | |
| 87/88 | 3600 | 4,035 | |
| 86/87 | 3600 | 3,500 | |
| 85/86 | 3600 | 1,805 | |
| 84/85 | 3600 | 1,200 | |
| 83/84 | 3600 | 997 | |
| 82/83 | 3600 | 1000 | |
| 81/82 | 3600 | 907 | |

Table 1. Commercial arctic char quota for Sam Ford Fiord and reported harvest Fisheries and Oceans (DFO) - Science advice remains unchanged from 1999 for Sam Ford Fiord. This population is considered at moderate risk[1] of harm from fishing at a level of 5500 kg.

The five-year exploratory fishery protocol is used to provide information on the viability of a commercial fishery in a particular waterbody. It requires sustained harvest annually of the quota over the five-year period and a comparison of biological characteristics of the fish caught at the start and at the end of the five-year period. Changes to the population structure following sustained levels of harvest may indicate that the level is not sustainable. However, if the harvest over that period does not change indicators of population health, then a higher level of harvest may be sustainable. Harvest of the full quota annually is necessary for this approach.

[1] Moderate risk: some information is missing which would allow for the assessment of the health of the stock. We think fishing at this level may not adversely affect the stock; however, it is very important to collect data from any harvest that occurs. It is also important to reassess the stock once biological data has been collected and analyzed.

**Recommendations:**

Based on a review of the available information and 1999 science advice and assuming the subsistence harvest remains unchanged on the waterbody, DFO's view is there continues to be a moderate risk to the Arctic Char population in Sam Ford Fiord at commercial harvest level of 5500 kg and a high risk to the population if the commercial quota was increased to 9000kg.

The fishery should be monitored to assess the effect of the harvest level on the stock and the following conditions implemented:

- The fishery should follow the exploratory fisheries five-year approach, with all samples and data being submitted annually to DFO-Science in Winnipeg;
- Minimum gillnet mesh-size of 5 ½ inches employed.

**Consultations:** A. McPhee and J. Moyer (DFO Resource Management – Winnipeg).

**Prepared by:** Jeremiah Young
Fisheries Management Technician
Fisheries and Oceans Canada
Northern Operations

**Date:** Aug. 1, 2017

**Attachment:**

ATTACHMENT:

## DFO 1999 Submission to the NWMB for Decision

**Issue:**

Request from the Clyde River HTO to increase the Arctic char commercial quota for Sam Ford Fiord.

**Background:**

DFO received a letter from the NWMB to assess a request for an increase in the commercial Arctic char quota for Sam Ford Fiord. The request from the HTO is to increase the commercial quota from 4500 kg to 6800 kg – a 50% increase in the quota. The fishery targets the Walker Arm River Arctic char stock (Shane Sather, DSD Officer, Clyde River, pers. comm.). Walker Arm is regularly fished commercially with an Arctic char quota of 4500 kg/year (see Table next page). Walker Arm also supports an important subsistence fishery. The Nunavut Harvest Study indicates that the reported total (domestic and commercial combined) Arctic char harvest is 13000 kg/year (preliminary results, Johnny MacPherson, NWMB pers. comm.). The reported domestic harvest for Walker Arm is then approximately 8500 kg/year.

It is important to note that there are discrepancies between the size of the total harvest reported in the Nunavut Harvest Study and the one reported by the HTO secretary manager and the local Renewable Resource Officer. While the Nunavut Harvest Study indicated an average yearly reported harvest of 13000 kg (including commercial and domestic catches), the HTO and local RRO report total catches of less than 5500 kg (4500 kg commercial and 1000 kg domestic). The ongoing Nunavut Harvest Study will yield useful information on the total Arctic char catches from Sam Ford Fiord.

In Nunavut, Arctic char populations appear to be able to sustain a harvest of about 5%-10% annually. If the current level of the domestic and commercial fisheries obtained from the Nunavut Harvest Study is accurate (i.e. 13000 kg or 4800 fish), a population of 50000-100000 is needed to sustain the present harvest. More information should be collected on the size of the domestic fishery before increasing the commercial harvest. Because of the important domestic fishery at this location, care must be taken to ensure that the commercial fishery does not impact on the domestic fishery.

We have little biological information on the Arctic char population of Sam Ford Fiord. Interviews with fishermen (C. Read, DFO Winnipeg, unpublished information) indicated that the fish number and size had changed little over the last 30 years. A sample of 100 Arctic char was taken in 1997-98. The average length and weight were 62.5 cm and 2.7 kg respectively. 42 Arctic char were sampled for length and weight in 1993-94 and their sizes were not significantly different than what was obtained in 1997-98. From the little information we have, the stock does not appear overexploited.

The following table illustrates the annual commercial catches from Sam Ford Fiord from 1977 to 1998. Unpublished data from the Department of Fisheries and Oceans Commercial Harvest Statistics.

| Year | Quota kg (round) | Taken kg (round) | % Taken |
|---|---|---|---|
| 77/78 | 3629 | N/A | N/A |
| 78/79 | 3629 | 472 | 13 |
| 79/80 | N/A | N/A | N/A |
| 80/81 | 3629 | N/A | N/A |
| 81/82 | 3600 | 907 | 25 |
| 82/83 | 3600 | 1000 | 28 |
| 83/84 | 3600 | 997 | 28 |
| 84/85 | 3600 | 1200 | 33 |
| 85/86 | 3600 | 1805 | 50 |
| 86/87 | 3600 | 3500 | 97 |
| 87/88 | 3600 | 4035 | 112 |
| 88/89 | 3600 | 625 | 17 |
| 89/90 | 3600 | 227 | 6 |
| 90/91 | 3600 | 228 | 6 |
| 91/92 | 3600 | 400 | 11 |
| 92/93 | 3600 | 3600 | 100 |
| 93/94 | 3600 | 4220 | 117 |
| 94/95 | 3600 | 6182 | 172 |
| 95/96 | 4500 | 4356 | 97 |
| 96/97 | 4500 | 2108 | 47 |
| 97/98 | 4500 | 3708 | 82 |
| *Total:* | 74787 | 39570 | 53 |

Note: In 1996-97 and 1997-98, HTO and RRO reported that the quota was reached. However DFO files reported that the commercial quota was not reached.

**Options:**

| | | |
|---|---|---|
| Option 1. | Low Risk | The low risk option for this fishery is to leave the commercial quota at 4500 kg. The fishery has never been assessed before. We should treat this fishery as experimental. We have data from the commercial fishery of 1997-98 that could be compared to samples that would be collected in 2002-03. Better information should be collected on the importance of the domestic fishery at this location. The data from NWMB Harvest Study suggests that this waterbody is an important source of food for the community and as such should be managed to preserve the domestic fishery. **DFO recommends this option.** |
| Option 2. | Medium Risk | The quota for this waterbody could be raised marginally to 5500 kg. This will allow somewhat more commercial fish available with any potential impacts to be small enough to be recognized before serious problems exist. Periodic monitoring of the catch would help assess the impact any increase in harvest is having on the fishery. |
| Option 3. | High Risk | If the quota go up to 6800 kg, the potential for overfishing the stock and the impacts on the subsistence fishery become more serious. We have no data to determinate if the fishery can sustain a commercial harvest this large without having an impact on the subsistence fishery. **DFO recommends against this option.** |

Prepared by:

Patrice Simon
Fisheries Management Biologist and
DFO Nunavut Area Office DFO Winnipeg

# SUBMISSION TO THE NWMB

# FOR

# An increase to the Cumberland Sound TAH

Submitted By

**Cumberland Sound Fisheries Ltd.**

## AUGUST 4, 2017

**Cumberland Sound Fisheries Ltd .**
PO Box 185
Pangnirtung, NU
X0A 0R0

**Nunavut Wildlife Management Board**
3rd Floor, 1106 Ikaluktuutiak Drive
P. O. Box 1379
Iqaluit, NU
X0A 0H0

August 4, 2017

Dear Sir/Madam:

Attached please find our request to increase the **Cumberland Sound Inshore Turbot Quota.**

We are projecting that the full inshore quota (500 MT) will be harvested in the 2018 Winter Fishery. Therefore, we are requesting that the **Cumberland Sound Inshore Turbot** quota be increased to accommodate the developing Summer Fishery.

To support our commitment, CSFL has purchased a 40' inshore fishing vessel, the f/v Pijiua II. It is anticipated that additional vessels will also be part of this developing fishery.

To ensure the successful development of the Summer Fishery and the continued development of the Winter Fishery, there is a need to increase the TAH in Cumberland Sound. We are proposing that the quota be increased to 1,000MT, from the current level of 500MT.

We trust that the Nunavut Wildlife Management Board agrees with out assessment and supports our request to increase the Cumberland Sound inshore quota.

We are available to meet with NWMB staff if further clarification is necessary and/or to present our case.

Sincerely,

for Joopa Sowdlooapik
Chairman
*Cumberland Sound Fisheries Ltd.*

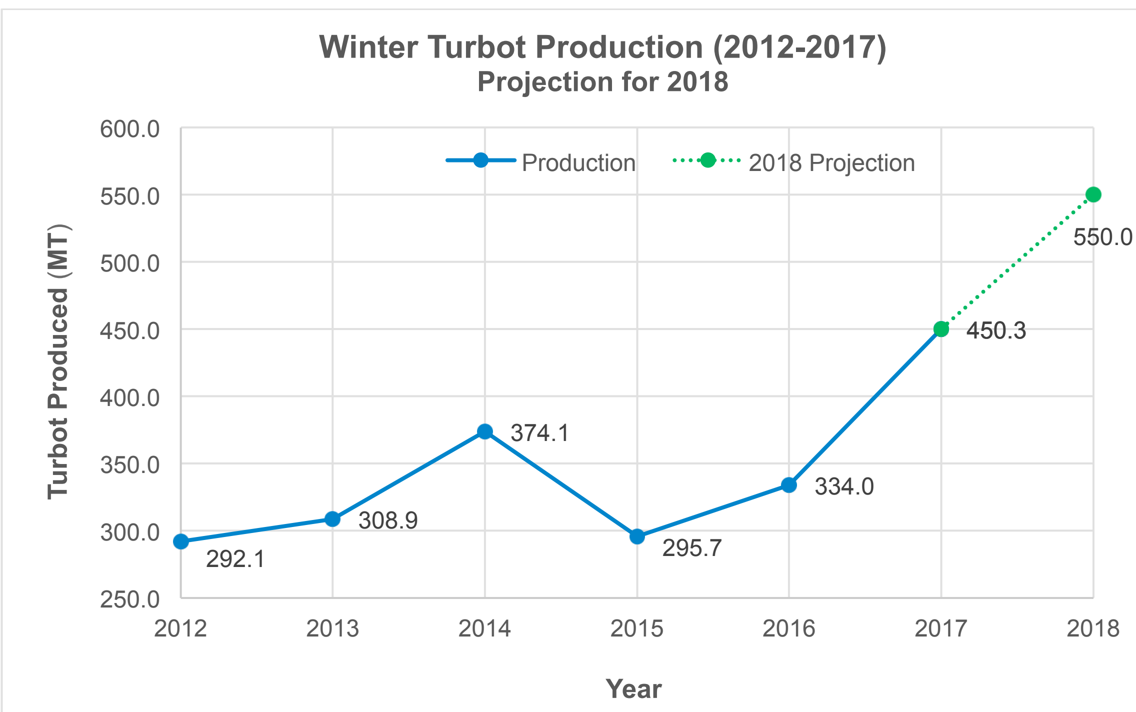
## Table of Contents

# 1. Background

## 1.1 Winter Fishery

The winter fishery in 2017 has been the most successful to date, with landings of 450MT (from the 500MT Cumberland Sound Allocation). It is estimated (see chart below) that the Winter fishery in 2018 will meet the current quota of 500MT for the inshore fishery in Cumberland Sound.

| Year | Amt Processed (MT) |
|---|---|
| 2012 | 292.1 |
| 2013 | 308.9 |
| 2014 | 374.1 |
| 2015 | 295.7 |
| 2016 | 334.0 |
| 2017 | 450.3 |
| 2018 | 550.0 |



It is anticipated that a Summer fishery will start in 2018 and the inshore quota in Cumberland Sound will need to increase to support the industry's continued development.

## 1.2 Cumberland Sound Border

The border for the Cumberland Sound Turbot Management Area (CSTMA) has been moved (see below) as requested by PHTO in May 2013, and approved by The Minister of Fisheries in 2014. The CSTMA now includes all of Cumberland Sound. This move will provide harvesters with more flexibility, and opportunities to pursue other species that may become available.

The move of the CSTMA border is very positive for NU's developing fishery, and, the CSTMA border move is in line with NWMB's mission of "conserving wildlife through the application of Inuit Qaujimajatuqangit (IQ) and scientific knowledge", and is in line with the NWMB's vision to make Nunavut 'a world class model for the cooperative management of healthy wildlife populations".

As previously established, harvesting within Cumberland Sound is 'hook and line' only and the use of gill nets is not permitted. Vessel size is also limited to <85'. These harvesting restrictions contribute to Cumberland Sound being a world-class model of cooperative management, which contributes to a healthy, sustainable resource.

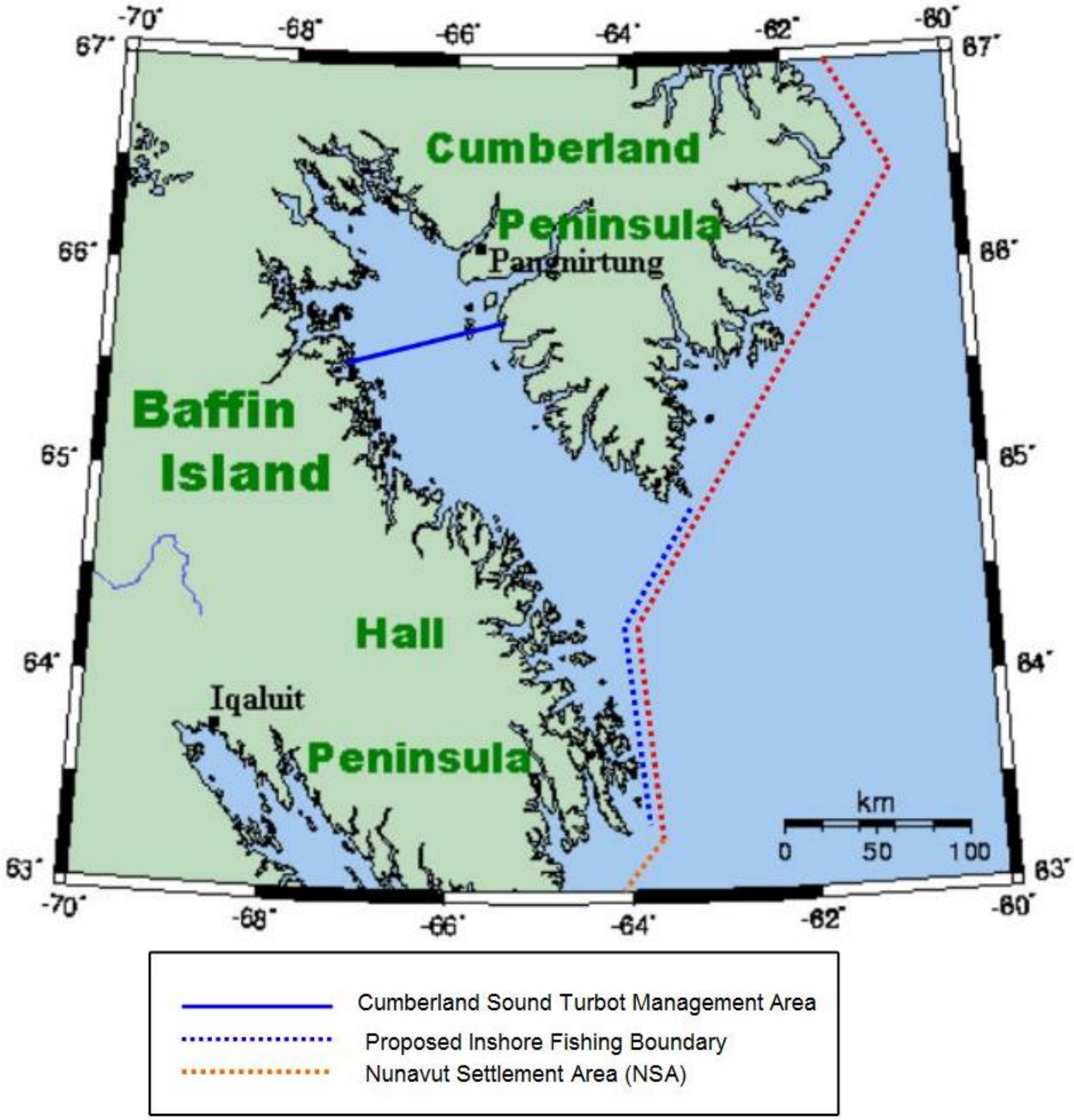
CSFL is requesting that the Inshore turbot quota be increased to1,000 MT, from the current quota of 500MT. This increase is required to support the growing Winter fishery as well as the fledgling Summer fishery, which will start in 2018.

### 1.2.1 Consultation

Consultation was made by telephone and e-mail to the following:

1. Kevin Hedges, DFO Winnipeg
2. Charlotte Sharkey, DFO Iqaluit

### 1.2.2 Map Of Cumberland Sound



The reasons that were used to justify the extension of the fishing boundary in Cumberland Sound also support the proposed inshore quota increase as follows:

1) IQ information supports increasing the Cumberland Sound turbot quota. The NWMB's mission is "conserving wildlife through the application of Inuit Qaujimajatuqangit (IQ) and scientific knowledge." Increasing the quota as propose does not negatively impact on conservation.

2) The current fishery is developing & growing. There may be other species, including a summer fishery for Turbot, that can be pursued in the future thus further enhancing the local (Pangnirtung) economy; and

3) The NSA already has the 12-mile boundary outside Cumberland Sound.

Increasing the quota in Cumberland Sound also supports the goal of the Nunavut Land Claims Agreement: to encourage self-reliance. Local harvesters will have more opportunity to fish Turbot, and possibly other species thus benefiting the residents of Pangnirtung.

It should be noted that Cumberland Sound harvesting is already a model for others in that NO gillnets are permitted in the Sound. Only 'hook and line' fishing is permitted.

This request is reasonable and within the NWMB's mandate. Extension of the fishing boundary to the already existing NSA 12-mile limit is also reasonable and will enhance the economic opportunities available to the people of Pangnirtung. While enhancing the turbot fishery, the potential to develop new fisheries in Cumberland Sound will also be possible.

Further developing a summer fishery will contribute to the local fish processing operation at Pangnirtung allowing for an extended operating season.
**This request also supports the Goal of Nunavut Land Claims Agreement: To encourage self-reliance.**

## 1.3 Harvesting Capacity

At present, there are 60 active fishers in the Winter Fishery with a total of 90 licenses issued from DFO. 30 employees are employed at the plant, Pangnirtung Fisheries Limited

To support the Summer Fishery, CSFL's has purchased a vessel, the f/v Pijiuja II (see Appendix #1)

### 1.4 NWMB Discussion

Leading up to the preparation of this report, discussions were held with the NWMB. The following was recommended by staff of the NWMB:

"As a total allowable harvest has been established for the Cumberland Sound turbot fishery, you would have to submit a request to the NWMB for an increase to this total allowable harvest (from 500t to 550t). I've attached the NWMB's governance manual, which outlines what we require to be included in such a request (see Section 4.4). In particular, we would need you to submit:

1. A clearly written statement of what NWMB decision the proponent is seeking;

2. The best available western scientific, *Inuit Qaujimajatuqangit* and/or community information related to the Proposal, including the reasons in support of the Proposal, as well as relevant evidence - and argument, if the proponent wishes - to reasonably justify the proposed decision;

3. A reasonably-detailed summary of what relevant consultations have been undertaken, and with whom – including a report of the matters consulted on, the views raised by those consulted, and the results of the consultations; if Government is the proponent, or one of the proponents, it should also indicate, where appropriate, what accommodations, if any, it has made as a result of the consultation process;23

4. If the matter is urgent or otherwise time-sensitive, the provision of reasons and supporting evidence for fast-tracking the Proposal; and

5. All of the above translated into English or Inuktitut (Inuinnaqtun), as the case may be – except that supporting documentation over 10 pages in length need not be translated if accompanied by a reasonably-detailed, translated summary."

## 2. Request to NWMB

CSFL is requesting that the Turbot TAH in Cumberland Sound be increased from the current level of 500MT to 1,000MT.

The primary reason for this request is that additional allocation is required to support the ongoing Winter fishery in Cumberland Sound. There are 90+ (60 active in 2017) licensed harvesters involved in the Winter fishery and the landings (see graph) are nearing the quota allocated to the inshore harvesters in CS.

The secondary reason for this request is that a quota increase is required for the following reasons:

1) To further support the developing Winter fishery: &
2) To support the development of a successful Summer fishery.

Since the Plant started in the 80's (or earlier?) our fishery has continued to develop, and we are known throughout the world for our quality. In order to continue our successful development, additional allocation is required to support the developing Summer Fishery in Cumberland Sound. In 2017, 450MT was landed in the Winter Fishery.

# 3.0 Science & Inuit Qaujimajatuqangit (IQ)

Consultation was made by telephone and e-mail with the following DFO staff:

1. Kevin Hedges, DFO Winnipeg
2. Charlotte Sharkey, DFO Iqaluit

## 3.1 Turbot

Appendix II contains a copy of correspondence with Mr. Hedges, DFO Winnipeg

## 3.2 Cumberland Sound

Re; Section 1.2

# 4. Consultations

## 4.1 People of Pangnirtung

This request is supported by the Municipality of Pangnirtung and the PHTO as the inshore turbot fishery has been developing over the last few years.

## 4.2 DFO

See Appendix II.

# 5. Timing 2018

It is anticipated that the Summer inshore turbot fishery will start in 2018.

# 6. Summary

Overall, CSFL feels that this request is reasonable and required as the fishing industry in Cumberland Sound continues to evolve.

# 7. Appendices

# Appendix I Inspection and Valuation of Fishing Vessel by RCG Marine Consulting

*Note : Formatting and image quality has been changed from the original document

## Inspection and Valuation of Small Fishing Vessel: Pijiuja II

Pangnirtung, Nunavut

August 28, 2016

## Introduction

On August 11, 2016, a representative of Cumberland Sound Fisheries Limited approached RCG Marine to conduct a basic survey and valuation of the small fishing vessel “Pijiuja II” for the purposes of purchasing the vessel for inshore fishing in the Cumberland Sound Region. The vessel was attended during the period of August 21-23, 2016 and a basic marine survey, inspection and examination was conducted of the vessel located at Pangnirtung, Nunavut. At the time of the inspection, the subject vessel was viewed out off the water. The purpose of the survey was to identify the general condition of the vessel, present insurable value, and to identify any defects or damages to its structure and equipment.

A preliminary examination of the hull, superstructure, internal scantlings, and mechanical equipment was conducted. As well, all ancillary equipment, including electrical, electronic and hydraulic equipment was powered and tested. The results of this inspection and observation are contained in this report. As well an estimated asset valuation was determined from the inspection process and is included in this report.

## Vessel History

The fishing vessel Pijiuja II is a traditional maritime small fishing vessel, built in 2013 for the owner at Cheticamp Boatyard, in accordance with the Small Fishing Vessel Regulations as outlined under the Canada Shipping Act 2001 (CSA 2001). The owner's intention was to prosecute the exploratory inshore turbot fishery recently permitted by federal regulation in the Cumberland Sound area. The vessel was completed and delivered to the owner in the late summer of 2013. However, as a result of low fish prices and heavy ice coverage in the area, the Pijiuja II did not enter the fishery and has spent the last two seasons laid up, in cradle at Pangnirtung, Nunavut. The vessel has received very little commercial sea going time and as a result has been put for sale by the owner. The vessel is approximately 39' in length and is registered as less than 15 gross tons (GRT) with a traditional "Cape Island" hull design commonly employed in the inshore fishing industry on Canada's East Coast. Although, properly winterized and well attended, the vessel has been subjected to several harsh northern winters, therefore a thorough examination, including the powering of all equipment was undertaken. The results of this inspection process are categorized in this report.

## Vessel Particulars

| | |
|---|---|
| Surveyor | RCG Marine |
| Name Of Vessel | Pijiuja II |
| Date Of Survey | August 22, 2016 |
| Hull Design | Maritime "Cape Island" |
| Construction Material | FRP - Fibreglass Hull, |
| Builder | Cheticamp Boat Yard/Bruno Gaudet |
| Vessel Type | Small Fishing Vessel |
| Engine Type and Horse Power | Cummins Diesel- 300hp - 2013 |
| Year Built | 2013 |
| LOA | 38'11" |

| | |
|---|---|
| Beam | 15’9” |
| Draft | 4’ |
| Hull Colour | Blue |
| Superstructure Colour | White |
| DC Power | 12 volt |
| AC Power | 120 Converter |
| Holding Tank | N/A |
| Fuel Tank | Approx. 500 gal |
| Water Tank | 40 gal |
| Weight | 13.9 GRT |
| Ballast | N/A |
| Hailing Port | Iqaluit, NU |
| Survey Completed for | CSFL |

## Hull and Deck

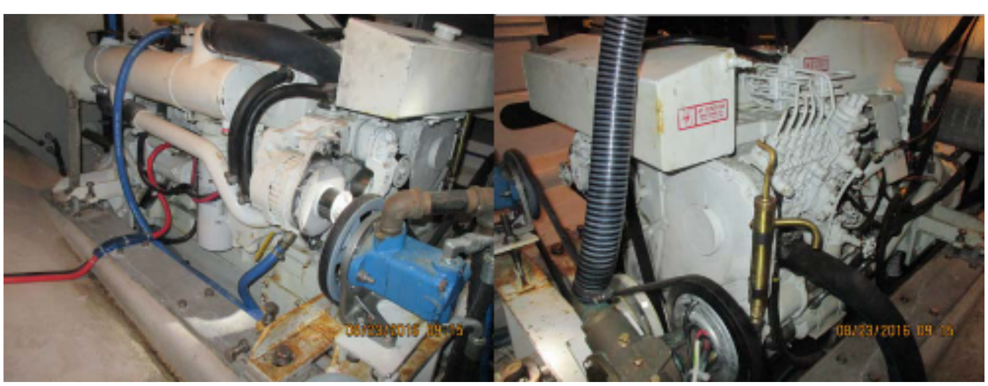
The exterior hull and deck was visibly inspected and both were found to be in excellent, like new condition. The vessel has received such little time in-service that no apparent, normal wear and abrasion of several years’ vessel activity were visible. The hull below the waterline was inspected and no damage was apparent. Externally, the hull to deck assembly was found to be in excellent condition no distortion apparent in any areas. The original paint has not peeled or worn and there is no evidence of marine growth on the hull. All deck fittings, stem fittings, mooring cleats, life rails, stanchions, hatches, and cleats were inspected and found in good condition. The original corrosion anodes are in excellent condition as well. All deck area, rails and fittings are in excellent condition and are have no visible signs of wear. See photos (1 &2).


**Photo 1 & 2 (Vessel Profiles)**

## Engine

The vessel is powered by a 300 horse power, Cummins diesel engine that was manufactured and installed in 2013 during the new build process. The engine is in like new condition and has a service reading of 397.5 hours. The manual indicates that this engine should have an initial servicing at 250 hours which was completed and recorded onboard. The engine space is in clean condition with no wear evident, with minimal surface rust.

The engine was de-winterized and prepared for start-up. Initially, it was difficult to perform a start-up, since the battery bank was found to be low of stored power with some battery cells completely dry. When the batteries were replaced, the engine was fired up and running from the first start cycle in mere seconds. The engine ran smooth immediately and ran at the correct operating temperature. The engine compartment is clean and dry and in excellent condition. There are also, available a considerable selection of spare belts and parts as well as fuel and engine filters, that were purchased with the new vessel, that represent good value.



**Photo’s 3 & 4 (Engine)**

## Navigational Equipment and Electronics

All of the vessels navigational equipment was powered up and tested. The Charting system, Radar, Sounders and GPS units were all found to be in good working condition when powered. All other bridge console equipment was found to be in excellent condition and in good working order. All appendage fittings for the Radar, GPS units and Transducers were checked and were found to be in excellent condition and in good working order.

**Photos 5 & 6 (Electronic Navigational Equipment with Exterior Appendages)**

## Electrical Panel and Equipment

The vessel’s electrical system and equipment was powered and tested, including all navigational lights, cabin lights, gauges and power converters. The electrical panel is like new with no visible signs of damage and all breakers, switches and power outlets were checked and observed as operational.

**Photos 7 & 8 (Electrical panel and Power Converter)**

## Steering and Propulsion Systems

The steering and propulsion systems were examined and found to be in excellent condition and both were working freely. The steering flat was clean and steering rams presented as like new. The rudder and assembly presented in excellent condition as well. The propeller blades, shafting and stuffing box also presented as like new condition. There was no visible damage in any of these areas, as evidenced from the pictures below. There is no visible corrosion or rusting to any of the assembly.


**Photo’s 9 & 10 Steering Flat and Rudder**


**Photo’s 11 & 12 (Stuffing Box and Shafting)**

## Port and Starboard Fuel Tanks

The port and starboard fuel tanks were examined and presented as in excellent condition. The tanks are clean, free of rust and both fuel shut offs and tank drains were functional. As well the fuel lines and filters indicate a clean and corrosion free status.

**Photo's 13 & 14 (Port and Starboard Fuel Tanks**

**Photo's 15 & 16 (Fuel Filters and Fuel Lines)**

## Cabin and Interior

The internal cabin and bunking area is clean and dry and presents in excellent condition. There is no evidence of any moisture or mildew and the area is as "built".


**Photo's 17 &18 (Cabin, Bunks and Sink Area)**

## Safety Equipment

The vessel has been initially equipped with a full suite of safety equipment that would exceed the Transport Canada; Small Fishing Vessel Regulations requirements, including the following:

1. One six person life raft which appears to be in good condition, however, the service date is for June 2014, therefore a service re-pack, prior to operating the vessel will be required.

2. Six, universal size, Immersion suits in like new condition; not photographed.

3. One Class I, Float Free EPIRB. This unit is operational and has a battery service date of December 2018.

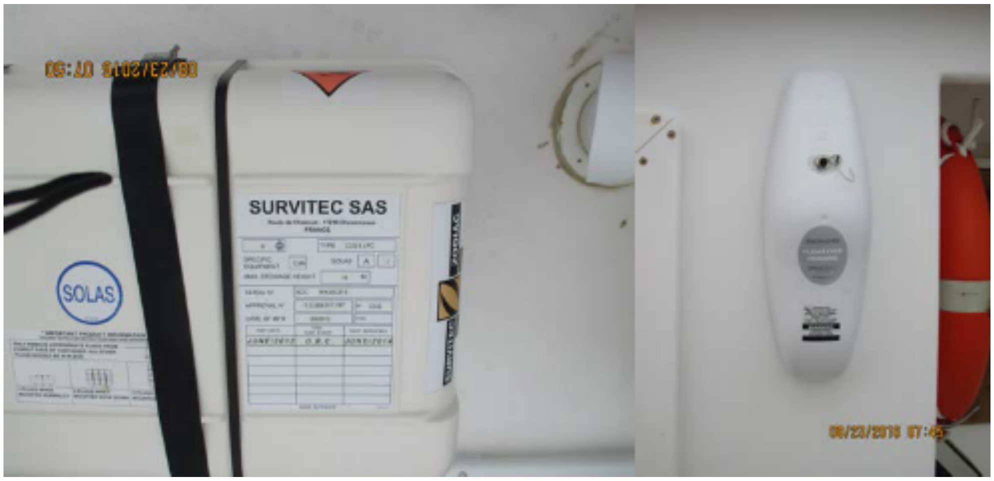
4. Six Transport Canada approved Life Jackets and Six Personal Flotation Vests. (new condition).

5. One lifebuoy fitted with 27 m of line and two Anchors with 100 metres of chain and rope.

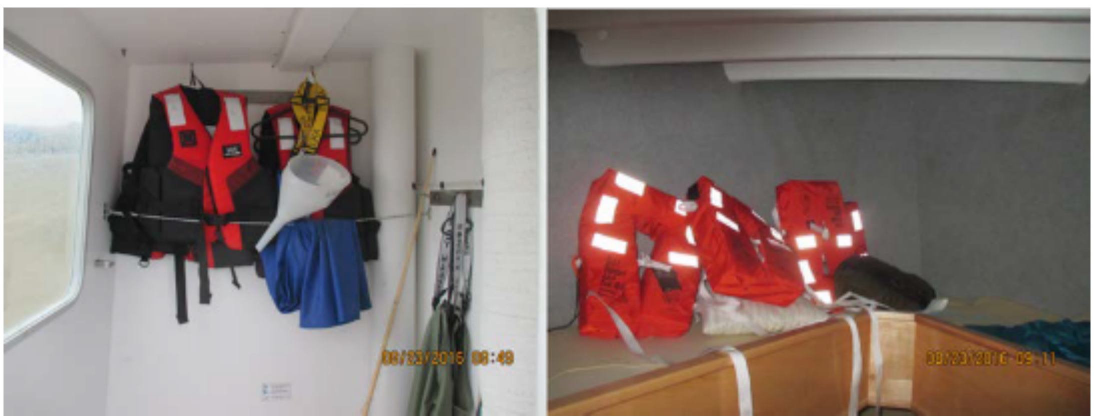
6. Two 4.5 L foam fire extinguishers and one fire bucket.

7. Two First Aid Kits and one Flashlight.

The only safety equipment that was not observed were the required Transport Canada approved, self -igniting flares. These flares are dangerous goods and were stored at the current owner's premises and unavailable for examination.




**Photo's 19 &20 (Life Raft and EPIRB)**



**Photo's 21 &22 (Life Jackets and PFD's)**

## General Observations and Recommendations

**1.** Twenty Two photographs included in this report document the vessel's current physical condition as in good to excellent. This vessel is less than three years old and has not been in service, except for a minimal amount of time during the 2013 operating season, following delivery. This is evidenced by the fact that there are merely 397.5 actual running hours. This would amount to less than 3 - 4 weeks of actual operation. This is further evidenced by the lack of any marine growth lines that are normally observed on any vessel after an operating season. In its service life, this vessel has never required a hull cleaning.

**2.** The engine and equipment is in excellent condition and has been serviced as required by the manufacturer. Oil and filter changes have been followed as recommended as well. The quick startup, following the insertion of new batteries indicates the engine has no deficiencies. The exhaust stack is constructed of stainless steel and presents in excellent condition, however the stack should be covered for protection during winterization and to prevent leakage from the elements into the engine and engine compartment.

**3.** The only visible damage to the vessel is several cracked windows in the working deck area due to vandalism. This damage is not structural and when the glass is replaced will present in excellent condition. A maintenance schedule would also be good practice.

**4.** All of the safety equipment that requires servicing (life rafts and flares) should identified and be sent out at the seasons end for servicing. This equipment is mostly dangerous goods and it is much more economical to receive certification for the following season via sea freighting.

**5.** The vessel had a coating of fine dust over the entire superstructure and some had penetrated the cabin area. If left this fine gravel type substance could cause some damage to moving machinery parts as well as failure of electrical and electronic equipment. Shaft and equipment greasing's and light oiling of machinery should continue to occur at regular intervals. Protective tarping could be added around the wheelhouse.

**6.** While the hydraulics onboard the vessel were powered, tested and found to be in excellent working condition, the fishing gear was stored at the current owner's premises, therefore no comment can be afforded to the condition of this equipment.

**7.** The vessel is currently stored in a small and insufficient cradle for the harsh winter weather experienced at Pangnirtung. It is recommended that the new owners upgrade the existing boat cradle for long term seasonal storage stability. In the interim, additionally blocking would ensure the vessels continued stability while dry docked.

## Vessel Valuation

The new build costs, for the small fishing vessel **Pijiuja II** when completed in the spring of 2013 was determined at an overall costing of approximately $280,000.00. This costing did not include the vessel required safety equipment or spare parts and fishing gear, all of which are currently offered in the purchase. This equipment and spares was valued at approximately $25,000. The vessel was therefore valued at approximately $300,000.00 when completed as a new build. Much of this value remains with the vessel, however, it is normal practice to depreciate a new vessel approximately 15 % in the first 2- 3 years of service life, given that in many cases equipment warranties are limited to a 1,3 or 5 year terms. Therefore an average value for this vessel would be approximately $ 250,000.00. This valuation is based on the vessel's current condition as presented at Pangnirtung on August 21-23, 2016.

R. Gibbons MMS FM I September 14, 2016

RCG Marine Consulting

# Appendix II
# DFO Consultation Emails

**From:** "Hedges, Kevin J" <Kevin.Hedges@DFO-MPO.GC.CA>
**Date:** Wed, 19 Jul 2017 21:34:19 +0000
**To:** "T. Paul Hiscock" <paul@atlanticasolutions.com>
**Cc:** "Panipak, Joanna" <Joanna.Panipak@dfo-mpo.gc.ca>, sakiasie sowdlooapik <Sowdlooapik@hotmail.com>
**Subject:** RE: Latest DFO science on turbot

Hello Paul,

We survey the offshore component of NAFO SA 0B annually and the stock assessment is conducted through the NAFO Scientific Council.

The Cumberland Sound Turbot Management Area has never had a true stock assessment. In 2011 I started an annual longline survey in Cumberland Sound to generate a fishery-independent stock index. The survey was conducted in 2011-2014; in 2015 we were unable to survey because of heavy ice conditions and in 2016 the survey vessel was unavailable and I couldn't find a suitable replacement. I am planning to conduct the longline survey again this year and next year, and then in fall of 2018 or winter of 2019 we will conduct a formal stock assessment. DFO has run a plant sampling program to collect demographic data from the commercial catch since the first year of the fishery. Fisher logbooks are also collected to provide data on effort relative to catch and bycatch; not all fishers turn in their logbooks however so we have an incomplete picture.

In conjunction with the fishery-independent survey I have collaborated with Scott Grant (Memorial University) on a bycatch reduction study to reduce Greenland Shark bycatch mortality on longlines, and with Aaron Fisk and Nigel Hussey (University of Windsor and Ocean Tracking Network) to assess habitat use, movement patterns, stock connectivity and trophic dynamics in Greenland Halibut, Greenland Shark and Arctic Skate. The bycatch reduction study is completed. Last year was the final year of the fish tracking study in Cumberland Sound; we are currently working up the data and planning to report our results to DFO Fisheries Management and Pangnirtung early in 2018.

That is a quick overview of recent Greenland Halibut related research in Cumberland Sound. Is there something specific that you are looking for?

Kevin J. Hedges, Ph.D.

Research Scientist
Arctic Aquatic Research Division, Central & Arctic Region
Fisheries and Oceans Canada / Government of Canada
Kevin.Hedges@dfo-mpo.gc.ca / Tel: 204-983-3001

Chercheur scientifique
Division de la recherche aquatique de l'Arctique, Région Centrale et de l'Arctique
Péches et Océans Canada / Gouvernement du Canada
Kevin.Hedges@dfo-mpo.gc.ca / Tél.: 204-983-3001

---

**From:** T. Paul Hiscock [mailto:paul@atlanticasolutions.com]
**Sent:** July-19-17 3:27 PM
**To:** Hedges, Kevin J
**Cc:** Panipak, Joanna; sakiasie sowdlooapik
**Subject:** Re: Latest DFO science on turbot

Hi Kevin:

Looking for the latest info on 0B turbot (particularly Cumberland Sound). Can you help?

Thanks,

Paul Hiscock
Atlantica Solutions Inc

---

**From:** "Panipak, Joanna" <Joanna.Panipak@dfo-mpo.gc.ca>
**Date:** Wed, 19 Jul 2017 19:47:20 +0000
**To:** "T. Paul Hiscock" <paul@atlanticasolutions.com>
**Cc:** sakiasie sowdlooapik <Sowdlooapik@hotmail.com>, "Hedges, Kevin J" <Kevin.Hedges@DFO-MPO.GC.CA>
**Subject:** RE: Latest DFO science on turbot

Good afternoon Paul,

You'll want to get in touch with Kevin Hedges Kevin.Hedges@DFO-MPO.GC.CA
I've also cc'd Kevin.

Jo

---

**From:** T. Paul Hiscock [mailto:paul@atlanticasolutions.com]
**Sent:** July-13-17 9:06 AM
**To:** Panipak, Joanna
**Cc:** sakiasie sowdlooapik
**Subject:** Latest DFO science on turbot

Hi Joanna:

I'm doing some work with the the CSFL/PFL partnership. I'm looking for the latest science on 0B turbot, specifically Cumberland Sound. Any suggestions where I could get that info?

Paul Hiscock
Atlantica Solutions Inc.
647-345-4104

# Nunavut Birthright Corporation

***A Success Story for the Inuit of the Qikiqtani Region***

**Presented to:**

Nunavut Wildlife Management Board

**September 11, 2017**

# Content

1. Purpose of this Presentation
2. Overview of Qikiqtaaluk Corporation (QC)
3. QC’s Involvement in the Fisheries
4. QC’s Share of NU Allocations
5. Use of QC’s Fishery Returns
   - Investing within the Fisheries
   - Investing in other major projects and Inuit employment
   - Giving back to member communities
   - Working with the communities
6. Moving Forward

# Why are we here today

## PURPOSE OF THE THIS PRESENTATION

a) Demonstrate that QC plays an important role in the Nunavut Fisheries, and furthermore in the economic development of Nunavut.

b) Present the investments that QC has been making within the fishery industry but also in other economic areas that benefit all Inuit.

c) Persuade the Nunavut Wildlife Management Board (NWMB) that QC's request for higher fishery quota/allocations is justified and beneficial to all.

# Qikiqtaaluk Corporation (QC)

## HIGHLIGHTS

- Inuit birthright corporation established in 1983
- 100% owned by the Qikiqtani Inuit Association (QIA)
- 30 companies (subsidiaries, joint-ventures, partnership and affiliated)
- More than 81% of the employees are Beneficiaries
- Represents 13 Communities across the Qikiqtani Region and over 14,000 Qikiqtanimuit

## MISSION

- To create meaningful economic, employment and career development opportunities for Inuit.

# Qikiqtaaluk Corporation (QC)

## OUR CORPORATE VALUES

- To own and operate sound businesses that generate profit for today and wealth for tomorrow
- To develop people, create employment and career opportunities
- To contribute to community well-being and wealth generation
- To uphold Inuit values and protect the earth, air and water
- To participate successfully in the emerging global economy
- To foster a strong sense of pride in our businesses and our people

# ᑲᒻᐸᓃᑦ ᐱᓕᕆᕖᑦᑐ ᐊᐅᓚᓂᖕᒋᑦ
# COMPANIES AND SECTORS OF ACTIVITY

## ᑐᑭᖕᒋᑦ / LEGEND

- ᓇᖕᒥᓂᖁᑎᔾᐅᔪᑦ 100% ᓇᖕᒥᓂᖁᑎᖕᒋᑦ QC
  Subsidiaries 100% owned by QC
- ᐹᓇᐅᓯᓚᐅᕐᓱᐊᕐᓂᕐᒧᑦ ᑲᑐᔾᔨᖃᑎᖕᒋᑦ 51% ᓇᖕᒥᓂᖁᑎᖕᒋᑦ QC
  Joint-Ventures Majority owned by QC
- ᐹᓇᐅᓯᓚᐅᕐᓱᐊᖅᑎᐅᖃᑎᒌᑦ
  Joint-Ventures < 51% owned by QC
- ᑲᑐᔾᔨᖃᑎᖕᒋᑦ / Affiliated

## ᓂᐅᕕᕐᕕᒃ, ᑕᐅᕝᔫᒐᑦᑕᐅᑎᓂᖅ ᐱᔨᑦᑎᑏᑦᑐ / RETAIL, TRADE AND SERVICES

- ᕿᑭᖅᑕᓂ ᓂᐅᕕᕐᕕᓕᕆᔨᒃᑯᑦ ᓕᒥᑎᑦ
  Qikiqtani Retail Services Ltd.
- ᕿᑭᖅᑕᓂ ᐃᖅᑲᓇᐃᔭᖅᑎᓕᕆᔨᒃᑯᑦ
  Qikiqtani Resource Agency Ltd.
- ᕿᑭᖅᑖᓗᒃ ᓇᖕᒥᓂᖁᑎᓕᖓᓄᑦ ᐱᕙᓪᓕᐊᑎᑦᓯᓂᕐᒧᑦ ᑯᐊᐳᕇᓴᓐ
  Qikiqtaaluk Business Development Corporation
- ᕗᐲᐱᐅᑦ (2006) ᓕᒥᑎᑦ
  Frobuild (2006) Ltd.
- ᕿᑭᖅᑖᓗᖕᒥ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ
  Qikiqtaaluk Environmental Inc.
- QC ᓯᒃᑲᓖᑦ ᒥᐊᓂᕐᓯᔩᑦ
  QC-Scarlet Security Services Inc.
- ᓛᒐ ᐸᕝᕙᓐ / Larga Baffin Ltd.
- ᑑᕈᒫᓐ ᐅᑭᐅᖅᑕᖅᑐᒥ ᑎᒥᖓ
  Toromont Arctic Inc.

## ᐃᖏᕐᕋᔪᓕᕆᓂᖅ ᑐᓴᐅᒪᖃᑕᐅᑎᔪᐃᑦᑐ / TRANSPORTATION AND COMMUNICATION

- ᕿᑭᖅᑕᓂ ᓯᕗᓪᓕᖅ ᖃᖓᑕᔫᓕᕆᔨᒃᑯᑦ ᓕᒥᑎᑦ
  Qikiqtani First Aviation Ltd. (QFAL)
- ᓄᓇᕗᑦ ᐅᖅᓱᐊᓗᓕᕆᔨᒃᑯᑦ ᑯᐊᐳᕇᓴᓐ
  Nunavut Petroleum Corporation
  - ᐅᖅᓱᖅ ᑯᐊᐳᕇᓴᓐ
    Uqsuq Corporation
- ᓄᓇᕗᒥ ᐅᓯᒃᑕᖅᑏᑦ
  Nunavut Sealink and Supply Inc.(NSSI)
- QC ᑲᓇᑕᒥᐅᓐ (ᖁᖏᑦᑐᖅᑐᑦ)
  QC Canadian (Helicopters)

## ᐃᓪᓗᓕᐅᕐᓂᖅ ᐊᒻᒪᓗ ᐊᖏᔪᑎᓂᒃ ᐱᓕᕆᐊᓂᒃ / CONSTRUCTION AND MAJOR PROJECT

- 3379442 ᑲᓇᑕᒥ ᑎᒥᖓ
  3379442 CANADA INC.
- ᕿᑭᖅᑖᓗᒃ ᓇᖕᒥᓂᖁᑎᖕᒋᑦ
  Qikiqtaaluk Properties Inc.
- ᕿᑭᖅᑕᓂ ᓴᓇᕕᓕᕆᓂᕐᒧᑦ ᑎᒥᖁᑖ
  Qikiqtani Industry Ltd.
- ᐊᑭᐅᖅ ᑯᐊᐳᕇᓴᓐ
  Akiuq Corporation
- ᓴᓇᕙᓪᓕᐊᓂᖅ ᓕᒥᑎᑦ
  Sanavallianiq Ltd.
- NCC ᐹᓇᐅᓯᓚᐅᖅᑏᑦ ᑲᑐᔾᔨᖃᑎᒌᑦ
  NCC Investment Group
- ᓄᓇᓯ ᑯᐊᐳᕇᓴᓐ
  Nunasi Corporation

## ᐃᖅᑲᓗᓕᕆᓂᕐᒧᑦ ᑕᕆᐅᓕᕆᓂᕐᒧᑦᑐ ᐱᔨᑦᑎᑏᑦ / FISHERIES AND MARINE SERVICES

- ᕿᑭᖅᑖᓗᒃ ᐃᖅᑲᓗᓕᕆᔨᒃᑯᑦ ᑯᐊᐳᕇᓴᓐ
  Qikiqtaaluk Fisheries Corporation
- ᐅᓈᖅ ᐃᖅᑲᓗᓕᕆᔨᒃᑯᑦ / Unaaq Fisheries
- ᓯᒃᑯ ᑯᐊᐳᕇᓴᓐ ^ / Sikku Corporation
  - ᑐᓚᒃᑕᕐᕕᒃ ᑎᒥᖓ / Tulaktarvik Inc.
- ᓇᑦᓯᖅ ᐹᓇᐅᓯᓚᐅᕐᓱᐊᖅᑏᑦ ᑯᐊᐳᕇᓴᓐ
  Natsiq Investment Corporation
  - ᐅᑭᐅᖅᑕᖅᑐᒥ ᑕᕆᐅᓕᕆᔨᒃᑯᑦ ᑯᐊᐳᕇᓴᓐ
    Arctic Ocean Development Corp.
- ᐅᑭᐅᖅᑕᖅᑐᒥ ᑭᖑᒃᐸᖕᓂᒃ ᖃᐅᔨᓴᖅᑏᑦ
  Northern Shrimp Research Foundation
- ᐅᑭᐅᖅᑕᖅᑐᒥ ᑲᑐᔾᔨᖃᑎᒌᑦᑐᑦ ᑯᐊᐳᕇᓴᓐ
  Northern Coalition Corporation
- ᓄᓇᕗᒥ ᐃᖅᑲᓗᓕᕆᓂᕐᒧᑦ ᑕᕆᐅᓕᕆᓂᕐᒧᑦᑐ ᐱᓕᖕᒪᒃᓴᐅᑎᒃᓴᓕᕆᔩᑦ ᑲᑐᔾᔨᖃᑎᒌᖕᒋᑦ
  Nunavut Fisheries and Marine Training Consortium
- ᓄᓇᕗᑦ ᐃᑲᖕᒪ ᑯᑕᓕᕆᓂᕐᒧᑦ ᑲᑐᔾᔨᖃᑎᒌᑦ
  Nunavut Offshore Allocation Holders Association

# QC's Fisheries Division

## HISTORY OF QC'S INVOLVEMENT IN THE FISHERY

- **1987:** Northern shrimp licence issued to the Baffin Region Inuit Association Licence - *now held by QC*
- Another licence was issued to Unaaq Fisheries and same year – *the licence is shared equally between QC and Makivik Corporation of Nunavik.*
- **TODAY:**
  - There are 17 northern shrimp licenses in the Canadian Northern Shrimp Fishery.
  - QC has 1.5 of these licenses or almost 9% of all the offshore shrimp in Canada.

# QC's  Fisheries Division

**INITIAL USE OF ROYALTY CHARTER ARRANGEMENTS**

- Common in the early inception of the fishery because access to capital and expertise was a barrier for many licence holders, including QC
- Royalties from offshore licences were invested in building QC's other lines of business and increase Inuit employment

# QC’s  Fisheries Division

## TAKING OWNERSHIP

- As its royalty charter arrangement was ending, QC decided to participate directly in the northern shrimp fishery and in 2004 purchased a 64 metre vessel and created the company Qikiqtaaluk Fisheries Corporation (QFC)
- In addition to its shrimp licences, QC also has 0A/0B turbot and shrimp allocations which it receives through the NWMB Access and Allocation process
- QFC fishes all of its fishable fish quotas, including shrimp and turbot, **secured by QC from Nunavut and Non-Nunavut allocation holders**

# QC's Fisheries Division

## MV Saputi

- Multi species mobile gear vessel; turbot and shrimp
- Built in 1987, and extended in 2012 from 64 metres to 76 metres
- Carrying capacity: turbot 900t or shrimp 600t
- Average daily production: turbot 35t or shrimp 50t

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QIKIQTAALUK FISHERIES

# Commercial Fishery

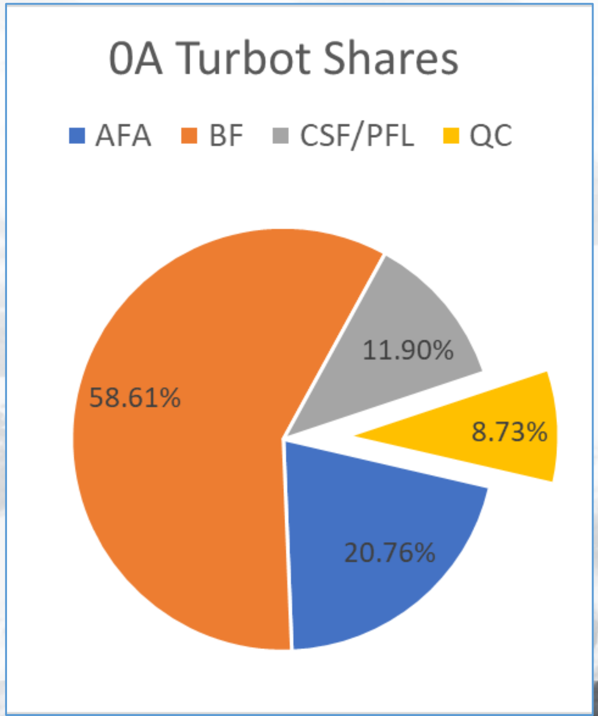
**QC participates in two distinctive commercial offshore fisheries:**

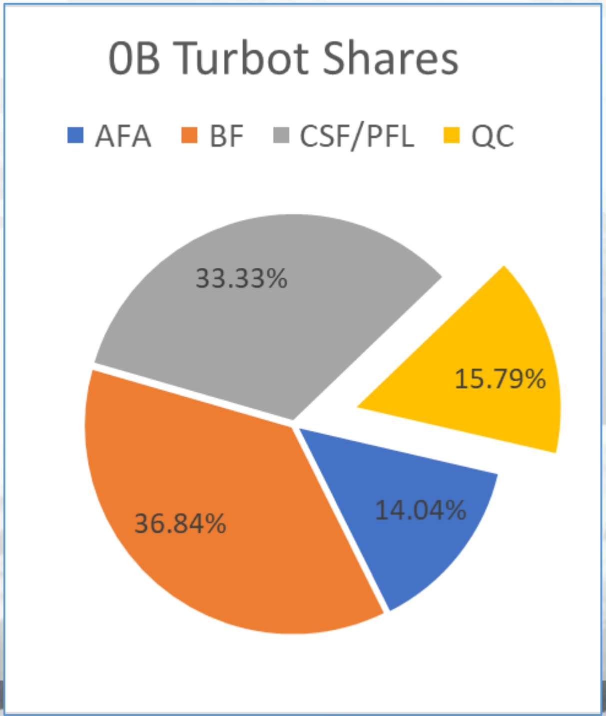
- Northern Shrimp Fishery

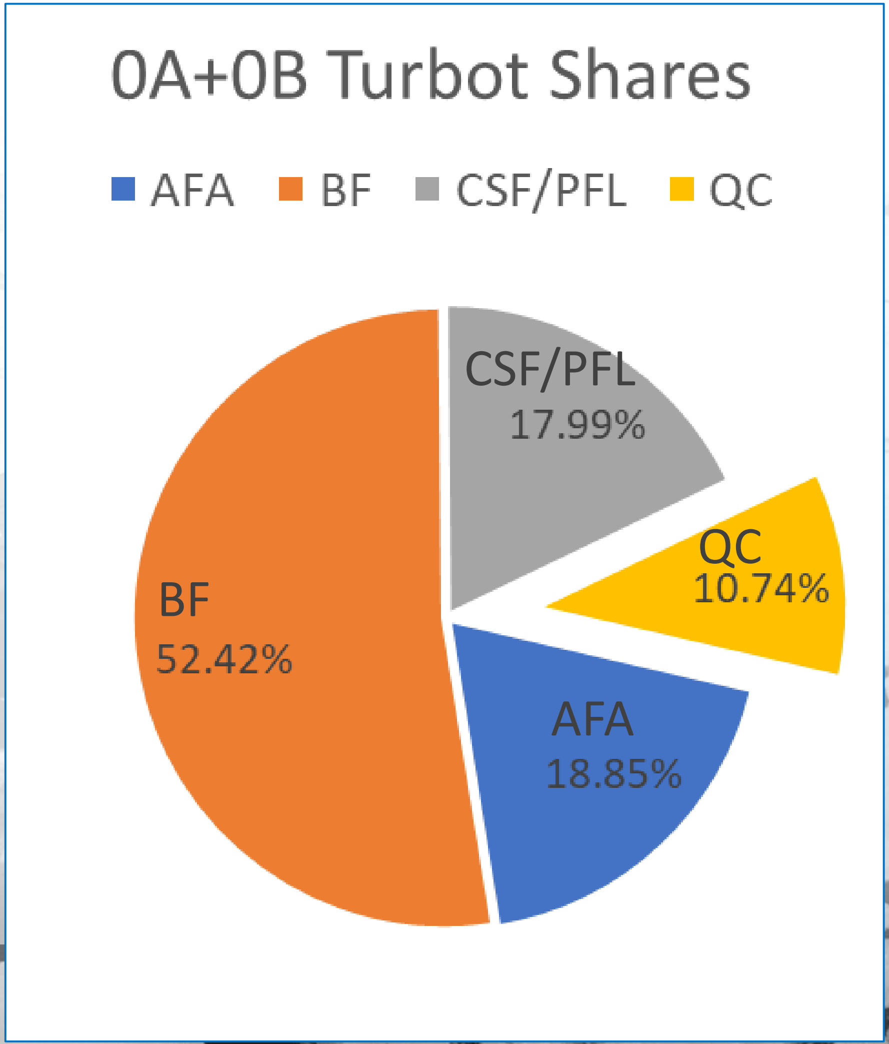
- Greenland Halibut (Turbot) Fishery

# QC's Share of NU Allocations

## GREENLAND HALIBUT (TURBOT):

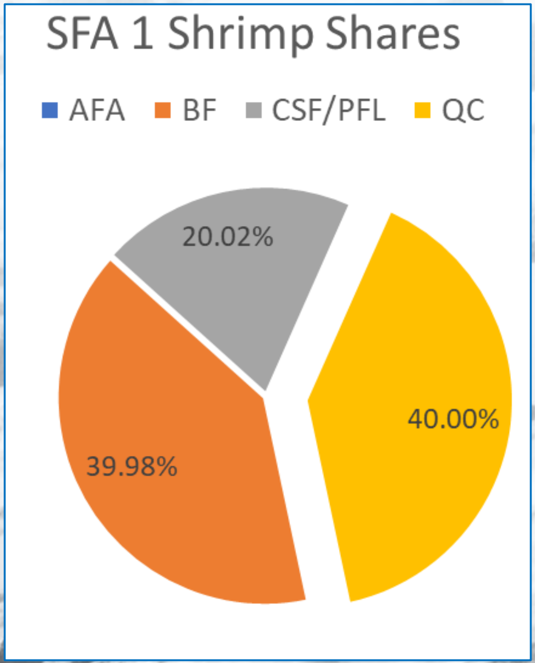


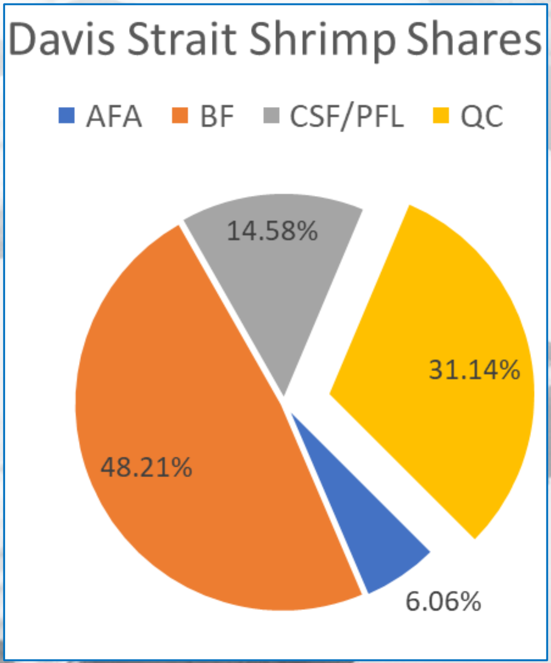



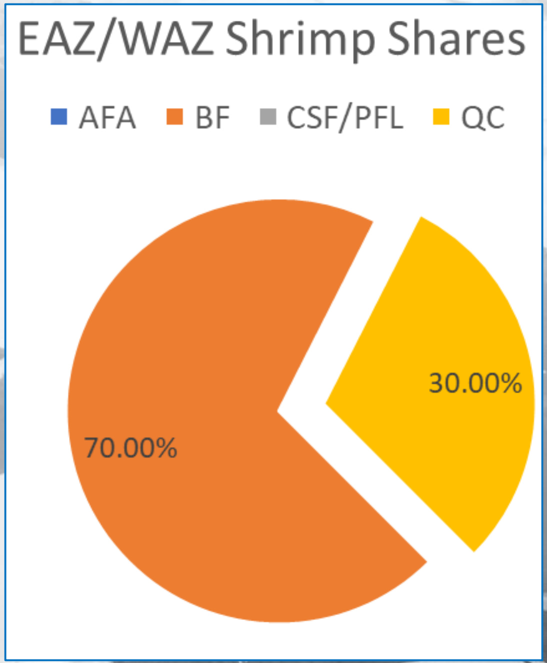



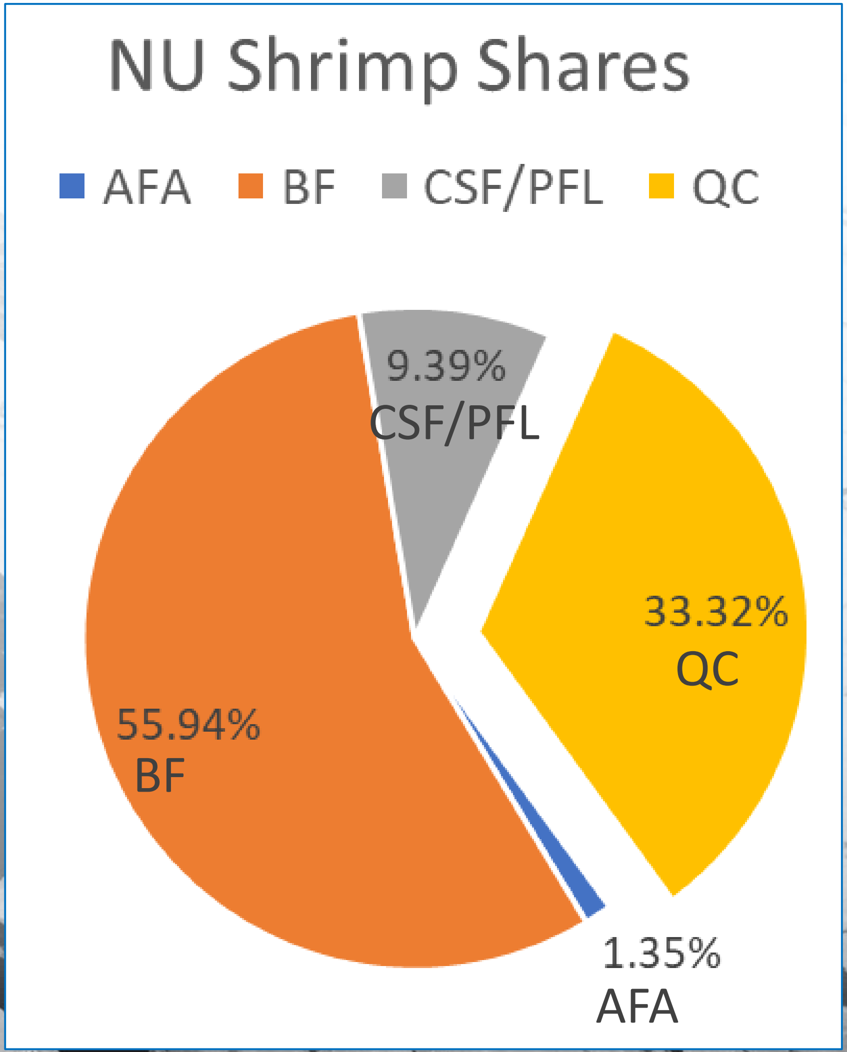
# QC's Share of NU Allocations

## SHRIMP:



# QC's Share of NU Allocations

**CHALLENGES**

- Combined, QC has only 22.16% of Nunavut's total Greenland Halibut (Turbot) and Shrimp allocations as provided by the NWMB.

- Due to low NU allocations, especially for turbot, QC has had to lease quota from other NU and non-NU allocation holders to keep its vessel operational at its capacity
  - An average of over 50% of the turbot harvested by Saputi had to be leased
  - Prior to 2016, 25% of the shrimp harvested by Saputi had to be leased

**CONSEQUENCES:** Direct impact on

- QC's royalties and profitability
- Vessel viability; and
- QC's ability to meet its goal of maximizing benefits for Inuit from fishery

# Use of QC's Fishery Returns

**INVESTING WITHIN THE FISHERY**

- Invested in the Saputi to maintain the vessel and improve its capacity and productivity
- Optimized Inuit employment on the vessel – highest share of Inuit employees of any NU operator
- Invested in training, science and research, MSC certification, and participation in industry organizations, either individually or with other NU operators, based on current share of allocations
- Plan future investments in vessel ownership/modernization and inshore fishery development for member communities

# Use of QC's Fishery Returns

- **INVESTING WITHIN THE FISHERY *(Cont'd)***
  - Investment opportunities and benefits available to Inuit from the fishery industry are limited due to;
    - Training and experience requirements
      - ➢ *Less than 50% of vessel crew are Inuit*
    - Lack of Maritime Infrastructure
      - ➢ *With no landing ports in NU, unable to obtain other benefits from offloading, crew changes, resupply, and vessel servicing*
    - Status of Research and Development
      - ➢ Inshore fisheries at an early stage of development, more science/research needed to confirm sustainability and potential
- **Further to investing within the fishery, QC is investing in other areas, though its Group of Companies, to maximise benefits available to Inuit and local communities**

# Use of QC’s Fishery Returns

## INVESTING IN OTHER AREAS TO MAXIMIZE BENEFITS

- Growing QC to a diversified company with investments in four major sectors:
    - Fisheries and Marine
    - Retail, Trades and Services
    - Transportation and Communication
    - Constructions and Major Projects
- Maximizing Inuit Employment
    - 360 of 443 employees (81%) are Inuit, earning $7.5 M in salaries. Compared to 50% Inuit employment in the GN (March 2017) and even less in the fishery industry

# Use of QC's Fishery Returns

## BUILDING PARTNERSHIPS


Met Tower Installation, Sanikiluaq


Nunavut Media Arts Centre


Iqaluit – Wind Study


Sanikiluaq – Wind Study


Cape Dorset – Metal Clean Up

# Use of QC's Fishery Returns

## MAJOR PROJECTS UNDER DEVELOPMENT

DEVELOPMENT OF INUIT OWNED LAND PARCEL E (IQALUIT)

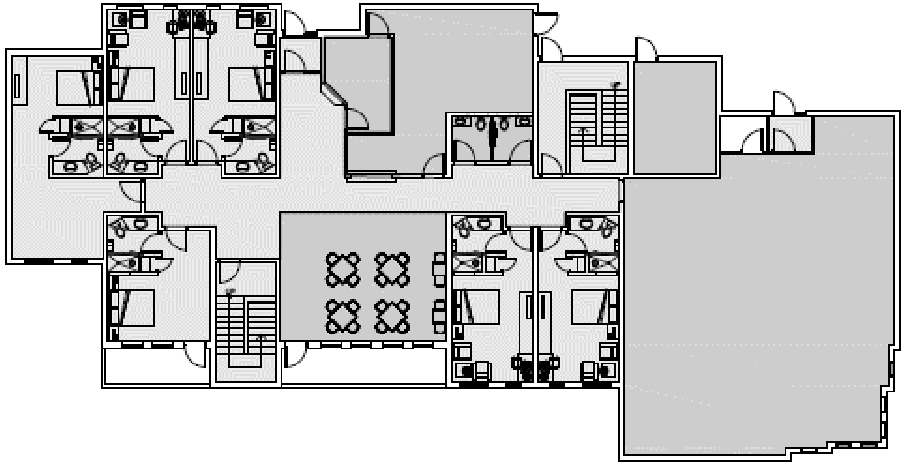
Nunavut Heritage Centre

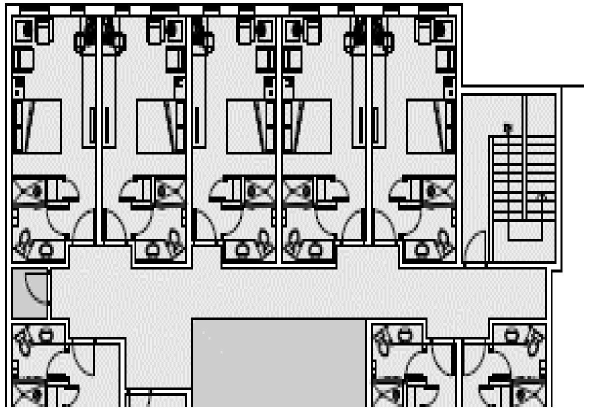
Hotel and Conference Centre

Emergency Services Building

# Use of QC's Fishery Returns

## GRISE FIORD LODGE & CULTURAL CENTER



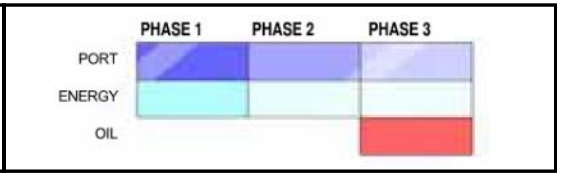


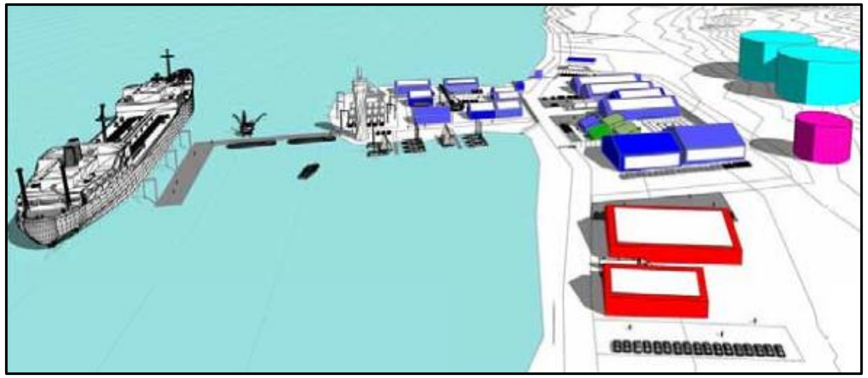
# A DEEP WATER PORT IN QIKIQTARJUAQ, NU

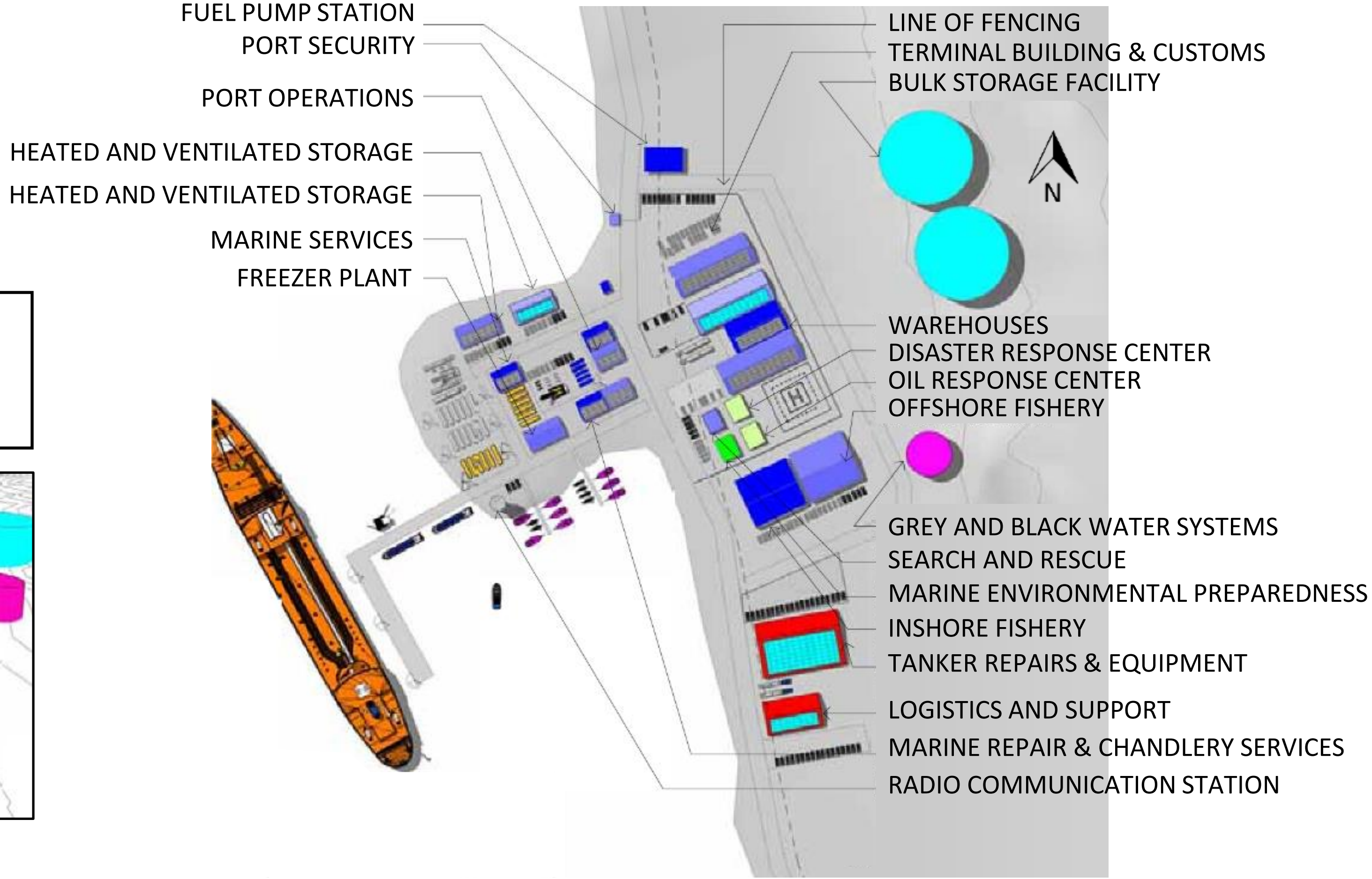
# Use of QC’s Fishery Returns

## QIKIQTARJUAQ DEEP WATER PORT

**ZONING LEGEND**





# Use of QC's Fishery Returns

## GIVING BACK TO MEMBER COMMUNITIES

- Annual dividends to QIA: **$1,063,157** in 2016-2017 fiscal year.
- Sponsorships and charitable contributions to three key areas:
  - Cultural Development
  - Community Development
  - Youth Development

✓Over $600,000 contributed over last five years

# Use of QC's Fishery Returns

**MOVING FORWARD – FOCUS ON THE COMMUNITIES**

Work with the communities to:

- Create Community Economic and Career Development Opportunities – Partnership, Investment and Innovation
- Economic Infrastructure – Land Development, Transportation, Communications & Renewable Energy
- Social Infrastructure – Cultural Facilities, Daycares, Medical Care Facilities
- Environmental Remediation – Legacy Contaminated Sites, Landfills, Solid Waste

# QC's Concerns with the NWMB Process

- **The FAC and NWMB should recognize and take into consideration the contributions made by QC to the Nunavut economy overall, from the profit generated from its fishery quotas/allocations**
- **Majority of all past and current allocations is going to one allocation holder**
  - NWMB proclaimed from the start that it wanted four strong, economically viable entities in the Nunavut fishery.
  - Its recent decisions on allocations are in fact making it less viable for the other Nunavut allocation holders.
- **Emphasis on 100% vessel ownership – not at any cost**
- **Policies not being applied properly and creating overcapacity in the fishing industry**
  - Largest allocation holder being rewarded for adding capacity – not consistent with past policy implementation for QC

# Conclusion

- QC is requesting a higher quota allocation, in line with the capacity of its vessel
- QC represents 13 communities and over 14,000 Qikiqtanimiut
- An increase of QC’s share on NWMB administered quotas/allocations will be directly beneficial to Nunavut’s economy and fishing industry

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QIKIQTAALUK CORPORATION

# NAKURMIIK
# THANK YOU

HARRY FLAHERTY

PRESIDENT, QIKIQTAALUK CORPORATION