



# Aerial Survey of Peary Caribou (*Rangifer tarandus pearyi*) and Muskoxen (*Ovibos moschatus*) on Banks Island, July 2014

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## ABSTRACT

Peary caribou and muskoxen have been surveyed on Banks Island, Northwest Territories by aerial fixed-wing strip-transect methods at two to five year intervals since 1982. Between July 8 and 18, 2014, an aerial survey of caribou and muskoxen on Banks Island was conducted using similar methods. Survey lines were spaced 5 km apart and the aircraft flew at an average elevation of 120 m above ground and an average speed of 160 km/hr. A distance of 500 m on either side of the aircraft was used as “on-transect” and ground coverage island-wide was 19.65%.

The adult Peary caribou population was estimated at  $2,234 \pm 830$  (95% Confidence Interval (CI)) and has approximately doubled since 2010, although it is still well below the peak numbers estimated in 1982 of about 9,000 caribou. Caribou were distributed across of most of Banks Island, however, there were very few in the southwestern part of the island and the largest numbers were on the northwest corner of the island.

The adult muskox population was estimated at  $13,767 \pm 1,938$  (95% CI), a large and significant decline of 62.5% since the last estimate of  $36,676 \pm 4,031$  in 2010. A decline of this magnitude in just four years indicates exceptionally high adult mortality rates, which is consistent with local reports of die-offs in that time period. Muskoxen were distributed across the island, with relatively low densities at the south end.

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## INTRODUCTION

Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) are important to Canadian High Arctic communities as a traditional food source and are the iconic large mammal species in the region. Although there were some surveys before 1982, systematic island-wide surveys have been done on Banks Island regularly every two to five years since 1982 (Latour 1985, Davison et al. 2013). These surveys have documented the population trend and distribution of Peary caribou and muskoxen on the island.

The Peary caribou population declined from the highest estimate in 1982 of  $9,036 \pm 2,927$  (95% CI) to the lowest estimate of  $451 \pm 123$  (95% CI) adults in 1998. The caribou population then increased slightly and stabilized, with the 2010 population estimate of  $1,097 \pm 343$  (Davison et al. 2013). In this report, caribou and muskoxen population estimates are all adult animals (i.e., do not include calves).

Peary caribou were assessed by the Committee on the Status of Endangered Species of Wildlife in Canada (COSEWIC) as Endangered in Canada in May 2004 and legally listed as Endangered under the Federal *Species at Risk Act* in February 2011. Peary caribou were also assessed and listed under the *Species at Risk (NWT) Act* as Threatened in 2013. Peary caribou were recently reassessed by COSEWIC as Threatened.

The muskox population on Banks Island peaked at  $68,585 \pm 6,972$  adult animals in 2001 and had previously reached similar numbers in 1994. The population has been declining since 2001, with the population estimated at  $36,676 \pm 4,031$  in 2010 (Davison et al. 2013). In the summer of 2012 and 2013, there were reports of dead and sick muskoxen on Banks Island. The bacterium *Erysipelothrix rhusiopathiae* was identified from samples collected from dead muskoxen on Banks Island in 2012 (Kutz et al. 2015). Muskox die-offs had previously

occurred when the Banks Island population was at higher numbers; a die-off in summer 1986 was attributed to *Yersinia pseudotuberculosis* (Blake et al. 1991); it is possible that *Erysipelothrix* may have played a role in other muskox mortality events in the 1990s (Kutz et al. 2015).

Because of concerns about the muskox population, in 2013 the community of Sachs Harbour requested that Environment and Natural Resources (ENR) conduct an island-wide survey, thus a survey to estimate the numbers of Peary caribou and muskoxen was conducted over Banks Island in July 2014.

## METHODS

Survey lines were spaced 5 km apart across Banks Island, for 20% coverage of the island (Figure 1). Flight lines were flown with fixed-wing aircrafts with survey crews made up of a pilot, recorder and two observers. Observers were seated in the back of the aircraft, on either side of the aircraft and the recorder was in the front. The northern portion of the island was flown using a Helio Courier by a crew working from Polar Bear Cabin at Castel Bay. The southern portion of the island was flown using a Turbo Beaver by a survey crew staging out of Sachs Harbour. Peary caribou and muskoxen within a 500 m strip on each side of the aircraft were considered “on transect”. The strip width was marked by flying at survey altitude over a measured 500 m distant on the ground and marking the aircraft windows. Observations beyond the 500 m markers were considered “off transect”. The survey was flown at an average altitude of 120 m above ground level and at an average speed of 160 km/hr.

The recorder marked every observation using a GPS and flight lines were also collected using the GPS. All large mammal observations on and off transect were recorded and the location was marked. Muskoxen observed were classified as adult or calves. Caribou observed were classified as mature bulls, cows/young bulls, or calves. Mature bulls were identified by their antlers, and cows and young bulls were grouped as distinguishing them from the aircraft is more difficult. Larger groups of muskoxen or Peary caribou on transect were circled and photos taken with a small digital camera to be reviewed for an accurate count and classification.

Population estimates for adult Peary caribou and muskoxen were calculated using a ratio method for unequal-sized units sampled without replacement (Krebs 1999, Ecological Methodology Version 7.0). Population estimates were only calculated for the adults because of the high variability of yearly productivity and higher mortality rate of animals in their first year. Also, muskox calves were sometimes difficult to count reliably as they are



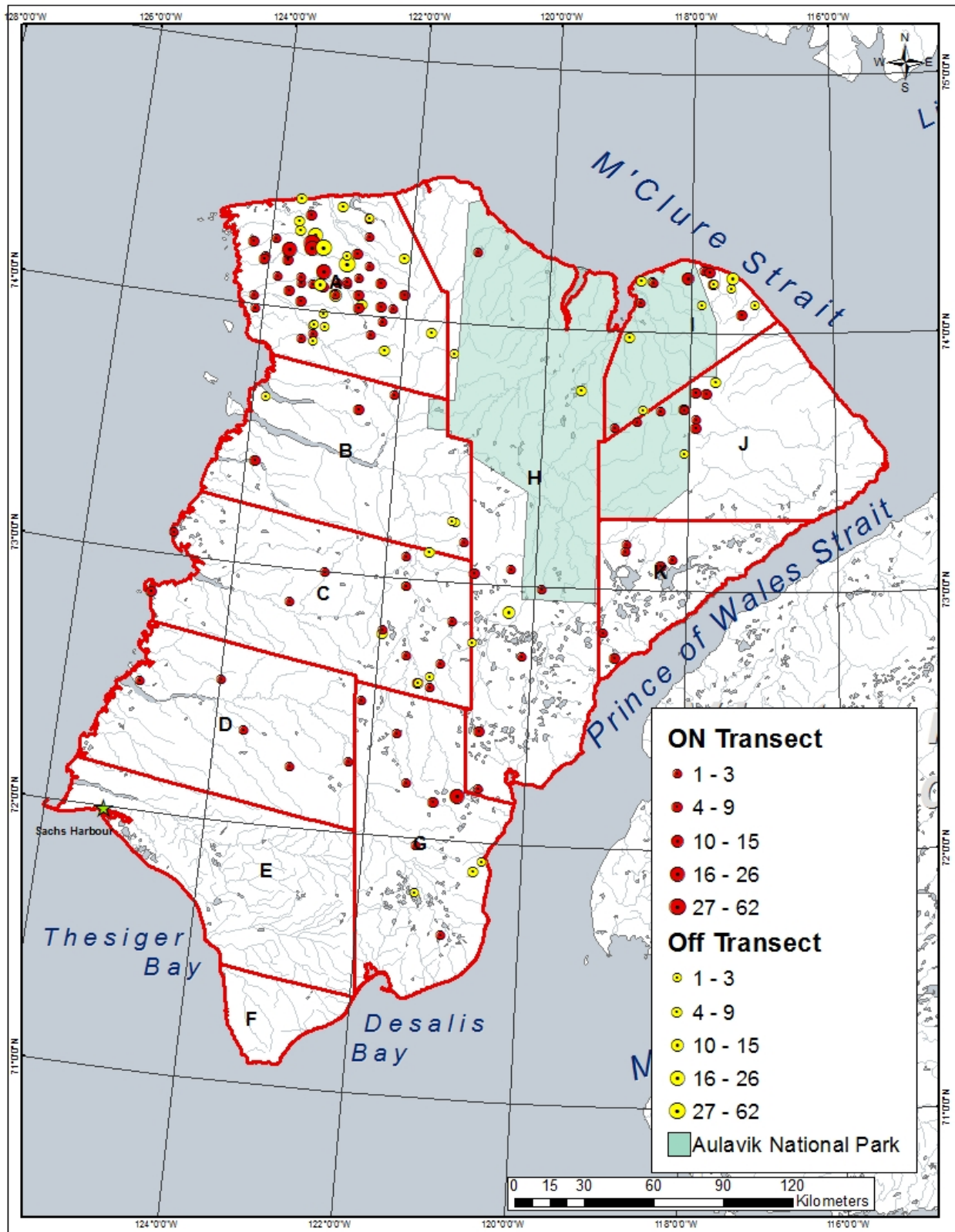
small and may be hidden if groups are tightly bunched. Adults-only population estimation is consistent with previous population estimates allowing trend determinations. A two-tailed t-test was used to determine if the population estimates of adult muskoxen and caribou were significantly different than the 2010 estimates (Gasaway 1986). Yearly growth rate ( $\lambda$ ) was calculated as  $\lambda=(N_{t2}/N_{t1})^{1/T}$  where  $N_{t1}$ =population at year one,  $N_{t2}$ =population at year two and  $T$ =number of years between population estimates. Growth rates were converted into percent change in population using the formula  $(\lambda-1)\times 100$  (Mills 2012).



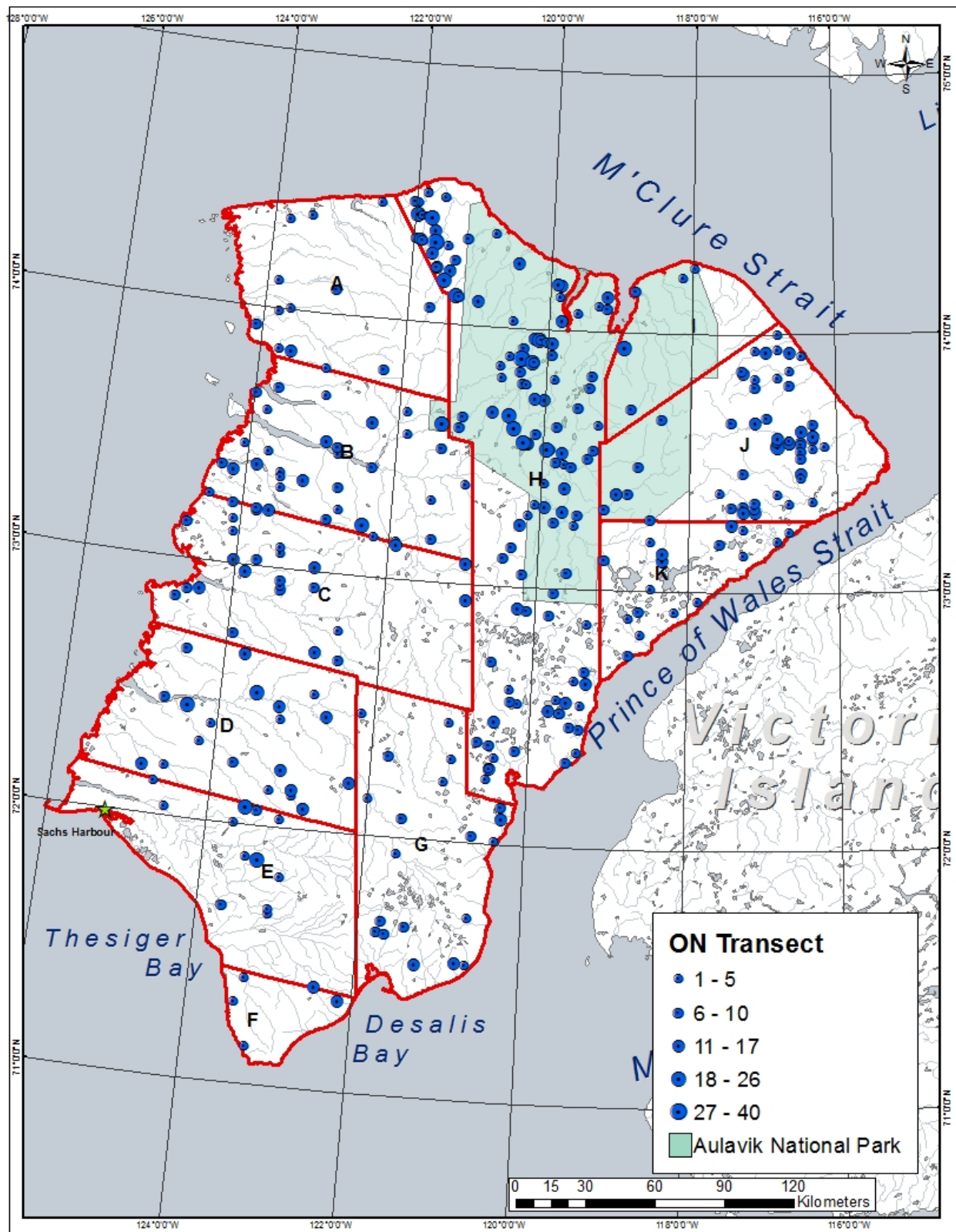
**Figure 1:** Survey blocks and transect lines planned and flown over Banks Island, July 2014.

## RESULTS

The survey was conducted between July 8<sup>th</sup> and 18<sup>th</sup>, 2014. The total flight time during the survey, including ferry flights, was 130.9 hours. The north crew flew survey blocks A, C, H, I, J and K (Figure 1) in ten days with no weather delay days. The south survey crew flew blocks D, E, F, and G in seven and half days, with three weather delay days due to high winds and/or low cloud ceilings. All planned transects were flown (Figure 1). Overall, the survey transects covered 19.65% of the island. The location of Peary caribou observed both on- and off- transect are show in figure 2. Location of Muskox observed on-transect are shown in figure 3.



**Figure 2:** On-transect and off-transect observations of adult Peary caribou during the July 2014 Banks Island survey.



**Figure 3:** On-transect observations of adult muskoxen during the July 2014 Banks Island survey.



A total of 439 adult and 95 calf Peary caribou were seen on-transect, and off-transect 345 adults and 64 calves were seen. Summaries of the numbers of Peary caribou observed broken down by block are shown in Table 1. The on-transect observations resulted in a population estimate of  $2,234 \pm 830$  (95% CI) adult Peary caribou for Banks Island. The proportion of all caribou (both on and off transect) observed that were calves was 16.9%. Peary caribou were observed in all blocks except E and F, on the south end of the island (Figure 2), and the largest number of caribou was concentrated in the northwest corner of the island in block A. The largest group of Peary caribou was a group of 62 adults and 13 calves observed off-transect.

**Table 1:** Summary of number of Peary caribou observed on transect during Banks Island survey July 2014, and resulting population estimates by survey block.

Block	Area (km <sup>2</sup> )	Transect Sampled	Possible Transects	On Transect		% Area Sampled	Adult Population Estimate	95% CI
				Adult	Calf			
A	6,249.1	19	96	248	62	19.92	1,245	818
B	6,627.1	24	114	11	0	19.99	55	50
C	8,012.3	32	138	31	8	19.77	157	86
D	6,930.6	31	117	7	2	20.07	35	22
E	6,605.5	34	129	0	0	20.11	0	0
F	1,405.2	12	57	0	0	19.88	0	0
G	6,768.3	27	129	32	6	19.01	168	174
H	14,759.1	57	255	26	4	18.91	138	103
I	3,047.3	17	84	38	11	20.14	189	177
J	6,966.0	25	123	32	2	19.92	161	140
K	3,209.3	19	92	14	0	19.84	71	47
<b>Whole Island</b>	<b>70,579.8</b>	<b>297</b>	<b>1,334</b>	<b>439</b>	<b>95</b>	<b>19.65</b>	<b>2,234</b>	<b>830</b>

A total of 2,705 adult and 294 calf muskoxen were seen on-transect, with an additional 3,350 adults and 131 calf muskoxen recorded off-transect. Summaries of the numbers of muskoxen observed broken down by block are in Table 2. The on-transect observations resulted in a population estimate of  $13,767 \pm 1,938$  adult muskoxen on Banks Island. The proportion of all muskoxen on-transect that were calves was 10.8%. Muskoxen were

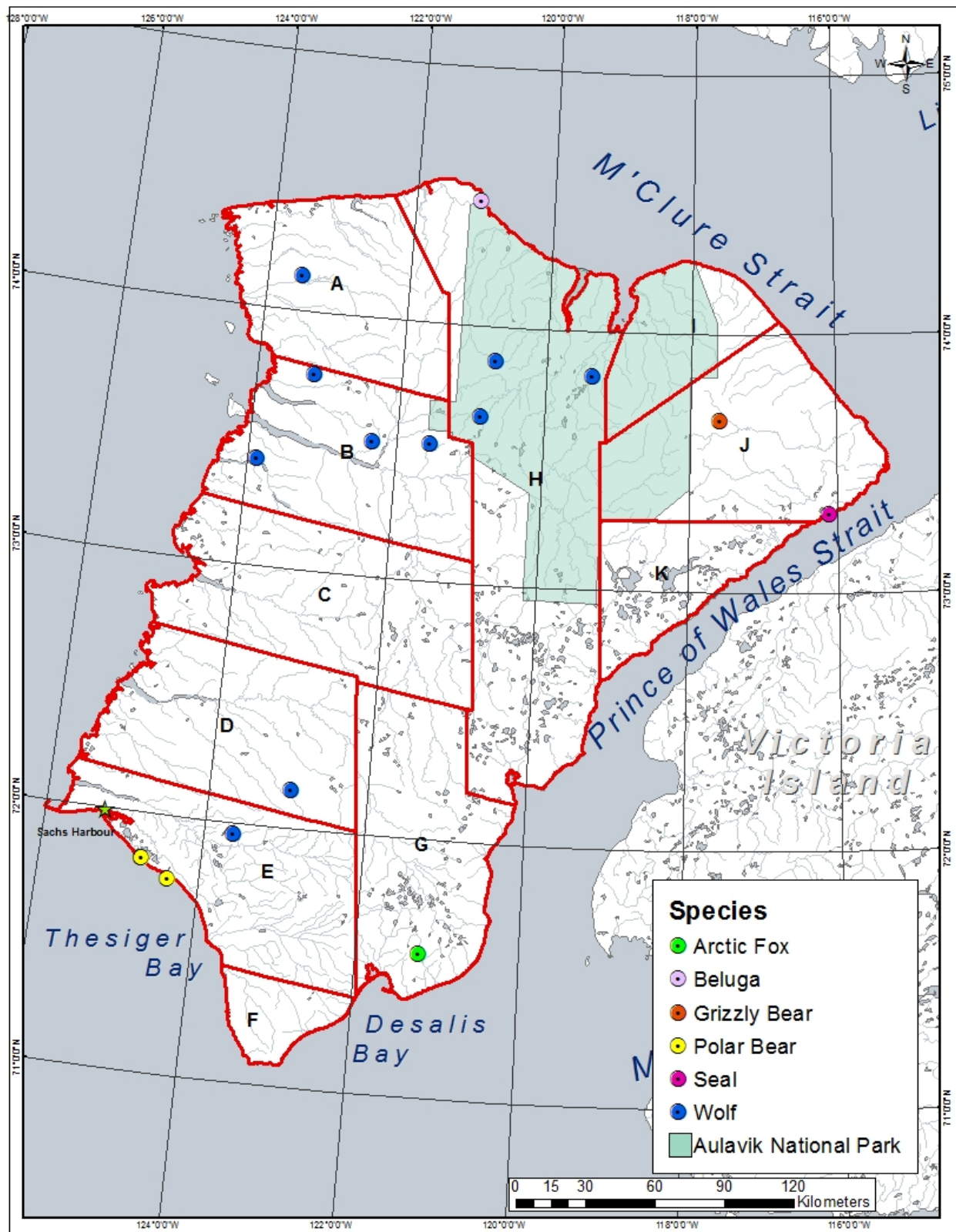
spread throughout Banks Island, with higher concentrations in blocks H and J (Figure 3). There were 335 groups of muskox seen on-transect, with the smallest group being a single animal and the largest 40 muskox. The average group size of on-transect muskox was nine.

**Table 2:** Summary of number of muskoxen observed on transect during Banks Island survey July 2014, and resulting population estimates by survey block.

Block	Area (km <sup>2</sup> )	Transect Sampled	Possible Transects	On Transect		% Area Sampled	Adult Population Estimate	95% CI	Density Adults/100 km <sup>2</sup>
				Adult	Calf				
<b>A</b>	6,249.1	19	96	67	15	19.92	336	232	5.4
<b>B</b>	6,627.1	24	114	245	22	19.99	1,226	448	18.5
<b>C</b>	8,012.3	32	138	220	27	19.77	1,113	462	13.9
<b>D</b>	6,930.6	31	117	196	16	20.07	976	284	14.1
<b>E</b>	6,605.5	34	129	96	15	20.11	477	255	7.2
<b>F</b>	1,405.2	12	57	23	1	19.88	116	154	8.3
<b>G</b>	6,768.3	27	129	122	17	19.01	642	265	9.5
<b>H</b>	14,759.1	57	255	1,163	132	18.91	6,151	1,268	41.7
<b>I</b>	3,047.3	17	84	43	4	20.14	214	216	7.0
<b>J</b>	6,966.0	25	123	426	39	19.92	2,138	850	30.7
<b>K</b>	3,209.3	19	92	104	6	19.84	524	242	16.3
<b>Whole Island</b>	<b>70,579.8</b>	<b>297</b>	<b>1,334</b>	<b>2705</b>	<b>294</b>	<b>19.65</b>	<b>13,767</b>	<b>1,938</b>	<b>19.5</b>

Muskox carcasses were also noted by observers, with most observations being sites where there were mostly just bones left. There were 30 muskox carcasses observed that were believed to be recent (less than a year old).

Other mammal species observed during the survey included one grizzly bear, one Arctic fox, 16 adult wolves, seven polar bears, one seal and three belugas (Figure 4).

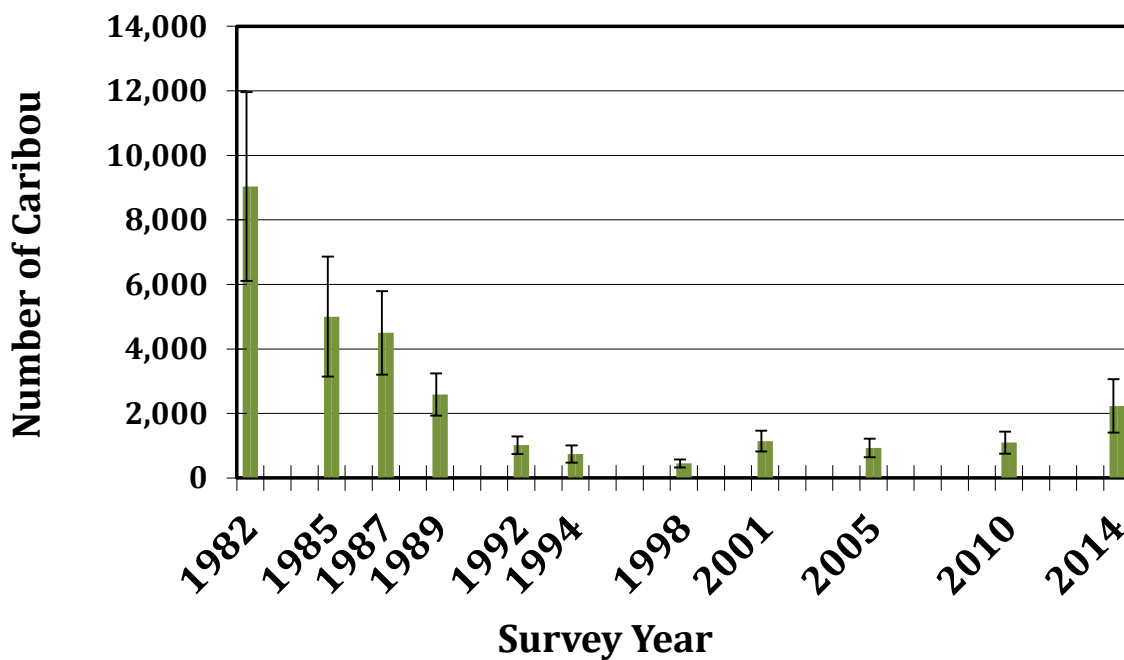


**Figure 4:** Other species observation during the Banks Island survey, July 2014.



## DISCUSSION

The population estimate for Peary caribou on Banks Island in 2014 is significantly higher ( $t=2.491$ ,  $P>0.05$ ,  $df=24$ ) than the 2010 estimate of  $1,097\pm343$  (Davison et al. 2013). The population estimates between 1982 and 2014 is shown in Figure 5. Peary caribou on Banks Island are recovering from a low of  $451\pm123$  adult caribou estimated in 1998. There was annual growth rate of the population between the 2010 survey and the 2014 survey of 19.5%. All survey blocks had an increase in the number of caribou since the 2010 survey except block J, where less caribou were observed this survey and blocks E and F where no caribou were observed in both 2010 and this survey (Davison et al. 2013). Block K had no caribou observed in 2010, however caribou were observed in that block during this survey.

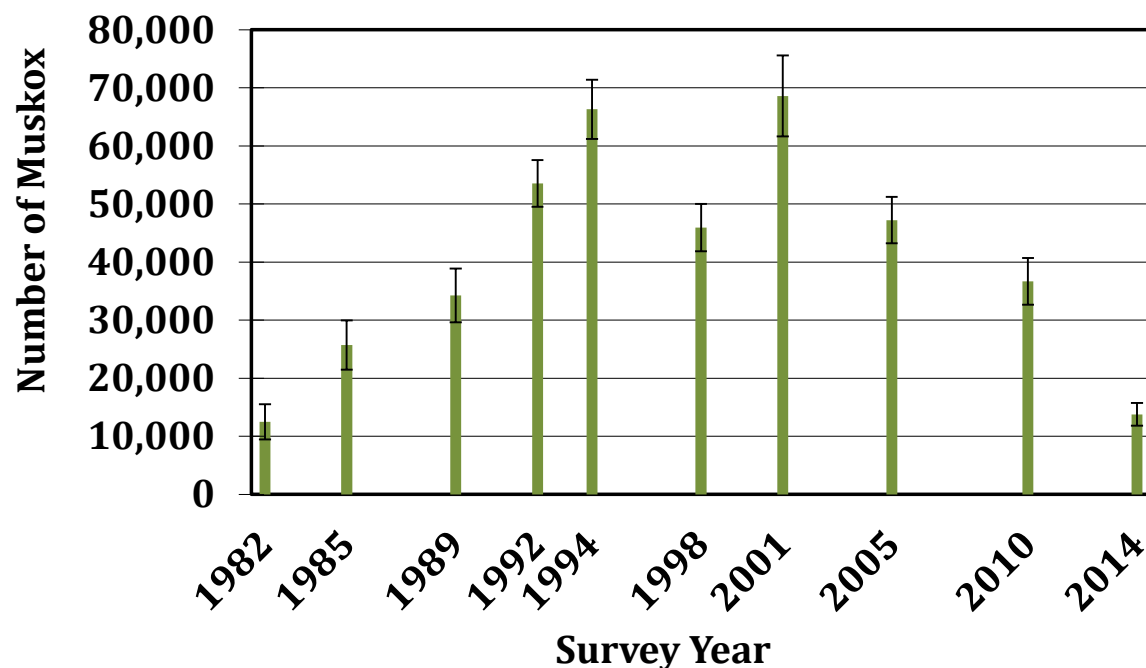


**Figure 5:** Population estimates with 95% CI for adult Peary caribou on Banks Island between 1982 and 2014<sup>1</sup>.

<sup>1</sup> Data from: 1982 from Nagy et al. 2009c; 1985 from McLean et al. 1986; 1987 from McLean 1992; 1989 from McLean and Fraser 1992; 1992 from Nagy et al. 2009a; 1994 from Nagy et al. 2013a; 1998 from Nagy et al. 2013b; 2001 from Nagy et al. 2006; 2005 from Nagy et al. 2009b; 2010 from Davison et al. 2013.

The proportion of caribou calves observed both on and off transect ranged from 28.8% to 18.9% between 1987 and 2010, with the exception of the 1994 survey, where the lowest percentage of calves, only 7.5%, was recorded (Davison et al. 2003, Nagy et al. 2009a-c, 2013a, 2013b). The percentage of calves found in this survey (16.9%) was on the lower side of the range and is similar to percentages found in 1982 and 1985, 17.4% and 15.3%, respectively (Nagy et al. 2009c, McLean et al. 1986).

The population estimate for muskoxen on Banks Island in 2014 is significantly lower ( $t=10.08$ ,  $P<0.05$ ,  $df=73$ ) than the  $36,676 \pm 4,031$  estimate from 2010 (Davison et al. 2013). The annual rate of decrease between the 2014 survey and 2010 survey was 21.7%. The muskox population has declined since the peak in 2001 of  $68,585 \pm 6,997$  (Nagy et al. 2006). The rate of decline between 2014 and 2010 is higher than the 6.7% annual decline observed between 2001 and 2010 (Figure 7). All survey blocks except block B had a decrease in muskox since the 2010 survey (Davison et al. 2013).



**Figure 6:** Population estimates with 95% CI for adult muskoxen on Banks Island between 1982 and 2014<sup>1</sup>.

The proportion of all muskoxen on-transect observed that were calves (10.8%) in 2014 was similar to the percentage observed during the 2010 survey of 10.7%. The percentage of calves in the last three surveys (2005-2014) tended to be lower than in earlier surveys (1982-2001), but calf percentage appears to be variable.

A muskox population decline was expected based on comments from the community of Sachs Harbour; however the recent rate of the decline is alarming. One contributing factor to the increasing rate of decline between 2010 and 2014 is likely disease and associated mortality in adult muskoxen. In summer 2012 approximately 150 dead muskoxen were reported on Banks Island by people traveling on the land and a helicopter pilot (M. Branigan, personal communication). There was no systematic survey of the island so the extent of the outbreak and full mortality levels are not known. Samples from several carcasses were obtained and the bacteria *Erysipolethrix rhusiopathiae* was isolated in 2012 and 2013 (Kutz et al. 2015). This is the first time this bacteria was isolated from Banks Island, but past die-offs have been recorded (see Blake et al. 1991). Some of these past die-offs were assumed to be from *yersiniosis* (caused by the bacterium *Yersinia pseudotuberculosis*.) (Blake et al. 1991) but it is possible that other pathogens were involved. The last muskox mortalities with confirmed *Yersinia* on Banks Island were in 1987-1991; however, samples were not tested for other bacteria (McLean 1996). Some muskoxen appeared to have died with severe pulmonary edema but cultures for *Yersinia* were negative (McLean 1996). Muskox mortalities linked to *Erysipolethrix* were also found on Victoria Island in 2009, 2010 and 2011 (Kutz et al. 2015) and the Victoria Island muskox population, on the Nunavut side of the island, has also declined substantially in recent years (LeClerc, Government of Nunavut, unpublished data). It is possible that a warming climate contributed to these die-offs; extreme weather was linked to an epizootic of fatal pneumonia in Norwegian muskoxen (Ytrehus et al. 2013).

Other mortality factors that could have contributed to muskox mortality rates are predation, weather such as severe winters and harvest. There may also be density related

factors that initiated the decline starting in 2001. However, the rate of decline appears to have increased between this survey and 2010, therefore there is other factors likely contributing to this.

Weather is a possible factor that influences Arctic ungulates (Aanes et al. 2000) and specifically has been hypothesized by previous researchers as a driver of population change of muskox on Banks Island (Gunn et al. 1991). Muskox numbers are showing distribution and declines island wide so large scale weather events such as winter icing that would affect muskox populations, while allowing caribou populations to increase, seems unlikely. However in Greenland muskox and caribou populations were shown to be influenced by winter precipitation differently, with muskox negatively affected by increased winter precipitation and caribou negatively affected by dry winters (Forchhammer et al. 2002). Muskoxen were also affected by winter temperature where caribou did not seem to be (Forchhammer et al. 2002). Therefore, different weather patterns could affect caribou and muskox on Banks Island differently. A study of snow on Banks Island (Larter and Nagy 1994) showed muskox cratered through deeper snow than caribou and in areas of extensive icing cratered through harder snow than caribou.

Estimating the population size of predators such as wolves is more difficult and thus so is their influence on muskox numbers. There were 16 wolves observed in this survey, which is less than the number seen in the previous five surveys. Previous wolf observations during similar surveys were: 28, 28, 40, 26, 23, and two wolves were seen in 2010, 2005, 2001, 1998, 1994, 1992, respectively (Davison et al. 2013, Nagy et al. 2009b, Nagy et al. 2006, Nagy et al. 2013b, Nagy et al. 2013a, Nagy et al. 2009a). There were quite a few polar bears observed this survey. All were located on the southern coast (Figure 6), where a group of five were observed on a whale carcass.

Muskox harvest has likely not been an important factor as a driver of muskox population change. Harvest records indicate the largest yearly harvest since the July 2010 survey was in the 2011/2012 harvest with 357 muskox reported harvested, including 251 taken for commercial harvest (ENR 2013). The last commercial harvest was in 2013 when only 66 muskoxen were harvested (ENR 2013).

Overall, while muskox populations have declined and caribou numbers have increased, the drivers of population change of both species on Banks Island is not well understood. This warrants further investigation.

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