PORCUPINE CARIBOU
ANNUAL SUMMARY REPORT
2018-2019

Photo: Sonny Parker

Submitted to: Porcupine Caribou Management Board

Submitted by: Porcupine Caribou Technical Committee

November 29, 2019

Indicator Table

Annual Summary Report 2018- 2019

Indicator	Value	Average	Notes
Population size and trend			
Population size	2019 = photocensus not attempted	--	Herd did not aggregate sufficiently for photocensus. Successful photocensus in 2017 found 218,457 (95% CI = 202-106 - 234,808) caribou.
Population trend	2019 = no data	Λ = 1.037 (2010-2017)	Declined by 55,000 caribou between 1989 and 2001. Recovered to 169,000 by 2010 and continued to increase to 218,457 in 2017. Annual growth rate almost identical to growth phase from 1972-1989.
Adult cow survival	2019 = data collection in progress 2018 = analysis in progress 2017 = 95.4% (95% CI = 83.9-98.2%)	87.9% (2012-2017)	Sampling interval is June 1 2019 – July 30 2020. Estimates for 2018 will be completed in winter 2020. Survival analysis also completed for adult males (2015-2017) and yearling females (2017).
Calf birth rate (Parturition rate)	≥ 4 yr olds = 0.81	0.84 (5-yr average)	35-year average = 0.82
	≥ 3 yr olds = 0.72	0.82 (5-yr average)	12-year average = 0.79
	3 yr olds = 0.47	--	Small sample sizes for each year and limited consecutive years limit the ability to calculate meaningful averages or adequate time-series weighted averages.
Post-calving survival	2019 = 0.94	0.87 (long-term average)	Includes ≥ 3 year old adult cows
Late June calf:cow ratio	2019 = 0.56	0.58 (long-term average)	Includes ≥ 3 year old adult cows
March calf:cow ratio	2019 = no data	--	17-year average = 0.35. Surveys in March 2017 were 0.35. There were few calves observed during March 2019 captures.
Bull Ratio	2019 = no data	--	
Peak of calving	2019 = June 4, 2019	1 June	
Body condition			
Average backfat	2018-19 = no data	1.8 cm	Limited samples in 2018 (5), caribou not available
Hunter assessment	2018-19 = no data	2.9	Limited samples in 2018 (5), caribou not available
Condition of caribou	2018-19 = no data	--	Limited samples in 2018 (5), caribou not available
Habitat and other considerations			

Snow conditions winter (2018-19)	Snow Depth Eagle = 68.7 cm Ogilvie = 47.7 cm Old Crow = 71.0 cm North Slope = no data Richardson = no data Snow Density Eagle = 0.22 g/cm^3 Ogilvie = 0.21 g/cm^3 Old Crow = 0.20 g/cm^3 Richardson = no data North Slope = no data	5 yr Av. Depth 79.5 cm 62.3 cm 75.8 cm no data no data Density 0.20 g/cm^3 0.21 g/cm^3 0.19 g/cm^3 no data no data	Eagle Region appears to have an increasing trend towards a deep snowpack over the last decade. Snow density increasing in Ogilvie Region.
Wildland fires	2019 = data not yet available 2018 = 162.5 km^2 *Yukon and Alaska data only, NWT data not available but believed not to be significant	1,119.6 km^2	Total of 17% of range affected by fires since 1960. No significant burns in 2019.
Linear disturbance and human development	2018-19 = No major increases	N/A	Oil and gas lease sales proposed for 2020 for the 1002 lands in Alaska. No current applications for seismic work in ANWR.

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INTRODUCTION

This report

This report was prepared for the Porcupine Caribou Management Board (PCMB) to provide information to make an assessment on the status of the herd as part of the *Harvest Management Plan for the Porcupine Caribou Herd in Canada* (HMP). Information within this report was guided by the topics listed in the HMP. As noted in relevant sections, some information is not available or analyzed. Under the HMP, Parties are requested to comment on this report and provide additional information to the PCMB at the Annual Harvest Meeting. Information for this summary report was provided by members of the Procupine Caribou Technical Committee (PCTC).

Herd background

1. The Porcupine Caribou Herd's (PCH) core home range is approximately 201,190 km^2 and extends into Alaska, Yukon, and the Northwest Territories. Within this range there are currently 12 different areas where different agencies have jurisdiction over land and/or wildlife management. Management of the herd must take into consideration:

    - 2 federal governments
    - 3 state or territorial governments
    - 8 Indigenous land claim agreements
    - 5 national parks or preserves
    - 1 territorial park
    - 2 special management areas
    - 2 specific ordinances
        - Dempster Highway Area Development Ordinance, and
        - a federal Order-in-Council Withdrawal (Yukon North Slope)

The PCH was the first international caribou herd with its own formal co-management agreements and boards. There are five main management agencies which work on the herd: Canadian Wildlife Service, U.S. Fish and Wildlife Service, Government of Yukon, Government of the Northwest Territories, and the Alaska Department of Fish and Game. Management and research is coordinated by the PCTC which consists of biologists from numerous agencies, co-management boards as well as occasional faculty members or students from various universities.

All aboriginal organizations within the Canadian range of the herd have land claim agreements. These agreements solidify the aboriginal right to hunt for food and ensure local participation in wildlife management through co-management boards. The agreements also created lands that are privately owned and managed by the First Nations or Inuvialuit. Self-governing agreements in Yukon also give the First Nation governments the ability to regulate their citizens and their land.

Management direction and goals

To help coordinate management, two Porcupine Caribou agreements were set up, each creating a co-management board. In 1985, three governments and three Indigenous organizations signed the *Porcupine Caribou Management Agreement* (PCMA), creating the within-Canada Porcupine Caribou Management Board. In 1987, Canada and the United States signed an International Conservation Agreement, creating the International Porcupine Caribou Board (IPCB).

Research and monitoring is guided largely by the *Porcupine Caribou Herd Strategic Framework 2015-16 to 2019-20 (Porcupine Caribou Management Board 2015)* and the Plan for the International *Conservation of Porcupine Caribou Herd* (International Porcupine Caribou Board 1993). The PCTC drafts workplans to coordinate research and monitoring activities, optimize funds and staff time, and provide technical information to co-management boards and agencies. Harvest management is co-operative among the Parties to the PCMA and is guided by the HMP and the accompanying Implementation Plan.

Goals that pertain to the PCTC taken from the *Porcupine Caribou Herd Strategic Framework 2015-16 to 2019-20* are:

> B. The Board shall review relevant scientific information [and traditional knowledge] on the conservation management of the herd and its habitat, and make recommendations to the Minister on policy, legislation and regulations regarding:
>
> - Management strategies
> - Further research where there appears to be a need, including recommendations on methods of data collection and presentation;
> - A herd management plan; and
> - A predator management plan.
>
> D. The Board may identify sensitive [caribou] habitat areas requiring special protection and recommend measures to protect such areas.

The *Plan for the International Conservation of the Porcupine Caribou Herd* outline a number of objectives pertinent to the PCTC.

- To conserve the Porcupine caribou herd and its habitat through international cooperation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized.
- To ensure opportunities for customary and traditional uses of the Porcupine caribou herd.
- To enable users of Porcupine caribou to participate in the international coordination of the conservation of the Porcupine caribou herd and its habitat.
- To encourage cooperation and communication among governments, users of Porcupine caribou, and others to achieve the objectives of the Agreement.

Alaska Department of Fish and Game (ADF&G) list the following as management objectives (Lenart 2007):

- Maintain a minimum population of 135,000 caribou.
  - Conduct censuses every 2-3 years.
  - Estimate parturition rates and late June calf:cow ratios of radio-collared females.
  - Monitor herd movements by periodically relocating radio-collared caribou.

- Monitor the harvest through field observations, hunter reports and contact with residents.

POPULATION

Population size – photocensus

Objective
To estimate the size of the herd every 2 to 3 years.

Methods
A technique called an Aerial Photo Direct Count Extrapolation has been used to estimate the herd size since 1972 (Davis 1979, Valkenburg et al. 1985, Rivest et al. 1998). Once the insects come out during the warm weather in late June or early July, the caribou gather into very large, tight groups sometimes consisting of tens of thousands of caribou. These large groups are photographed and caribou in the photos are counted. Any caribou that are found outside of the large groups are added and the estimate is rounded to the nearest thousand caribou. Radiocollared caribou are used to help locate the caribou aggregations and correct the estimate for any missing caribou. This technique is considered an accurate and reliable method to count large barren-ground caribou herds and can also provide a measure of uncertainty (confidence interval) around the population estimate. A confidence interval is a range of values that describes the uncertainty surrounding the population estimate. For example, the photocensus in 2013 found that the population estimate of the PCH was 197,228 (95% CI = 168,667 – 225,789). That means that we are 95% confident that the true population estimate is within the upper (225,789) and lower number (168,667).

Results
The herd was monitored using GPS collar locations throughout July to see if the herd would form large aggregations to allow for a photocensus. The herd moved east and did not aggregate sufficiently for a photocensus attempt (Figure 1).

The last photocensus (2017) resulted in a minimum count of 198,104 caribou and a population abundance estimate of 218,457 (95% CI = 202,106 – 234,808) caribou (Caikoski 2017). The annual growth rate from 2010 to 2017 was estimated at $\lambda = 1.037$ (SE = 0.0082; Caikoski 2017).

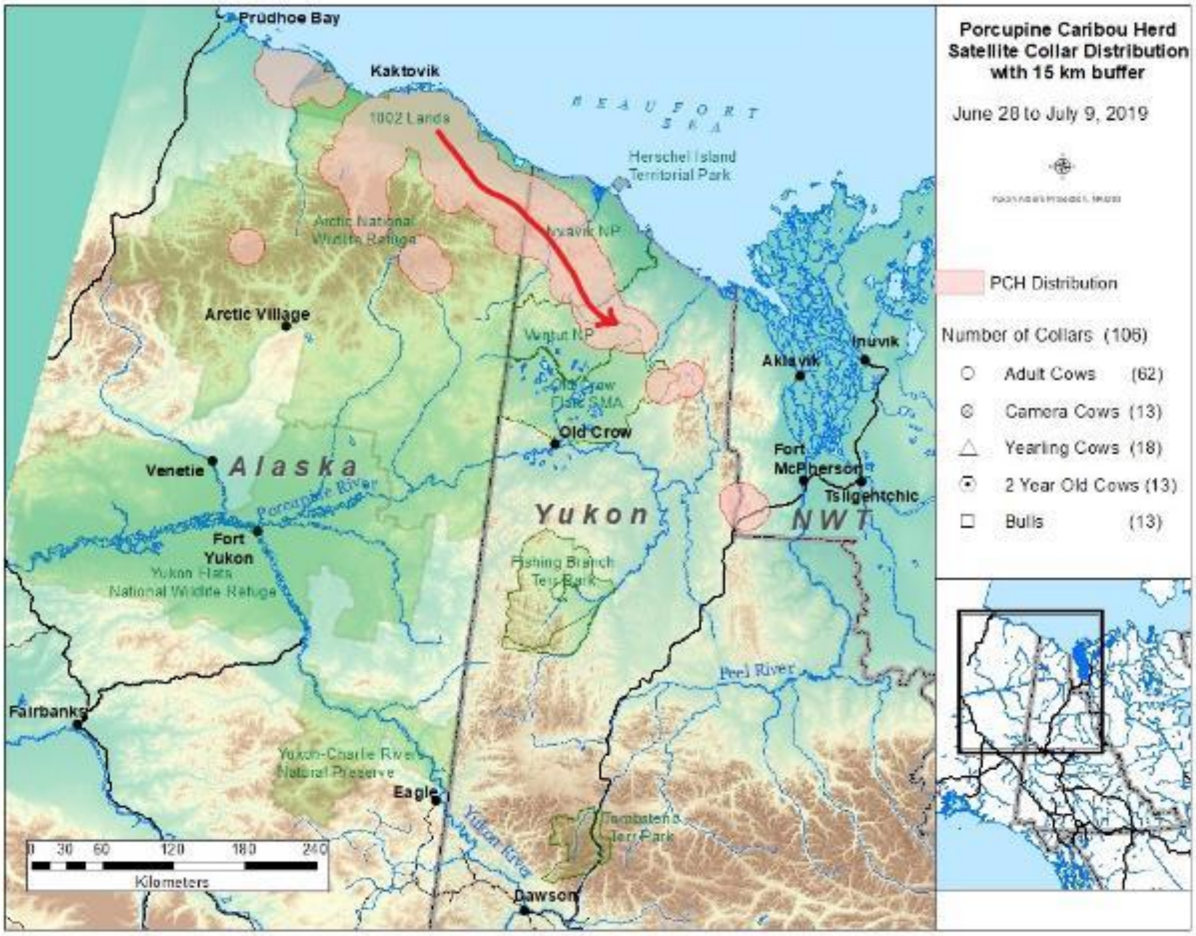

Figure 1. Map of the Porcupine caribou herd from June 28th – July 9th, 2019 showing large easterly movements that did not provided ideal aggregations to conduct a photocensus. Some caribou used to produce this range may have be considered Central Arctic Herd (particularly some of the northwest North Slope polygon data). Data will be monitored and it's possible that this map may need to be re-estimated in the coming year once determined.

Discussion

The most recent photocensus in 2017 indicated that the Porcupine Caribou herd was at its highest number since surveys began in the 1970's (Figure 2). Analysis of how fast the herd is growing shows that the current growth rate (λ = 1.037: Caikoski 2017) is almost identical to the growth rate during the last growth phase of the herd from 1972 to 1989. If this number (λ= lambda) is larger than 1 then population is increasing. A population with a λ <1 may indicate a decreasing population. We will attempt another photocensus the summer of 2020.

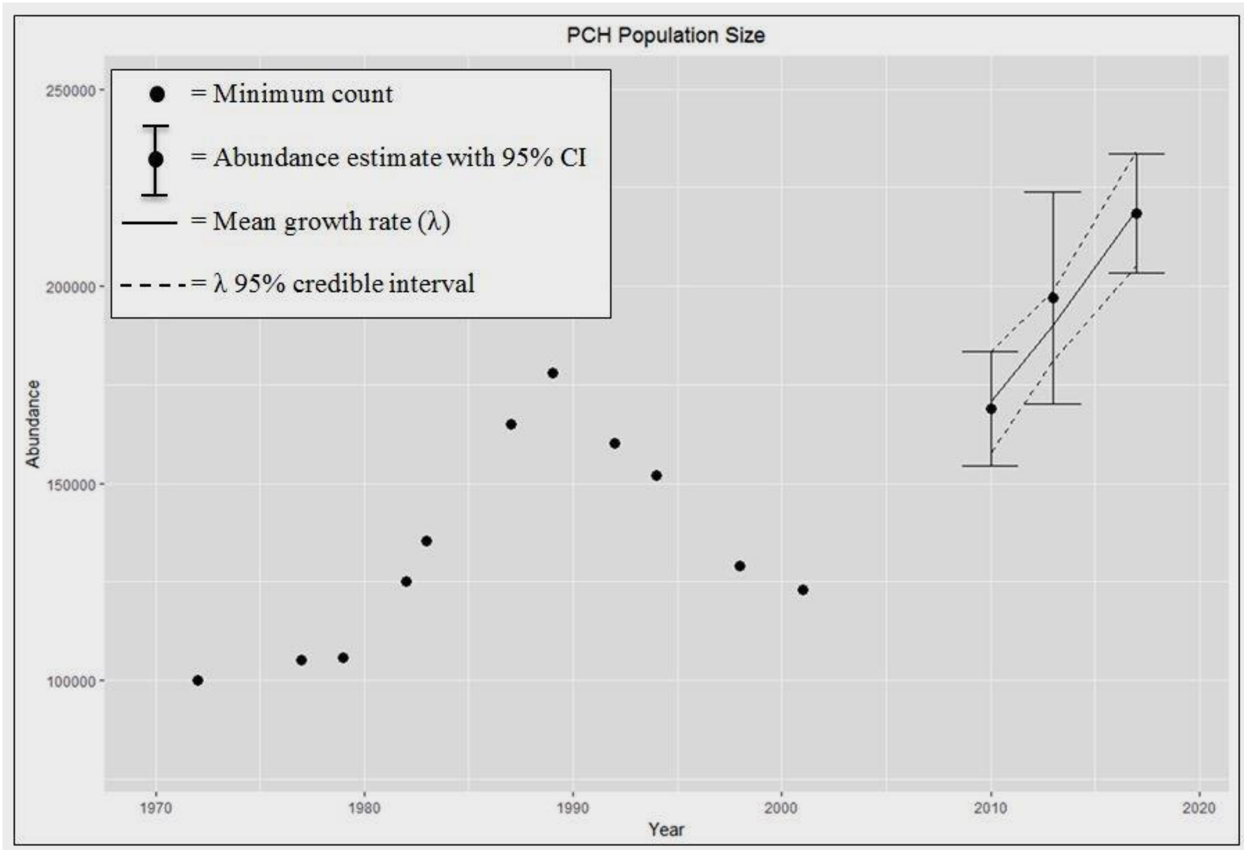

Figure 2. Population size of the PCH from 1972 to 2017. Data from 1972 to 2001 are photocensus minimum counts. Estimated abundance and associated 95% confidence intervals in 2010, 2013 and 2017 are derived from photocensus minimum counts and modeling (Rivest et al. 1998).

Adult female survival

Objective
To obtain an annual estimate of survival for adult female Porcupine caribou.

Methods
Annual survival was estimated from GPS collared caribou using known-fate models (logistic regression). Annual survival for adult females (years 2012–2017), adult males (years 2015–2017), and yearling females (year 2017) were conducted separately and were reported with 95% confidence intervals. A year was defined as June 1 through May 31, which represents the time period from birth to consecutive birth dates.

Results
The sampling time period extends from June 1 – May 31, 2019 so data is still being collected for the 2019 birth year. Adult female survival analysis for 2018 will be completed in winter 2020, therefore no new results are available.

From 2012–2017, annual survival of adult females ranged from 79.6% (95% CI = 64.5% – 88.8%) to 94.5% (95% CI = 83.9% – 98.2%) and averaged 87.9% (95% CI = 82.8% – 91.6%) across all years (Caikoski 2018; Table 1; Figure 3). During 2015–2017, annual survival of adult males ranged from 69.8% (95% CI = 45.1% –85.1%) to 78.5% (95% CI = 56.0% – 90.4%) and averaged 74.8% (95% CI = 61.8% –84.0%) (Caikoski 2018; Table 1). Yearling female survival in 2017 was 93.7% (95% CI = 63.2% – 99.1%), the only year data was available for this age and sex class.

Discussion

Prior to the deployment of significant numbers of GPS collars on the herd, previous studies estimated survival rates of adult females using periodic radiotracking flights of VHF collars throughout the year and staggered entry product-limit methods (Kaplan and Meier 1958, Pollock et al. 1989). Fancy et al. (1994) reported an average annual survival rate of 84% during 1982–1991, Arthur et al. (2003) reported an average annual survival rate of 81% during 1997–2001, and Wertz et al. (2007b) reported an average annual survival rate of 82% during 2003–2006. Average annual survival of 88% during 2012–2017, suggests that survival of adult females improved compared to previous studies and is consistent with population growth during the same time period.

Population models based on PCH demographics suggest that relatively small but persistent reductions in adult female survival would result in population decline (Walsh et al. 1995, Griffith et al. 2002, Arthur et al. 2003). However, a suite of demographic parameters likely confound the effect of adult survival on abundance and can either mask the effects of high adult survival or may mitigate against poor adult survival. Furthermore, precision associated with estimates of survival to date are insufficient to detect statistical differences when small changes in vital rates occur. However, empirical evidence from vital rates reported here and three other studies compared to population abundance over the same time periods suggests a minimum long term average of 84% in annual survival for adult females may be necessary to prevent population decline.

Yearling female annual survival was 94% in 2017 and similar to adult females in the same year (95%). Future estimates of yearling female survival will likely improve our understanding of recruitment to the 2-year-old age class, particularly during stable, growing, or declining phases in herd abundance.

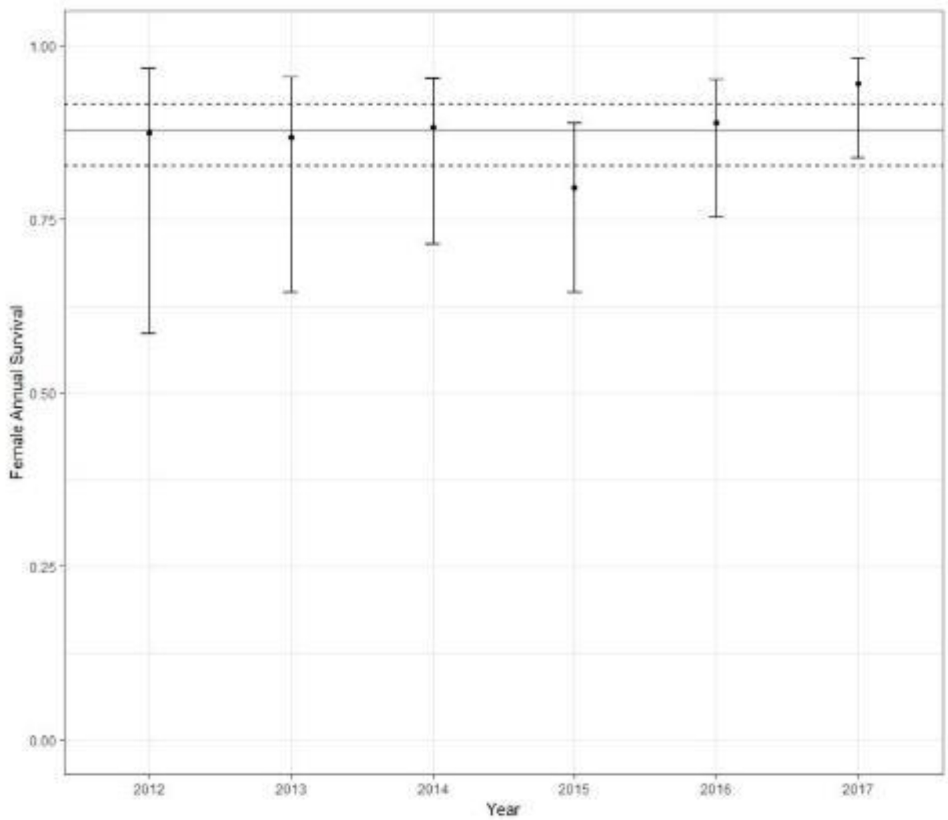

Figure 3. Adult female survival estimate within the Porcupine Caribou herds from 2012 – 2017 (Caikoski 2018).

Table 1. Year specific and grand mean survival estimates for adult females (2002–2017), adult males (2015–2017), and yearling females (2017; Caikoski 2018). A year is defined as June 1-May 31 (e.g. year 2012 = June 1 2012–May 31 2013).

	Year	Annual Survival	95% LCL	95% UCL
Adult Females	2012	0.874	0.586	0.967
	2013	0.868	0.645	0.955
	2014	0.881	0.715	0.954
	2015	0.796	0.645	0.888
	2016	0.888	0.752	0.952
	2017	0.945	0.839	0.982
	Grand Mean	0.879	0.828	0.916
Adult Males	2015	0.717	0.415	0.883
	2016	0.698	0.451	0.851
	2017	0.785	0.560	0.904
	Grand Mean	0.748	0.618	0.840
Yearling Females	2017	0.937	0.632	0.991

Calf birth rate and calf survival

Objective
To document the annual calf birth rate and survival rate.

Methods
Calving surveys are conducted each year to estimate the birth rate and early survival rate of calves. Radiocollared females ≥ 3-years old are located from a fixed-wing aircraft and are classified as barren, pregnant, or have given birth. Researchers can tell if female caribou are pregnant if cows are observed with calves, have hard antlers or distended udders (Whitten 1995). Starting in 2018 we will be providing parturition rates for both 3-year old and ≥4 year old cows. Researchers found that 3-year old parturition rates might be useful as an index of nutritional status on the calving and summer ranges reflecting herd recovery or potential overgrazing issues with populations increases (Boertje et al. 2012). When 3-year-old parturition rates fall below <55% (5-year moving weighted average) this signals low nutrition due to potential overgrazing or adverse weather conditions.

Female caribou are re-located after about one month to determine whether the calves have survived. Calving success is described as the percent of cows that had calves. The July calf ratio is based on the proportion of collared females still with calves in late June or early July.

During the March composition count we do not use the ratio of collared females in late winter because the majority of calves will have weaned by March, but instead estimate the number of calves for every 100 adult cows, called a calf:cow ratio.

Results
<u>Parturition rate</u>
Staff from ADF&G conducted a survey from 31 May through to 8 June, 2019 to estimate how many females were pregnant (parturition rate) in the population (Figure 4; Caikoski 2019a). The parturition rate for adult cows ≥ 4-years of age was slightly below average (81%, *n* = 42), and 9% lower for adult cows ≥ 3-years of age, (72%; n = 57; Figure 5). Parturition rate for 3-year-old cows was 47% (*n* = 15). We do not have a long enough time-series to calculate 5-year weighted moving average for 3-year-old parturition rate to determine if prolonged low nutritional status may signal a declining population.

<u>Post-calving survey</u>
ADF&G staff conducted a post calving survey on 22-23 June, 2019 to estimate cow:calf ratio and mid-summer calf survival 3 weeks after peak of calving (Figure 6; Caikoski 2019a). Post-calving survival, estimated from cows observed with calves in early June that were subsequently observed in late June (excludes mortality shortly before and after birth), was 94% for calves of adults cows ≥ 3-years of age (*n* = 29; Figure 5). The late June calf:cow ratio was 56 calves per 100 cows ≥ 3-years of age or older (Figure 5; *n* = 57). This rate was identical to the long-term mean. During the survey, most post-calving caribou were concentrated on the coastal plain between Katakturuk and Okpilak Rivers in Alaska (Figure 6).

<u>March composition count</u>
No composition count was conducted in March 2019. The last composition count (2017) reported a calf:cow ratio close to the long term average for the herd (35.8 calves per 100 cows; Figure 5**Error! Reference source not found.**).

Discussion

Population dynamics are most affected by survival of adult females over the medium and long term but can withstand fairly large annual fluctuations in calf birth rate or calf survival over the short term. Figure 5 shows large fluctuations in these rates, but if birth rates or calf survival rates are low for several years in a row, population growth is more vulnerable therefore we should keep monitoring calves to ensure that if a large change in productivity does occur, we are able to document it.

Since 2017, we have documented declines in birth rate for all age classes and similar declines in late June calf:cow ratio. Although these measures have declined, birth rates (with the exception of ≥ 3-year olds) and late-June survival are similar to long-term averages.

Three-year-old parturition rate is used as a long-term index that may reflect the impact of weather or range conditions on nutritional status. Based on past herd case studies, Boertje et al. (2012) suggest that managers can use this index to predict impending declines in herd numbers. We will continue to collect this information and compare to the threshold suggested by Boertje et al. (2012).

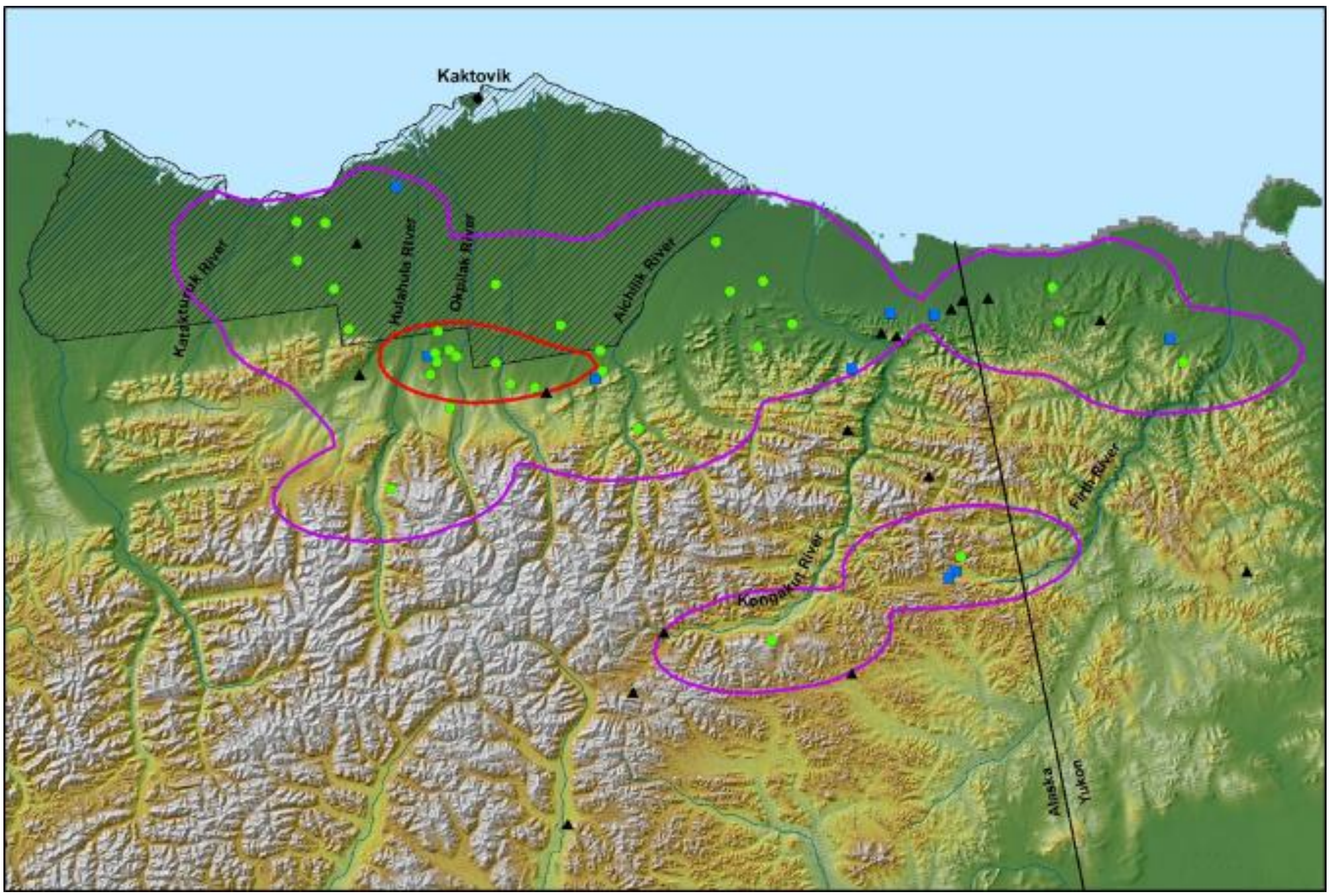

Figure 4. Locations of collared Porcupine caribou cows observed with a newborn calf (green circles), those judged to be parturient but had not yet given birth (blue squares), and those judged to be barren (black triangles), 31 May–9 June 2019 (Caikoski 2019a). Extent of the calving grounds was estimated by the isopleth encompassing 99% of the fixed kernel utilization distribution of locations of cows observed with a calf (purple polygon). The concentrated calving area is the area with greater than average density of caribou cows with calves (red polygon).

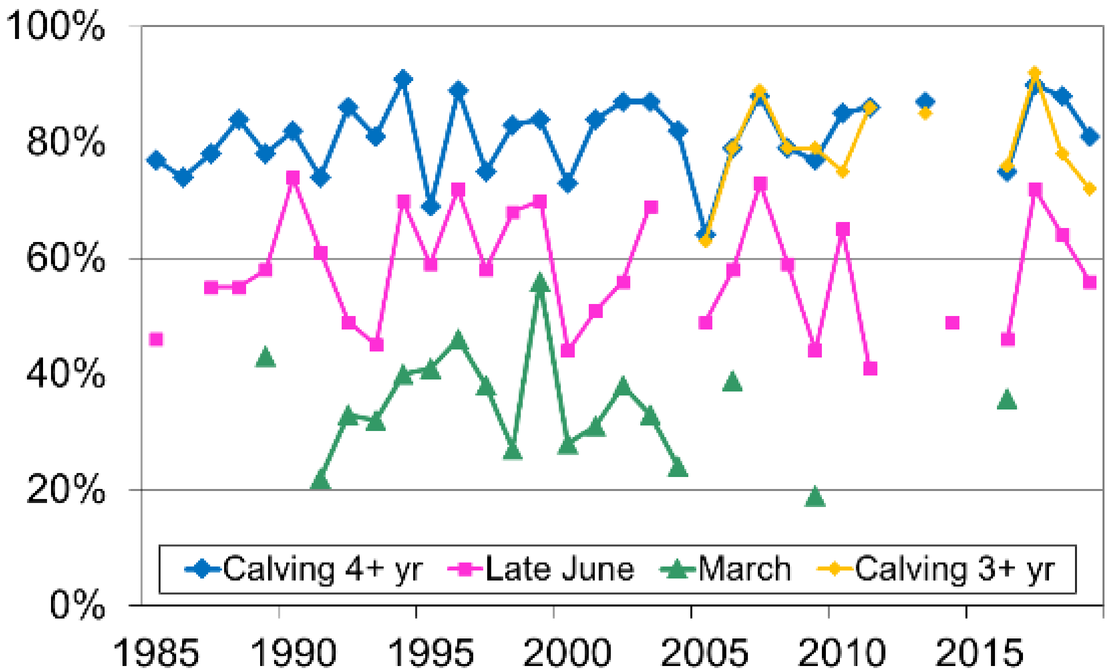

Figure 5. Estimated birth rate, calf survival indices and March composition count for the Porcupine Caribou herd from 1985-2019.

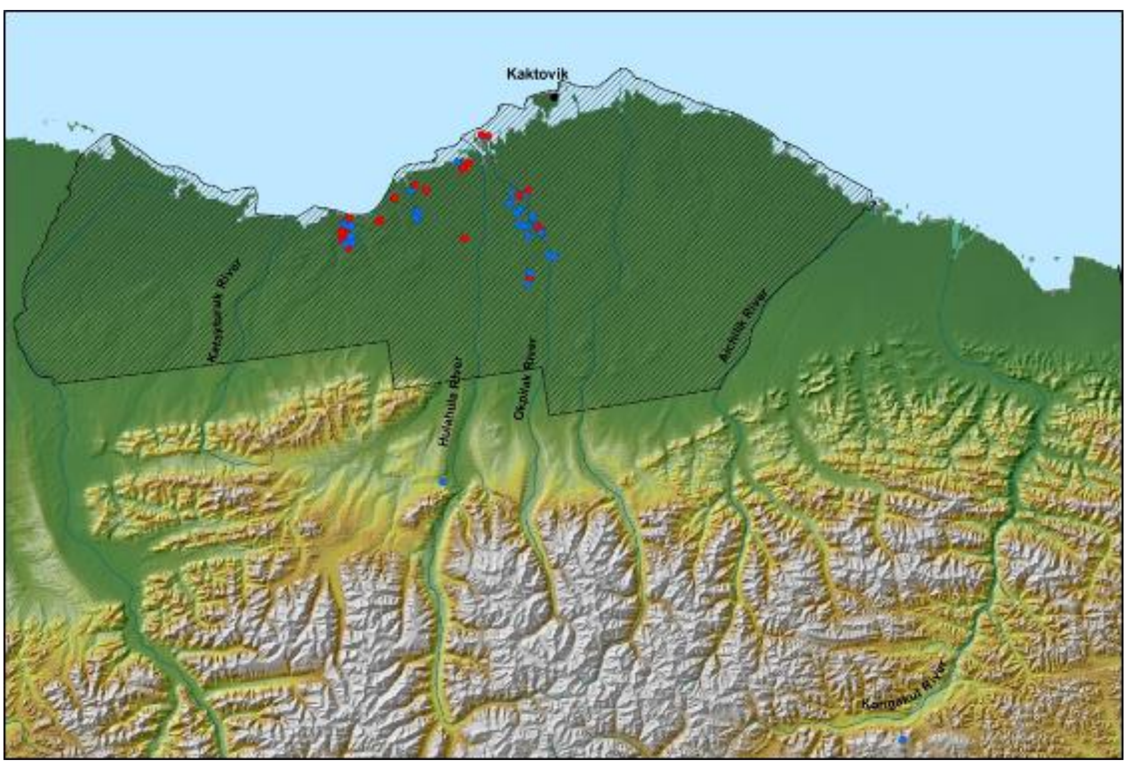

Figure 6. Locations of GPS collared Porcupine caribou cows observed with a calf (blue circles) and without a calf (red circles) during 22–23 June 2019 (Caikoski 2019a).

Peak and Extent of calving grounds

Objective
To estimate the date when greater than half of the collared adult female caribou have given birth each spring and the extent of the calving grounds.

Methods
During the calving surveys to document the birth rate (see previous), researchers record the date of their flights and how many of the collared cows have given birth. Only adult female caribou aged 3 years or older are used for this indicator. In some cases, the birth date is estimated based on the estimated age of the calf. The researchers then estimate the date when half of the collared adult female caribou have given birth. Peak of calving was approximated as the date at which greater than half of parturient cows were observed with a calf at heel.

Results
Of the cows ≥ 3-years of age that were judged to be parturient, 21 of 32 were observed with a calf at heel by 4 June, indicating peak of calving may have occurred later in 2019 compared to the long term mean of 1 June (Caikoski 2019a). Most calving occurred on the coastal plain and in the foothills from the Katakturuk River in Alaska to the Firth River in Yukon (Figure 4). However, two observations of cows with calves occurred in the mountains in the upper Kongakut and Firth Rivers. Concentrated calving occurred in the foothills from the Hulahula River to the Aichilik River in Alaska (Figure 4).

Discussion
Caribou typically give birth *en masse* with many of the cows giving birth within days of each other. This is thought to be a strategy to reduce the risk of predation on any individual calf. This means that most of the cows would have been bred within a very short time period therefore peak of calving can be used as an indicator of how the rut went the previous fall. If the calving period is extended, it might mean that the rut was disrupted and cows were bred in a second estrus. This shows up as calves being born over an extended period of time. This is important because calves born late in the season are probably more likely to die from predators and they also may be too small to make the migration south for winter, reducing calf survival.

Since 1999, the peak date of calving varies by a few days each year. This year the average peak of calving was 3 days later than the average (June 1st).There was also a late spring resulting in 1-2 feet of snow on the coastal plains during the calving period. We will continue to monitor this indicator to see if this is an emerging trend.

Table 2. Peak dates of calving for the Porcupine Caribou herd.

Year	Peak of calving	Note
1999	3-Jun	1 to 5 June
2000	7-Jun	
2001	8-Jun	5 to 10 June
2002	5-Jun	
2003	1-Jun	
2004	3-Jun	3 or 4 June
2005	2-Jun	1 to 4 June
2006	2-Jun	
2007	30-May	
2008	30-May	29 or 30 May
2009	2-Jun	Before 2 Jun
2010	2-Jun	
2011	2-Jun	
2012	No data	
2013	4-Jun	3rd or 4th June
2014	No data	
2015	No data	
2016	1-Jun	
2017	3-Jun	
2018	6-Jun	Could be bias late due to poor weather early in surveys
2019	4-Jun	
Average	1 June	

Bull Ratio

Objective
To document the ratio of bulls to cows in the herd.

Methods
We fly by helicopter during mid-October and classify as many as 200 caribou around each radio-collared caribou (bulls, cows, short yearlings). Caribou are classified into cow, calf, or either small, medium, or large bull. Then the number of bulls relative to the number of cows is calculated by dividing the total number of bulls by the total number of cows.

Results
Surveys are planned to coincide with years where photocensus surveys are completed, therefore surveys were not completed for 2019. The last survey was attempted by ADF&G in October 2017 but was unsuccessful due to poor weather.

The ratio of bulls to cows was estimated first in 1980 (Porcupine Caribou Management Plan 1989). That study estimated that there were about 60 bulls for every 100 cows which indicated a healthy herd. Bull survival and the bull ratio were not regularly monitored in following years because as long as the pregnancy rate remained high, there was no reason to believe that there are too few bulls to breed the cows. Subsequent surveys occurred in 2009 and 2010. Results from the 2010 survey are the most reliable and indicated a ratio of 57:100. In 2013 due to the poor result achieved in 2012 and the successful completion of a photo count on the herd, a rut survey was planned. Unfortunately leading up to the survey a large proportion of the herd moved to the western edge of the herd's range, eventually mixing with members of the Central Arctic Herd. Monitoring during the rut showed most caribou remained mixed with the CAH which resulted in the cancellation of the rut count.

Discussion

In the Harvest Management Plan for the Porcupine Caribou Herd in Canada (HMP; Porcupine Caribou Management Board 2010), there is a provision for bull only harvest to be implemented for different user groups if the herd drops below a certain population size. In addition, the PCMB continues to promote harvesting of bulls, regardless of population size. Population modeling has shown that if the proportion of bulls in the harvest rose from 30% to 80%, we could see a sex ratio in the herd of about 40 bulls per 100 cows. We don't really know what might happen to the herd sex ratio when we take more bulls during harvesting activities; as a result we completed composition counts to get an updated bull ratio in 2009 and 2010 prior to the projected increase in harvested bulls resulting from the HMP.

The PCTC plans to conduct a rut count every year that a photo count is completed in order to input the sex ratio into the population model (Herd Estimator). Accurate harvest data from all Parties, including the sex ratio of the harvest, is important to assess the effect of a bull dominated harvest on the herd sex ratio.

CARIBOU BODY CONDITION

Hunter assessments and condition indicators

Objective

This long term project uses specific samples from hunter killed caribou to track the fatness of Porcupine Caribou.

Methods

Starting in 1987, Anne Allaye-Chan (a PhD student from University of Alaska Fairbanks) developed equations to estimate the body weight, body fat and body protein for adult cow Porcupine Caribou (Allaye-Chan 1991). Government of Yukon (YTG) did collections from 1989 to 1991 to test these equations and in 1991, started regular monitoring with hunters from Old Crow (Porcupine River in September), Ft. McPherson, Dawson and Mayo (Yukon portion of the Dempster Highway in November and March).

In 2001, we formally modified the program so that hunters could submit samples from any caribou they harvest. This program is also called the Caribou Sampling Initiative (CSI) in the HMP and is also similar to the Circum-Arctic Rangifer Monitoring and Assessment network Level 1 monitoring (Gunn and Nixon 2007). Hunters record a number of variables and rate the condition of their caribou.

Results

During the fall and winter of 2018-19 caribou were generally not available to hunters. Only 5 body condition indices samples were collected from 8 caribou sampled. Porcupine Caribou moved out of the Yukon at the end of August 2018, and though some did return in late fall, they moved to areas where they were generally not available to harvesters.

Discussion

Overall, caribou condition seems to have improved in past years, although the data seem to be more variable after 2001 when hunters began rating their harvested caribou compared to when they were working with the biologists on the collection (Figure 7 and Figure 8). This could also be a seasonal effect; caribou collections in the early 1990's were done three times (Sept, Nov and March) whereas the current system allows hunters to submit samples all winter long. Bulls harvested in September tend to have the highest body condition and backfat values, while bulls and cows harvested in October and November tend to be significantly lower – as observed during this sampling period.

We should also keep in mind that hunters can be very selective when harvesting. This indicator gives an index of harvested caribou, not an index of the entire herd. Also, data are pooled over each winter but sample sizes remain small.

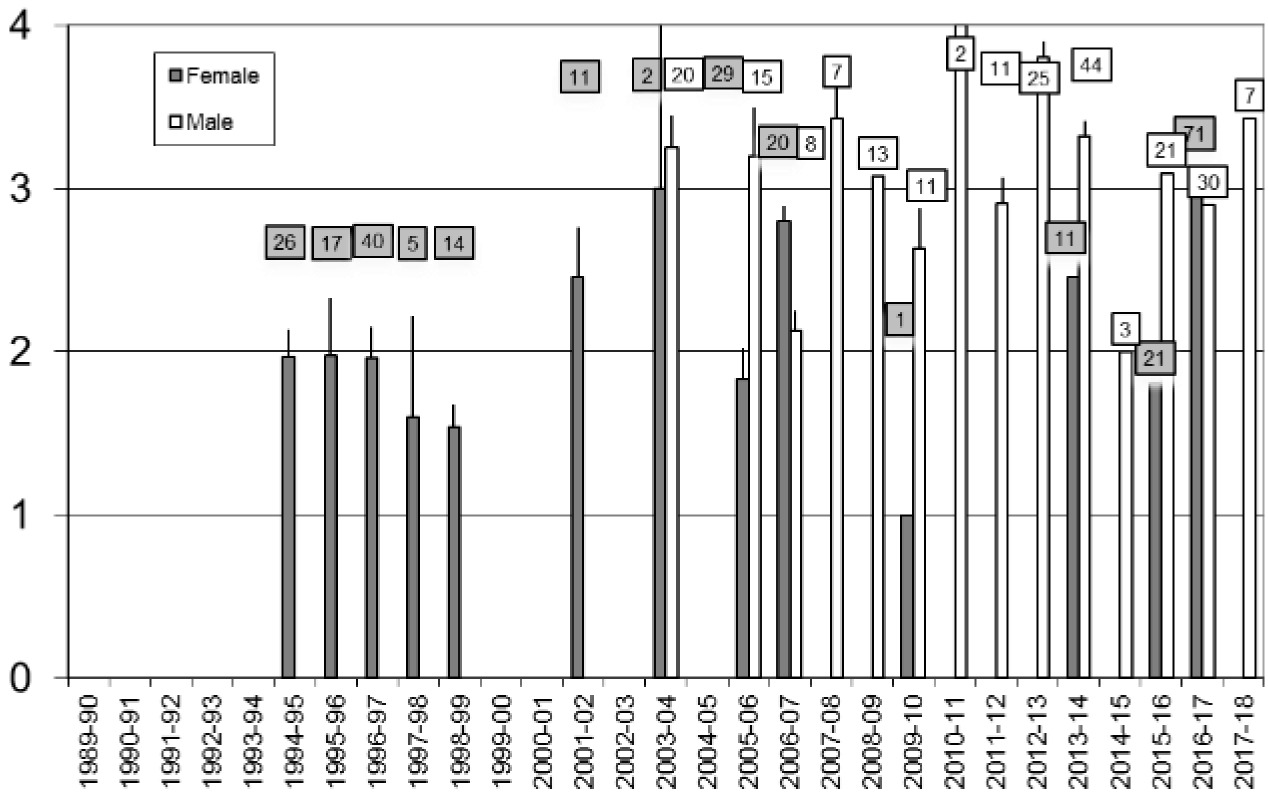

Figure 7. Average condition of harvested Porcupine caribou recorded by hunters. 1=poor 2=fair 3=good 4=very good. Error bars are standard errors. Labels indicate # of caribou sampled. There was limited data collected in 2018-19.

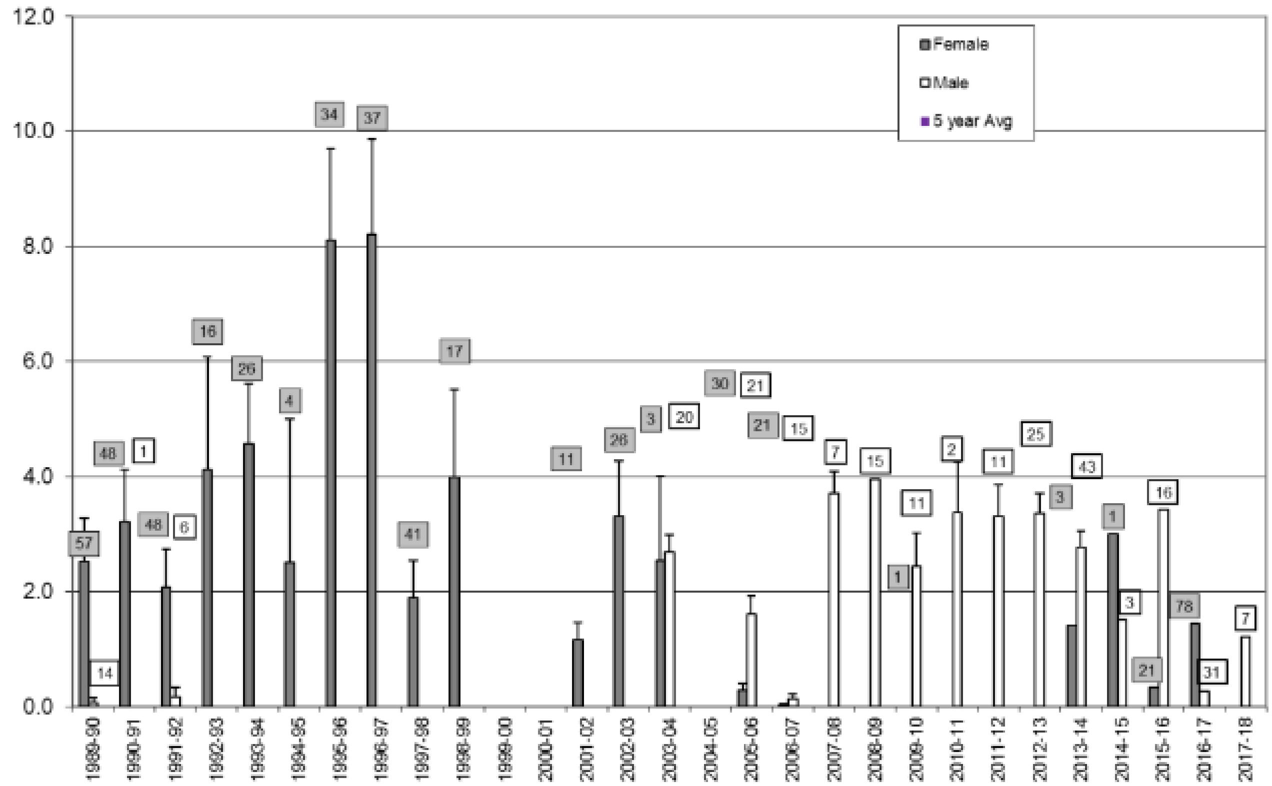

Figure 8. Average depth of backfat (cm) recorded in Body Condition Monitoring. Error bars are standard errors. Labels indicate # of caribou sampled. There was limited data collected in 2018-19.

HABITAT

Wildland fires

2019 season fire map data is not yet publicly available from Yukon or NWT, although we are aware that some significant fire events occurred in PCH range in 2019. This section of the report contains information current to 2018 for Yukon and Alaska. NWT data was not available at time this report was prepared, although it is believed that there were no significant fires on the NWT portion of the range in 2018.

Objective
To monitor the amount of Porcupine Caribou range burned as an index of range condition.

Methods
Historical fire perimeter data was downloaded from the respective agencies websites. Some judgments were made to delete what we thought were duplicate fires and merge incompletely mapped fires along the borders between jurisdictions. Fire polygons were clipped to the extent of PCH range and total area burned was summed for each year. The Alaskan fire perimeter data starts in 1945, Yukon in 1945 and NWT in 1965, therefore only fire information since 1960-2018 was summarized in this report.

Results

As of the 2018 season, the total area burned by fires since 1960 is 44,026.0 km^2 or roughly 17% of the Porcupine Caribou herd's total annual range (Figure 9). Yukon fires in 2018 burned a total of about 162.5 km^2, well below the 5 year average (1,119.6 km^2). In 2018 there were 6 fires in the Yukon portion of the PCH range and 2 in Alaska (Figure 10). Only 1 fire in Alaska was considered large (>10,000 hectares). Overall, fire activity during the 2018 fire season appeared to be fairly minimal on PCH range (Figure 11).

Discussion

Fire perimeters are mapped by the fire management sections of the 3 jurisdictions. Although there are many similarities in methods, there are five cautionary notes when considering the data presented here. Firstly, the technology for remotely detecting wildland fires improved only in the 1960's therefore data prior to that should be viewed with caution. Secondly, past fires are continually being digitized from satellite or other remote sensing methods so the dataset will change as new data on old fires is added. Thirdly, maps show perimeters of fires only and do not reflect any unburned patches or varying fire severity within burned area. Fourthly, some fires are too small to map and are not included in the map files, and finally some fires burn areas that were previously burned.

There is much variability in how fires affect caribou; however, research completed on the Beverly Caribou Herd found that forests burned by wildfire produced enough lichen forage as early as 40 or 50 years after the fire. These areas once again become important to caribou (Thomas and Kiliaan 1998). Caribou also tended to avoid burns larger than 10,000 hectares (100 km^2). The rate of re-growth of caribou forage can be quite variable and caribou use of burns is generally unknown, therefore wildland fire information presented here should be considered as an index of changes to winter habitat.

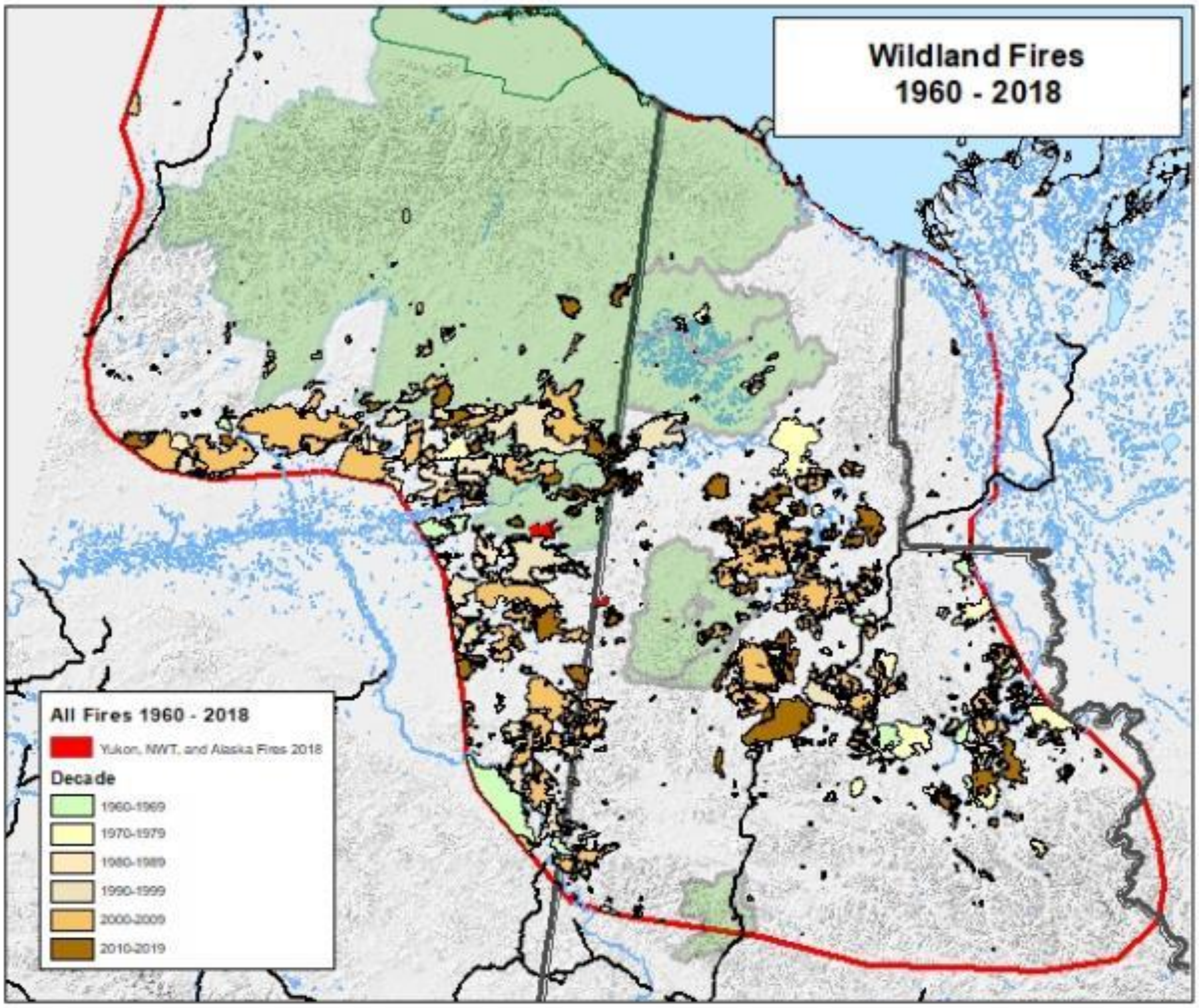

Figure 9. Areas burned within range of the Porcupine Caribou Herd in Yukon, NWT and Alaska from 1960 to 2018.

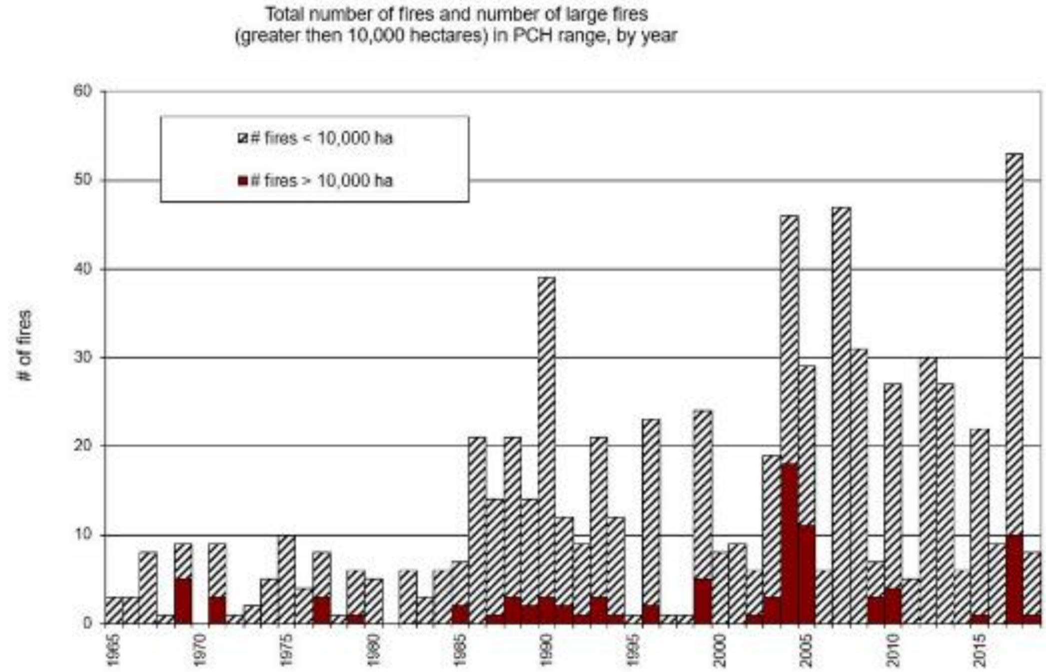

Figure 10. Total number of fires and number of large fires to 2018 within the range of the Porcupine Caribou Herd in Yukon, NWT and Alaska

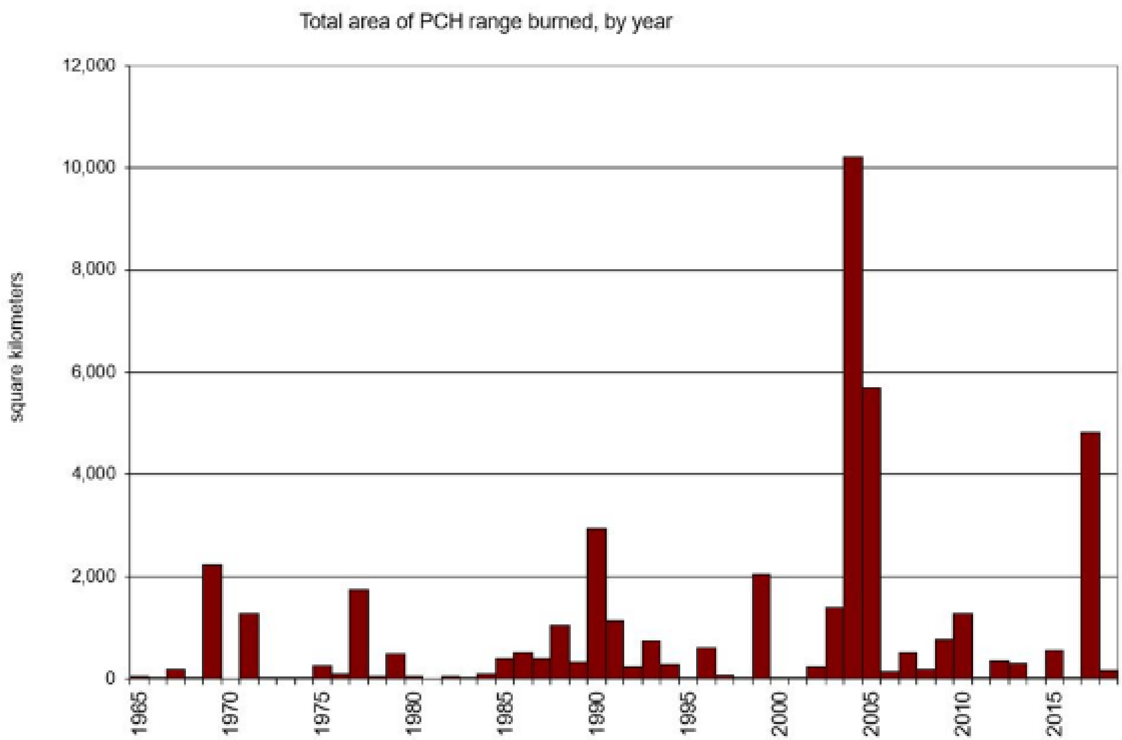

Figure 11. Total area burned by fire, by year to 2018 within the range of the Porcupine Caribou Herd in Yukon, NWT and Alaska.

Linear disturbance and human development footprint

Objective
To monitor the amount of linear disturbance and development footprint present on the herd's range.

Methods
Data is acquired from a number of sources in NWT, Yukon, and Alaska. Much of the historical data was acquired during a cumulative effects assessment completed for the PCMB in 2008-2012. Newer data was acquired for specific activities known to have been carried out within the range of the herd. Data quality varies for historical data but is thought to be more accurate for recent disturbances. Smaller developments (e.g., individual gravel quarries) may not be accounted for. In the case of historical disturbances (e.g., seismic lines cut in the 1960's), it is unknown whether features have adequately recovered or not to be removed from datasets, and in most cases a wide range of vegetation recovery can be expected even on the same feature.

Data is mapped at a range scale and areas with significant new development are provided with a map of the specific area that has been disturbed. Where appropriate the total linear footprint has been summarized for different disturbance types and a total area of the footprint provided where possible.

Results
In 2018-19, no detectable changes occurred in linear disturbance and human footprint. A current proposal is being developed by the Alaska Bureau of Land Management (BLM) to conduct lease sales in the 1002 area of the Arctic National Wildlife Refuge (ANWR). This area overlaps with PCH calving, post-calving and summer ranges. There is currently no proposal in ANWR to conduct winter seismic data collection.

Most development in the range of the Porcupine Caribou herd occurred prior to the 1980's so we know relatively little about the disturbances except when they are still active (Figure 12). In 2013-2014 a major 3D seismic project occurred in the Eagle Plains area of Yukon. Based on data provided by Yukon Oil and Gas Branch and the company responsible for conducting the work, a total of 2124 km of seismic line varying in width from 1.75-5 meters was cut, totaling approximately 5.35 km^2 of footprint. Access roads in the area totaled 228 km and varied in width between 3-5 meters (Figure 12).

Discussion
Linear disturbances and human footprint can affect caribou in multiple ways. Increased access can provide hunters with increased success and in some cases may facilitate predator movements resulting in higher predation levels or increased stress levels for caribou. Footprint can also impact habitat and habitat use by either directly impacting the habitat or by creating behavioural responses where caribou do not use high quality habitat as they may perceive it to be too risky. Large patches of intact habitat are known to be critical to caribou herds.

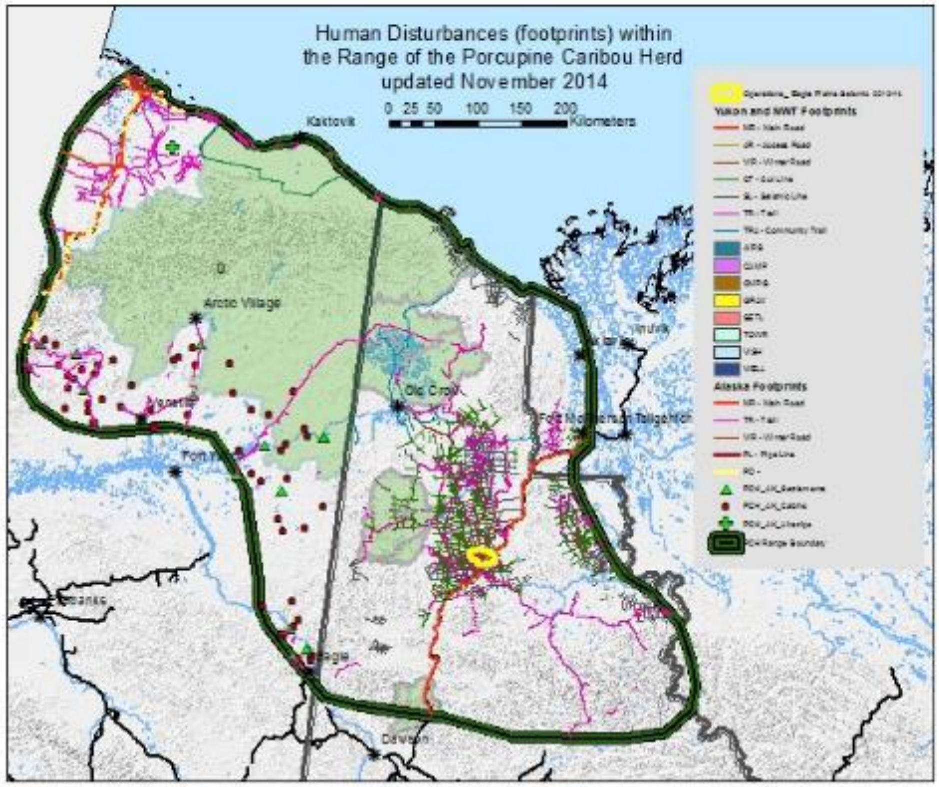

Figure 12. Human disturbance within the range of the Porcupine Caribou herd (updated Nov. 14, 2014 – November 23, 2017) in Alaska, Northwest Territories, and Yukon.

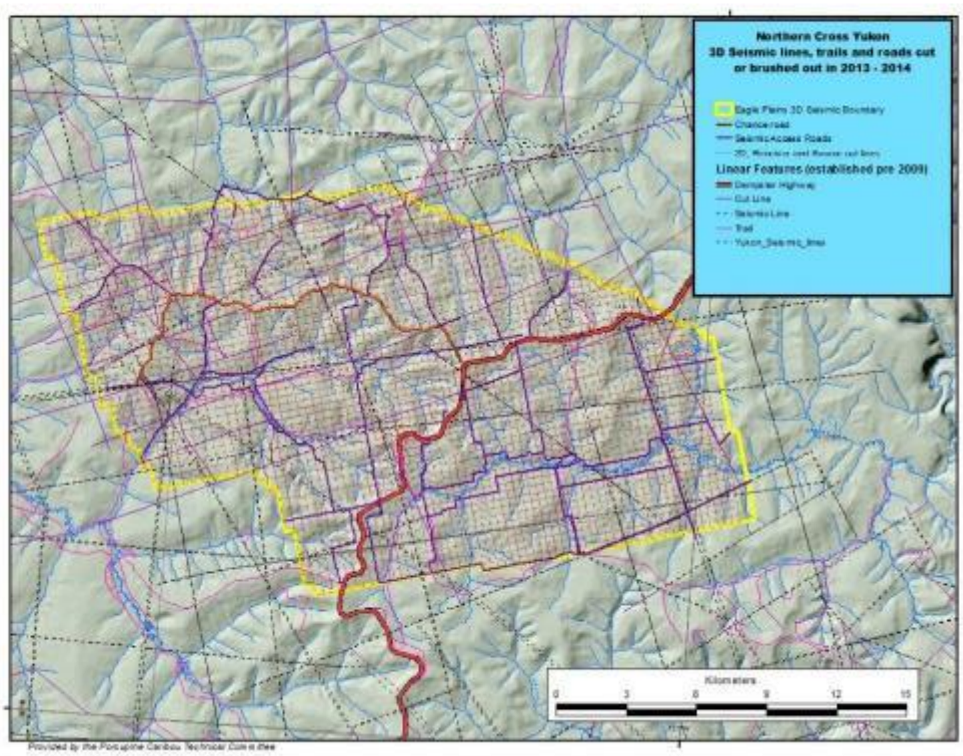

Figure 13. The extent of 3D seismic lines, trails and roads cut or brushed out in 2013-14 by Northern Cross within the range of the Porcupine Caribou Herd in Yukon

Snow condition

Objective
To gather an index of snow depth and hardness.

Methods
Water Resources (when under Environment Canada and now under Yukon Government) recorded late winter snow depth and snow water equivalent back to the 1970's. The Yukon Fish and Wildlife Branch also did late winter snow measurements along the Dempster Highway and Yukon north coast since the 1990's.

At specified permanent locations, a series of measurements are made, usually 10 repeated measures and depth and either snow density or snow water equivalent (SWE) is recorded. Where necessary, SWE is converted to density by dividing SWE by the depth of snow. Not all stations were measured in all years. Data presented in this report represents results from 17 stations from the Yukon since 2013. Data from other jurisdictions were not available in a compatible format for this report. For example the GNWT records SWE and not depth so snow density measurements cannot be calculated and do not appear on Figure 15.

Results
The majority of the PCH wintered in Alaska between Arctic Village and the Dalton Highway. In the Yukon, there were several thousands of caribou that wintered in the upper Miner and Whitestone drainages (Figure 14). Snow depth and density was above average in the Eagle and Old Crow Region, but well below average in the Ogilvie Region (Figure 15). Snow measures were not collected in the Richardson or North Slope regions. Most regions do not appear to have any changes in long term trends, however the Eagle Region does appear to have an increasing trend towards a deeper snow pack over the past decade as compared to the previous decade. Snow density may also be increasing in the Ogilvie and Eagle Regions.

During late winter fieldwork in the Yukon, we observed snow conditions that corresponded to the above data; snow in the upper Miner and Whitestone drainages was generally a lot shallower than we might have expected. During late winter fieldwork in Alaska, it appeared that snow conditions were quite variable: valley bottoms and treed areas appeared to have moderate to deep snow cover, whereas mountain ridges were generally windswept and hard packed or quite bare. Consequently, most large groups of caribou seemed to occupy windblown ridges.

Discussion
When snow is deep or hardened by wind, caribou expend more energy digging through the snow which can potentially affect their body condition, and reproductive capability. Caribou are not always in the areas where we measure snow but this information can be used as an index of winter conditions affecting caribou.

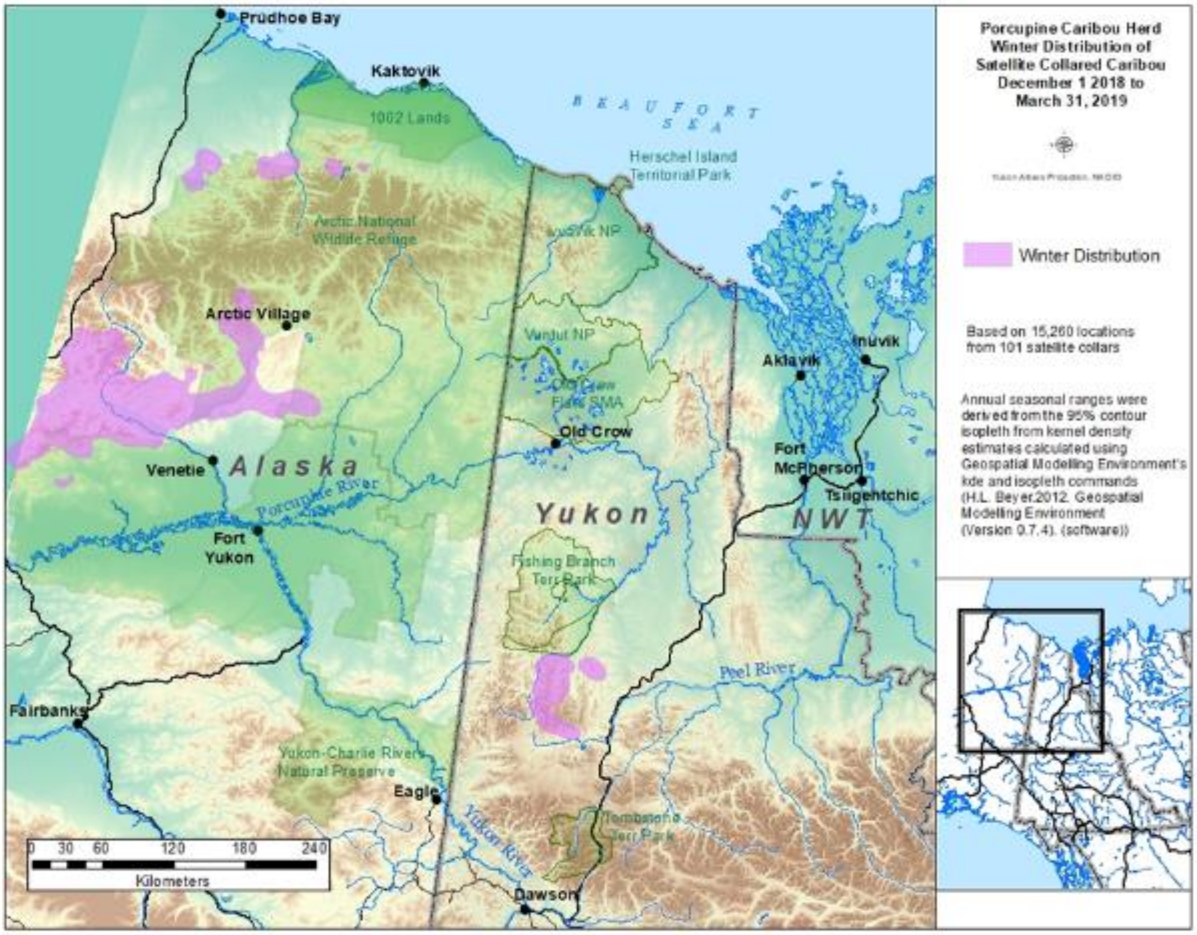

Figure 14. Winter distribution of Porcupine Caribou from Dec. 1, 2018 to March 31, 2019. Some caribou used to produce this range may have be considered Central Arctic Herd (particularly some of the North Slope polygon data). Data will be monitored and it's possible that this range map may need to be re-estimated in the coming year once determined.

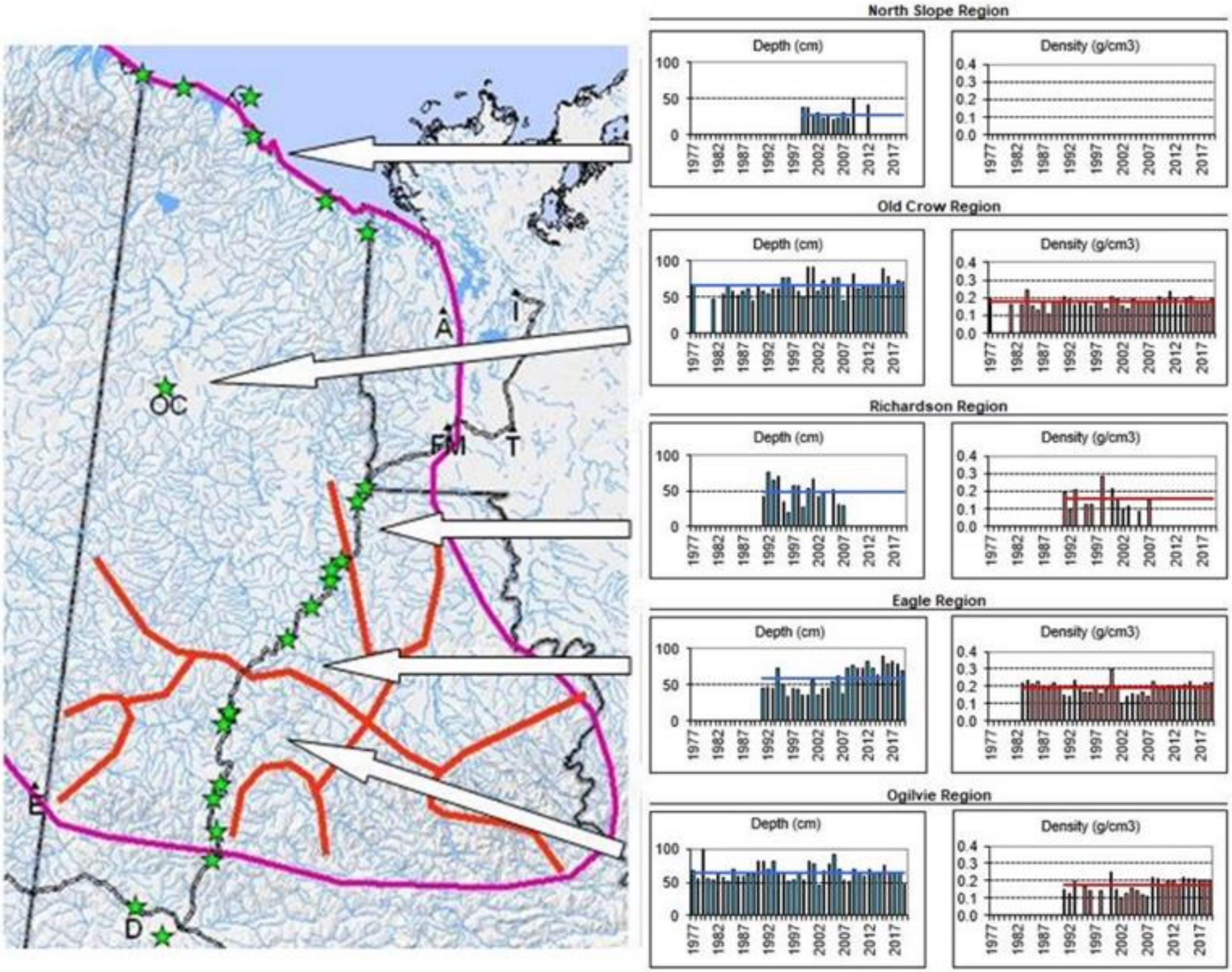

Figure 15. Summary of snow depth and density by snow region from permanent stations (indicated by green stars) for the Yukon portion of the Porcupine Caribou Herd range. Red lines on the map delineate snow regions relevant to caribou (Russell et al 1993).

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Appendix A. Summary of biological parameters

Year	Parturition Rate ≥ 4 yrs (sample size)	Parturition Rate ≥ 3 yrs (sample size)	Parturition Rate ≥ 3 yrs (sample size)	June Calf Survival[c]	Post-calving Survival[d]	Late June Calf:Cow[e]	March Calf:Cow[f]	Population Estimate	Peak of calving	Calving note
1985	0.77					0.46				
1986	0.74									
1987	0.78 (51)			0.71		0.55		165,000		
1988	0.84 (91)			0.65		0.55				
1989	0.78 (74)			0.74		0.58	0.43	178,000		
1990	0.82 (74)			0.90		0.74				
1991	0.74 (77)			0.82		0.61	0.22			
1992	0.86 (78)			0.57		0.49	0.33	160,000		
1993	0.81 (63)			0.56	0.83	0.45	0.32			
1994	0.91 (98)			0.77	0.93	0.70	0.40	152,000		
1995	0.69 (95)			0.85	0.92	0.59	0.41			
1996	0.89 (74)			0.81	0.91	0.72	0.46			
1997	0.75 (48)			0.77	0.90	0.58	0.38			
1998	0.83 (58)			0.82	0.94	0.68	0.27	129,000		
1999	0.84 (39)			0.83	0.86	0.70	0.56		3-Jun	1-5 June
2000	0.73 (44)			0.61	0.82	0.44	0.28		7-Jun	
2001	0.84 (70)			0.61	0.79	0.51	0.31	123,000	8-Jun	5-10 June
2002	0.87 (68)			0.65	0.85	0.56	0.38		5-Jun	
2003	0.87 (70)			0.79	0.85	0.69	0.33		1-Jun	
2004	0.82 (74)			g	g	g	0.24		3-Jun	3-4 June
2005	0.64 (55)	0.63 (65)	0.60 (10)	0.77	0.88	0.49	h		2-Jun	1 - 4 June
2006	0.79 (66)	0.79 (67)	1.00 (1)	0.73	0.86	0.58	0.39		2-Jun	
2007	0.88 (67)	0.89 (71)	1.00 (4)	0.83	0.90	0.73	h		30-May	
2008	0.79 (63)	0.79 (69)	0.83 (6)	0.73	0.92	0.59	h		30-May	29 or 30 May
2009	0.77 (65)	0.79 (72)	1.00 (7)	0.57	0.75	0.44	0.19		2-Jun	
2010	0.85 (41)	0.75 (48)	0.14 (7)	0.76	0.87	0.65	h	169,000	1-Jun	prior to 2 Jun
2011	0.86 (59)	0.86 (59)		0.48	0.59	0.41	h		30-May	prior to 1 Jun

Year	Parturition Rate ≥ 4 yrs (sample size)	Parturition Rate ≥ 3 yrs (sample size)	Parturition Rate ≥ 3 yrs (sample size)	June Calf Survival[c]	Post-calving Survival[d]	Late June Calf:Cow[e]	March Calf:Cow[f]	Population Estimate	Peak of calving	Calving note
2012	g	g	g	g	g	g	g		30-May	prior to 1 Jun
2013	0.86 (42)	0.85 (45)	0.67 (3)	i	I	i		197,000	04-Jun	3-4 June
2014	g	g	g	g	g	0.49			no data	
2015	g	g	g	g	I	i			no data	
2016	0.75 (28)	0.76 (37)	0.78 (9)	0.61	1.00	0.46	0.36		3-Jun	
2017	0.90 (42)	0.92 (54)	1.00 (12)	0.81	0.90	0.72		218,000	3-Jun	
2018	0.88 (41)	0.78 (50)	0.33 (9)	0.73[j]	0.88[j]	0.64[j]			6-Jun	
2019	0.81 (42)	0.72 (57)	0.47 (15)		0.94[j]	0.56[j]			4-Jun	
Mean	0.82	0.79	0.71	0.72	0.87	0.58	0.35			
5 yr mean	0.84	0.80		0.72	0.93	0.58	0.36		1-Jun	

[a] Data are from Fancy et al. (1994, Can. J. Zool. 72:840–846), Alaska Department of Fish and Game, and Yukon Department of Environment.

[b] Number of radiocollared adult cows for which parturition status was determined in early June, excluding those known to be <4 years old. Includes caribou of unknown age, but most likely > or equal to 4 years olds. Prior to 2003, all caribou were of unknown age.

[c] Estimated as (July calf:cow ratio)/(parturition rate).

[d] Includes only calves observed during early June that were subsequently observed in late June (i.e., does not include most perinatal mortality).

[e] Excludes radiocollared cows known to be < 4 years old.

[f] As of March of the year following birth of each cohort; includes all cows >1 year old.

[g] No data due to adverse weather conditions.

[h] No data due to mixing of herds on winter range.

[i] No data due to dense caribou groups making identification of cow:calf pairs not possible.

[J] Starting in 2018, all females ≥3 years old are included in the summary. Past status reports only reported adult cows ≥4 years of age unless otherwise stated in the footnotes. Parturition status remains for radiocollared adults ≥4 yrs old.

Appendix B. Previous research findings

Adult female survival

Objective

To obtain an annual estimate of survival for adult female Porcupine caribou.

Methods

There have been a number of issues with past methods to determine female survival estimates. However, with increases in the number of GPS collars deployed on the herd, the PCTC can calculate survival estimates using the known fate (i.e. alive, dead) of GPS collared females. Analyses will include how survival varies by age, sex and season.

Results

Analysis is currently underway and results are expected in early 2019. Researchers started a project in 2003 to get an updated estimate of adult female survival in response to the continued population decline (Wertz et al 2007a). Survival estimates ranged between 0.065 to 0.097 but showed a general trend of increased survival from 2003 to 2011. (Figure 16).

Discussion

As with many populations, the survival of breeding females is very important to the potential growth of the herd. A sustained change of 2 or 3 percent in survival can make the difference between a herd increasing and decreasing. Adult female survival has been estimated twice before; once when the herd was increasing and again when the herd began to decline (Fancy et al 1994, Walsh et al 1995). Information gathered from these earlier studies indicated that most cows died in winter, the harshest season of the year.

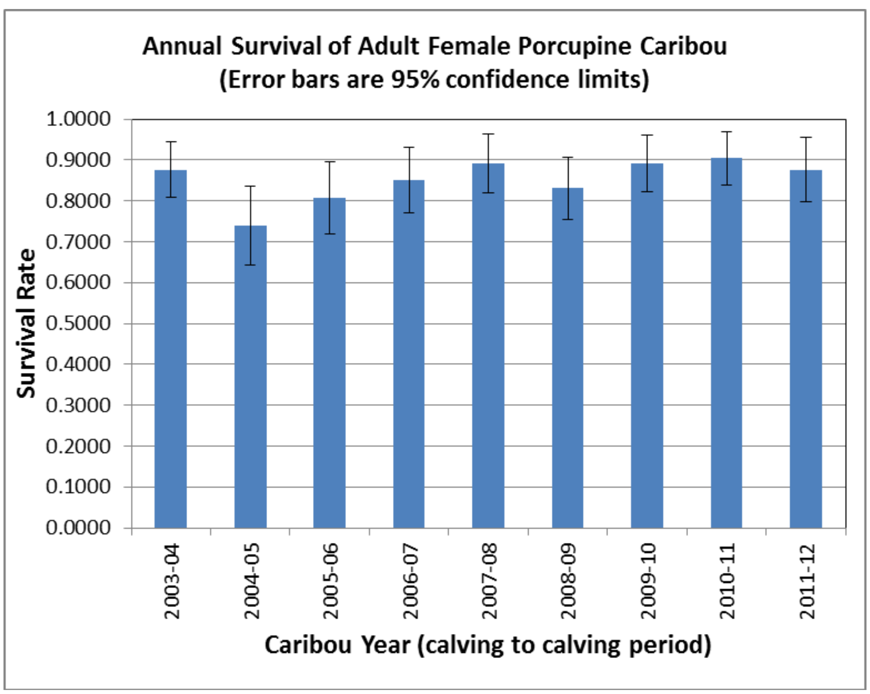

Figure 16. Annual survival estimates for adult female Porcupine Caribou, May 2003 – June 2012. Source: USFWS unpublished data.

Short yearling survival to 3 years of age

Objective
To document the survival of 9 month old calves to 3 years of age (2003-2010 only).

Methods
Starting in 2003, we captured about 10 female caribou in March that were born the previous spring (9 months old) and put conventional radio collars on them. The data from all years of captures were pooled to estimate how many calves survived to breeding age. Because we know exactly how old these caribou were, we recapture them after 3 years or sooner and replaced their collars to maintain a collared sample.

Results
The average survival rate of female Porcupine caribou appears to decline as caribou age from 9 months to 3 years but because of the error bars overlap on the estimates we cannot say for certain that there is any change in survival rate as caribou survive to breeding age (Figure 17). The average survival rates of female caribou 9 mo. – 3 yrs of age are similar (87%) to adult female survival rates taken from the same time period (84%). The last year of this seven year study was completed in 2010.

Discussion
In 2003, we started a 7-year study to estimate how well calves survive to 3 years of age when they should enter the breeding portion of the population. This has been estimated only once before in 1983-88 (Fancy et al 1994). We have been assuming that once calves reach one year of age, they survive at the same rate as adults. We are testing this assumption because, as with the survival of adult females, the survival of young females is important to population dynamics. Computer population modeling shows that it would take a decrease of only 6% in adult female survival or a decrease of 50% of calves to cause a decline like we have documented for the Porcupine Caribou Herd between 1989 and 2001 (Arthur et al 2003). Other work has shown that survival of calves in their first year of life is very low. Survival of these young, non-breeding animals is similar to adult females.

Small sample sizes are an issue for this analysis. The estimates are based on data pooled over multiple years of collaring efforts, however the sample size at step one of the analysis is 59 animals. In order to be able to detect small changes in short yearling survival with confidence, we would have to maintain collars on many more young caribou. There are constraints to doing that in terms of funding, availability of free radio frequencies, logistics of flying, and community concerns. Despite these constraints, we decided to continue small numbers collaring short yearling females each year to continue recording survival estimates (low statistical power given the small sample size) but also to ensure the collared sample of caribou is not biased toward older animals.

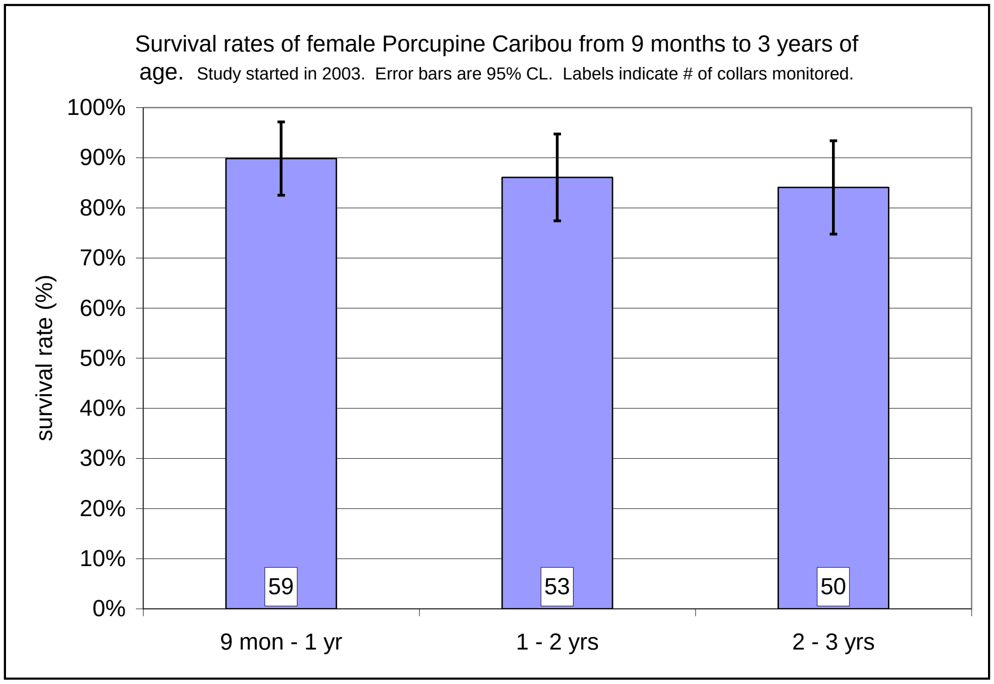

Figure 17. Survival of Porcupine Caribou females from 9 months to 3 years of age from 2003-2010.

Adult bull survival

Objective
To document the survival of adult bull caribou (2003-2010 only).

Methods
Each year before a census attempt, we deploy a number of collars on adult bull caribou so we can locate the bull groups during the census field work. Because we've been preparing for a census each year for 8 years running, we have an unprecedented number of bulls collared. We are able to do an analysis similar to the short yearling analysis. All collared bulls were pooled and we calculated their survival rate in years following capture.

Results
Between 2003 and 2006, more bulls died during the fall than any other season. Bull mortality rate increases dramatically about 5 years after collaring (Figure 18). Assuming bulls were at least 3 years old at the time of capture, bulls start dying at an increased rate at 8 or more years of age. The study on adult bull survival extended from 2003 – 2010. No further collaring of bulls is planned.

Discussion
As expected, we see that bulls seems to survive at a lower rate than adult cows. Bulls are probably more stressed during the rut which contributes to a lower survival rate.

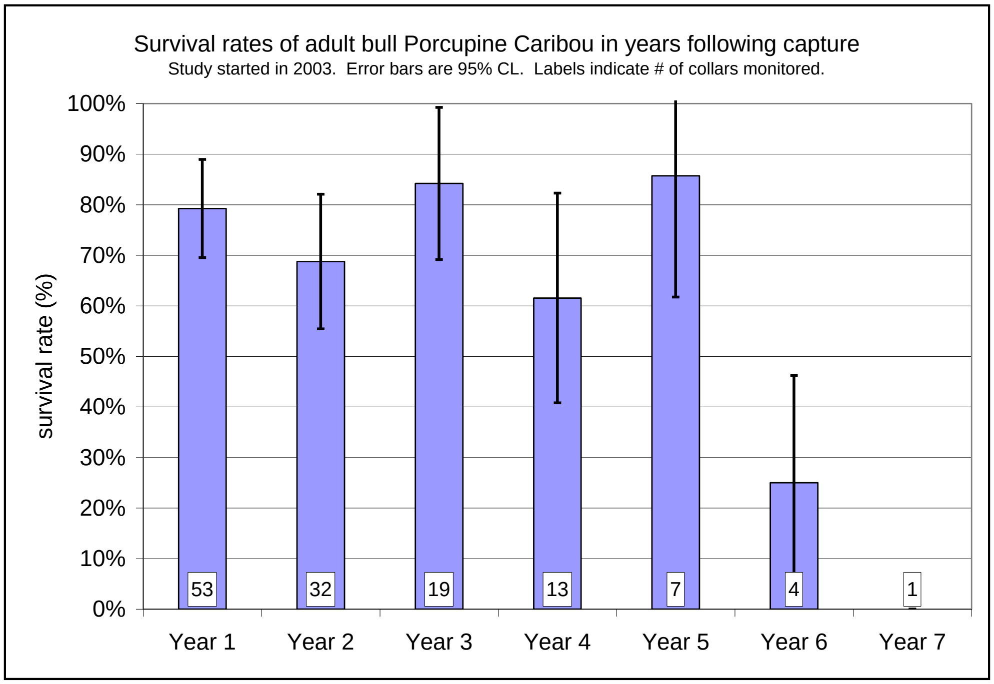

Figure 18. Survival of male Porcupine Caribou from 2003 to 2010.