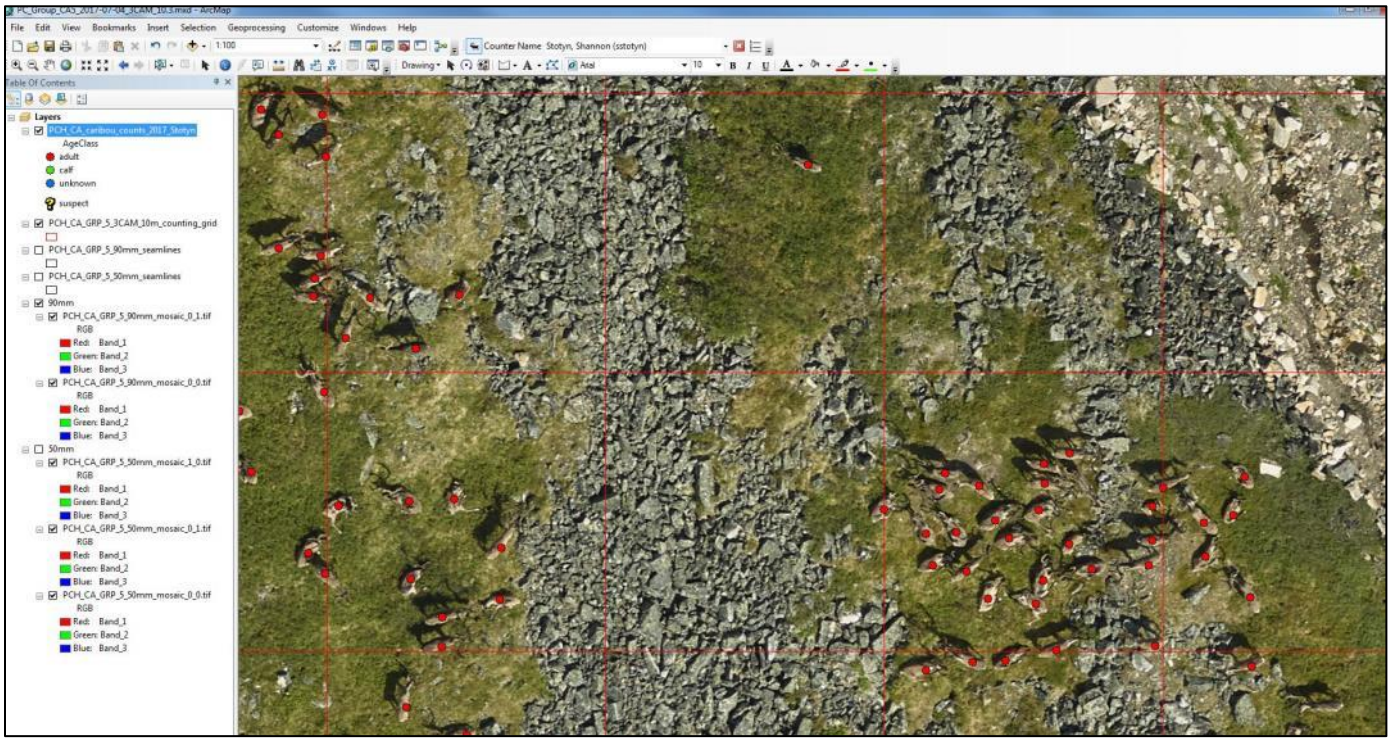
PORCUPINE CARIBOU
ANNUAL SUMMARY REPORT
2017



Porcupine caribou census, photo : ADF&G

Submitted to: Porcupine Caribou Management Board

Submitted by: Porcupine Caribou Technical Committee

November 30, 2017

Indicator Table

Annual Summary Report - 2017

Indicator	Value	5 year average	Notes	Assessment and Year Represented
Population size and trend				
Population size	2017 = results pending	--	Successful photocensus in July 2017. Waiting for final results	
Population trend	2017 = results pending	--	Declined by 55,000 caribou between 1989 and 2001. Recovered to 169,000 by 2010 and continued to increase to 197,000 in 2013.	
Adult cow survival	2017 = no data	0.879	The last estimated survival rate (2011-12) was relatively high and was indicative of a growing population at that time. Results from new analysis expected early 2018.	
Calf birth rate	2017 = 0.88	0.83	29-year average = 0.81	Higher than average (2017)
Late June calf:cow ratio	2017 = 0.72	0.56	27-year average = 0.58	Higher than average (2017)
March calf:cow ratio	2017 = 35.8	--	17-year average = 0.35.	Average (2017, 2016 birth year)
Bull Ratio	2017 = no data	--	Attempted, poor weather. Next survey scheduled for 2018.	
Peak of calving	2017 = June 3, 2017	1 June		(Average 2017)
Body condition				

Average backfat	F: 1.4 cm; M: 0.3 cm	2.6 cm	Caribou were generally not available to hunters in Old Crow in September but returned and were available in November. Caribou were available to hunters from the NWT delta communities September thru December on the north coast and in the Richardson Mountains.	Below average overall but good shape for time of year (Fall 2016)
Hunter assessment	F: 3.1 M: 2.9	2.9	Most samples were collected in November and December, few in September. Hunters assessment was based on condition for the time of year.	Higher than average (Fall 2016)
Condition of caribou	Good	N/A		Average (Fall 2016)
Habitat and other considerations				
Snow conditions winter (2015-16)	<u>Snow Depth</u> Eagle = 82.0 cm Ogilvie = 63.0 cm Old Crow = 68.0 cm North Slope = no data Richardson = no data <u>Snow Density</u> Eagle = 0.19 g/cm^3 Ogilvie = 0.20 g/cm^3 Old Crow = 0.18 g/cm^3 Richardson = no data North Slope = no data	<u>Depth</u> 77.5 cm 65.3 cm 73.5 cm no data no data <u>Density</u> 0.20 g/cm^3 0.20 g/cm^3 0.19 g/cm^3 no data no data	Spring precipitation, temperature and snowmelt appeared normal in most areas. Averages presented are for the length of record for each region and are not 5 year averages.	Above average snow depth in Eagle region (2016-17) Slightly below average snow depth in Ogilvie and Old Crow regions (2016-17) Average snow density in all areas (2016-17)
Wildland fires	2017 = data not yet available 2016 = 17.37 km^2	251 km^2	No fires in Yukon or NWT part of range. Very small fires in Alaska. Total of 15% of range affected by fires since 1960. 5 year average continues to decrease.	Well below average (2016)

Linear disturbance and human development	2016-17 = No major increases	N/A	Seismic project completed in 2013-14 south of Eagle Plains created the following: 2124 km new seismic lines and 228 km new access roads.	No additional increases in 2016-17.

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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). Arctic Borderlands Ecological Knowledge Co-op (ABEKC) provided local traditional knowledge on key indicators from 2012 to 2015. ABEKC was formed to monitor and assess ecological change in the range of the Porcupine Caribou herd and adjacent Mackenzie Delta area in NWT, Yukon and Alaska using both science and local traditional knowledge. In 2016, ABEKS embarked on a long term planning effort so interviews were limited to communities that had existing funding (Old Crow, Arctic Village). After securing funding through AANDC's Climate Change Preparedness program they were able to conduct interviews for 2017.

Herd background

1. The Porcupine Caribou Herd's (PCH) core home range is approximately 250,000 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 native 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 native 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
Radiotracking flights on 29 and 30th July, 2017 indicated that caribou were aggregated enough to photograph. ADF&G photographed the herd on 1 July in Alaska and 4 July in Yukon using high resolution digital camera equipment. At the time of the photocensus, the majority of the herd was in Alaska in the mountains of the Brooks Range near Peter and Sharder Lake and on the coastal plain north east of the Sadlerochit Mountains. Additional caribou were in the Richardson Mountains north of the Dempster Highway in Yukon (Figure 1). Digital photos were merged, orthorectified and caribou counted by staff from ADF&G, Yukon Environment, Canadian Wildlife Service. Final census results should be available by early 2018.

Discussion
When the herd was first counted with this technique in 1972, the herd was estimated at about 102,000 caribou. Herd size grew steadily at about 5% each year until it reached 178,000 caribou in 1989. The herd began to decline by 3 to 4% per year from 1989 to 1998, and by 1.5% per year from 1998 to 2001. The census in 2001 showed 123,000 caribou in the herd (Figure 2; Arthur 2001).

Working cooperatively, biologists from Canada and Alaska attempted to photo census the herd each year since 2003 but were unsuccessful. In 2007 photos were taken however they were not good quality. If the herd had continued to decline at the same rate, it was estimated that the herd could have numbered 100,000 or fewer caribou in 2010. In 2010, ADF&G switched from

minimum counts (bias low) to Rivest estimates that provided confidence intervals around the population estimate (Rivest et al. 1998).

Finally in July 2010, conditions permitted photos to be taken. The ADF&G estimated 169,000 (95% CI = 153,493 – 184,403) caribou in the herd from that census, the second highest on record. The high number of caribou showed the herd had obviously recovered from the 12-year decline documented between 1989 and 2001. Another successful photocensus was completed by ADF&G and Yukon Environment in 2013 that estimated the herd to be 197,228 (95% CI = 168,667 – 225,789) caribou (Figure 2). Researchers will attempt another photocensus in summer 2017.

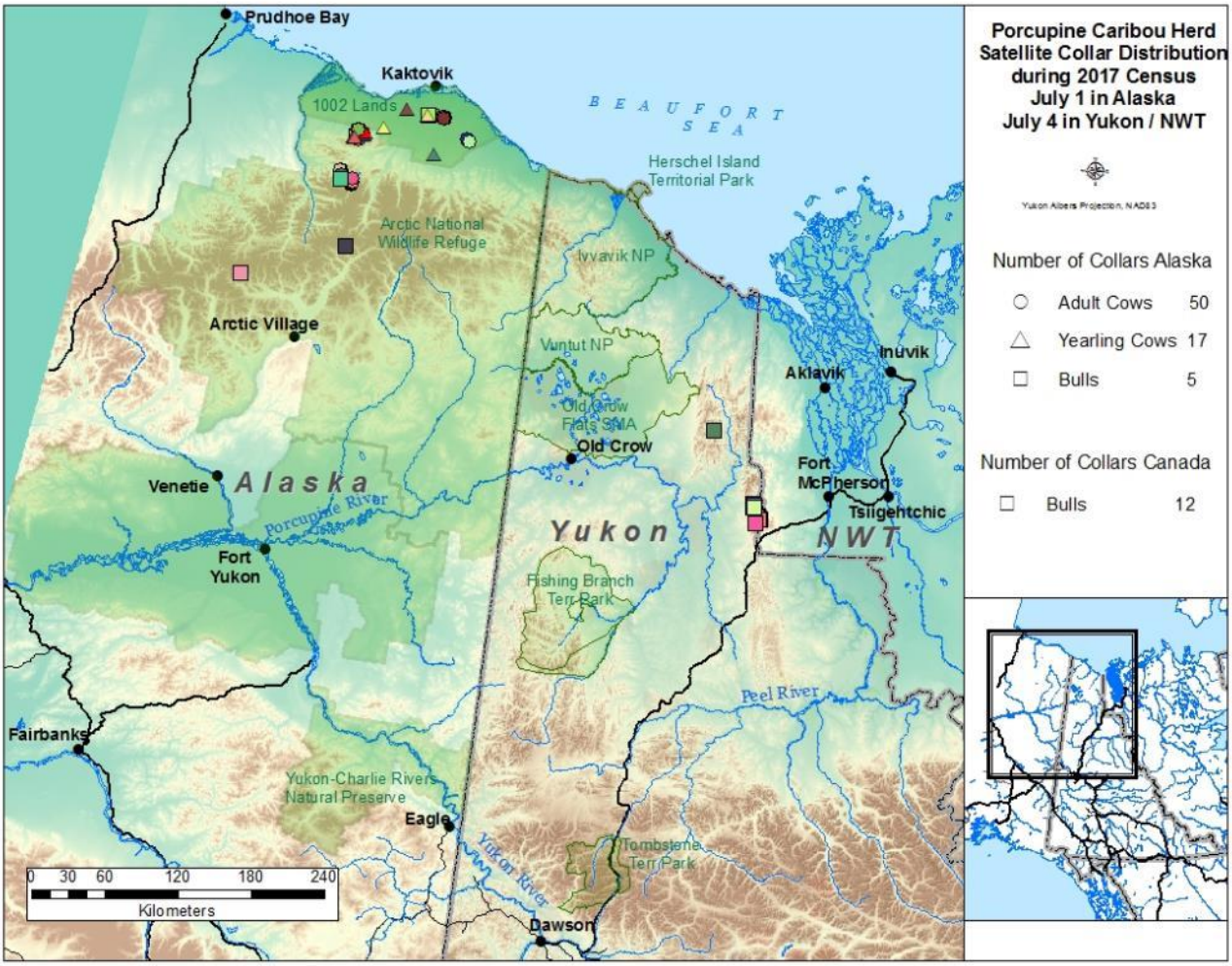

Figure 1. Locations of all GPS collared caribou in the Porcupine Caribou herd during the 2017 census that occurred between July 1st in Alaska and July 4th in Yukon / NWT. Data and map from Yukon Environment.

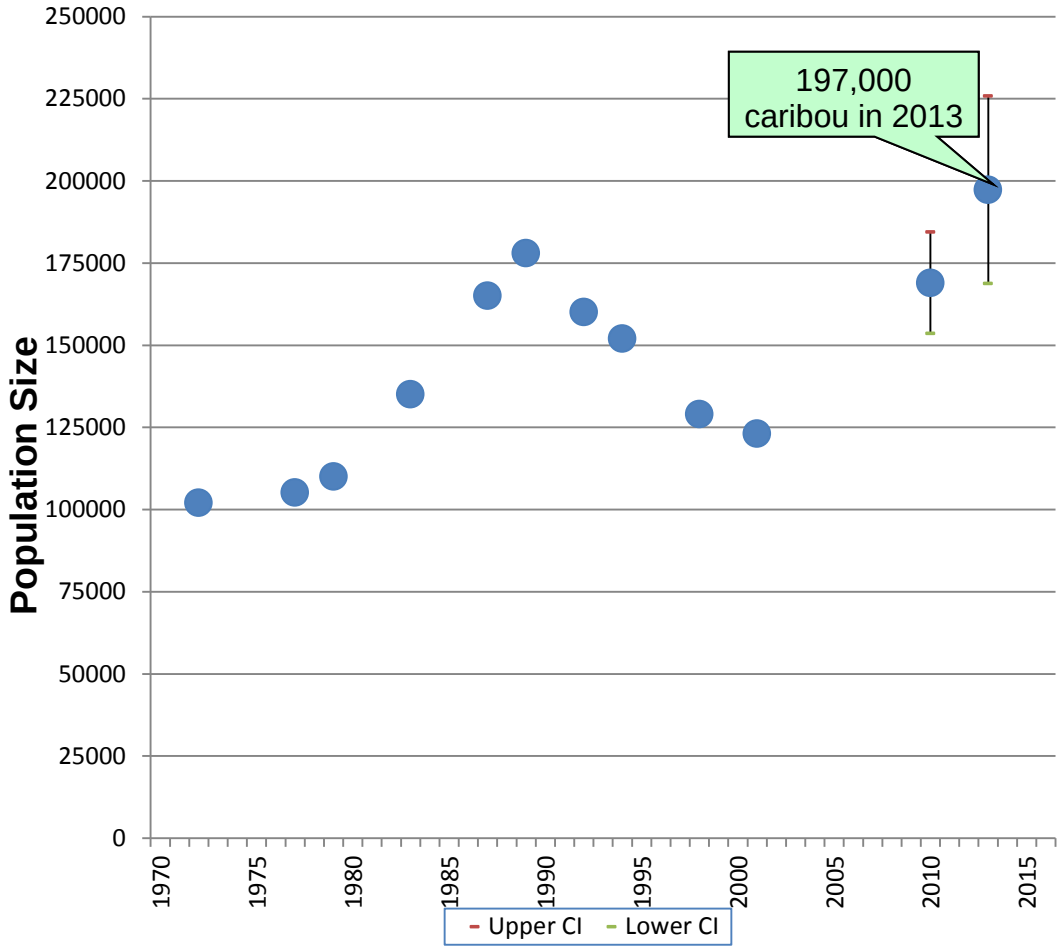

Figure 2. Estimated herd size of the Porcupine caribou herd and 95% confidence intervals 1972 to 2016. Confidence intervals are only available for 2010 and 2013 photocensus attempts. Blue dots indicate successful survey attempts.

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 2018.

Discussion
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 2007). 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. Survival estimates ranged between 0.065 to 0.097 but showed a general trend of increased survival from 2003 to 2011. (Figure 3).

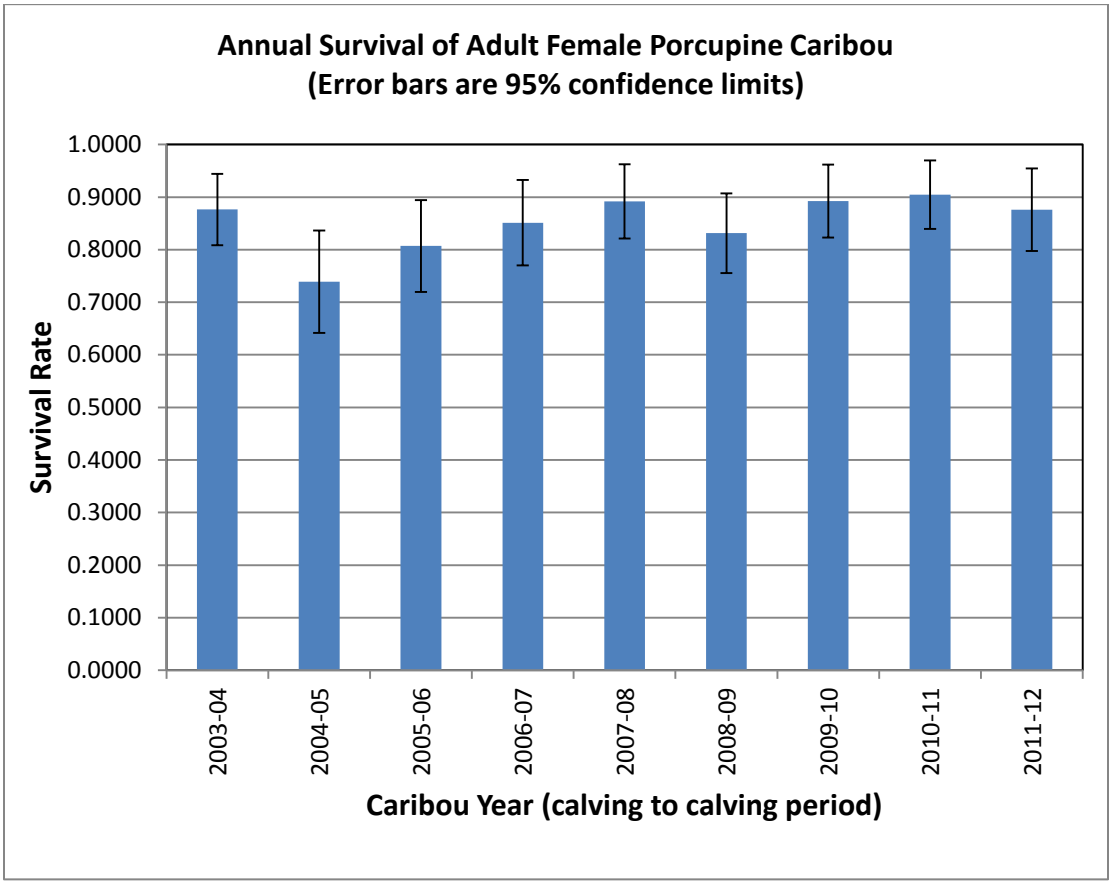

Figure 3. Annual survival estimates for adult female Porcupine Caribou, May 2003 – June 2012. Source: USFWS unpublished data.

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. Collared females 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). Female caribou are re-located after about one month to determine whether the calves have survived. Calving success is presented 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
Parturition rate
Staff from ADF&G conducted a survey from 26 May through to 7 June, 2017 to estimate how many females were pregnant (parturition rate).The parturition rate for adult cows ≥ 4-years of age was 88% (Figure 4, n=42). This figure could be have been as high as 100% based on the fact that all 5 caribou classified as "barren" had some characteristics of pregnancy (J. Caikoski, pers. comm). This is above the long term average of 81%. Of the cows that were judged to be parturient, 32 of 37 were observed with a calf at heel.

Post-calving survey
ADF&G staff conducted a post calving survey on 22-24 June, 2017 to estimate cow:calf ratio and calf survival 3 weeks after peak of calving. 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 100% for adults cows ≥ 4-years of age (n=42). The late June calf:cow ratio was 72 calves per 100 cows (Figure 4, n=39/54). The calf:cow ratio of 72 calves per 100 cows suggests an estimate of calf survival at 90%, (n = 36/40; excluding 3 early perinatal deaths that occurred during the parturition survey) calculated as the calf:cow ratio divided by parturition rate is more accurate.

March composition count
A composition count was conducted March 2017. Satellite collared cows deployed pre-2017 were used as the focus of sampling, with an attempt to classify 200 caribou around each collar. Overall the calf:cow ratio was 35.8 calves per 100 cows, which is close to the long term average for the herd (35:100 over 18 years). We observed differences in calf:cow ratios by area similar to patterns that we've observed in the past. The last successful attempt was 2010 (2009 birth year). Subsequent years were not attempted due to herd mixing, logistics and adverse weather conditions (Figure 4).

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 4. shows large fluctuations in these rates, but it 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.

In 2017, the parturition rate was high for both 3 year olds and older caribou, so nutrition and body condition appears to be outstanding coming out of this past winter. Calves born in June also had high survival rate after the calving season. This year's calving survey was also one of the most extensive calving surveys linked to GPS data locations. This information will be used to help determine when collared female caribou are having their calves so we can use changes in movement rates to help identify calving sites.

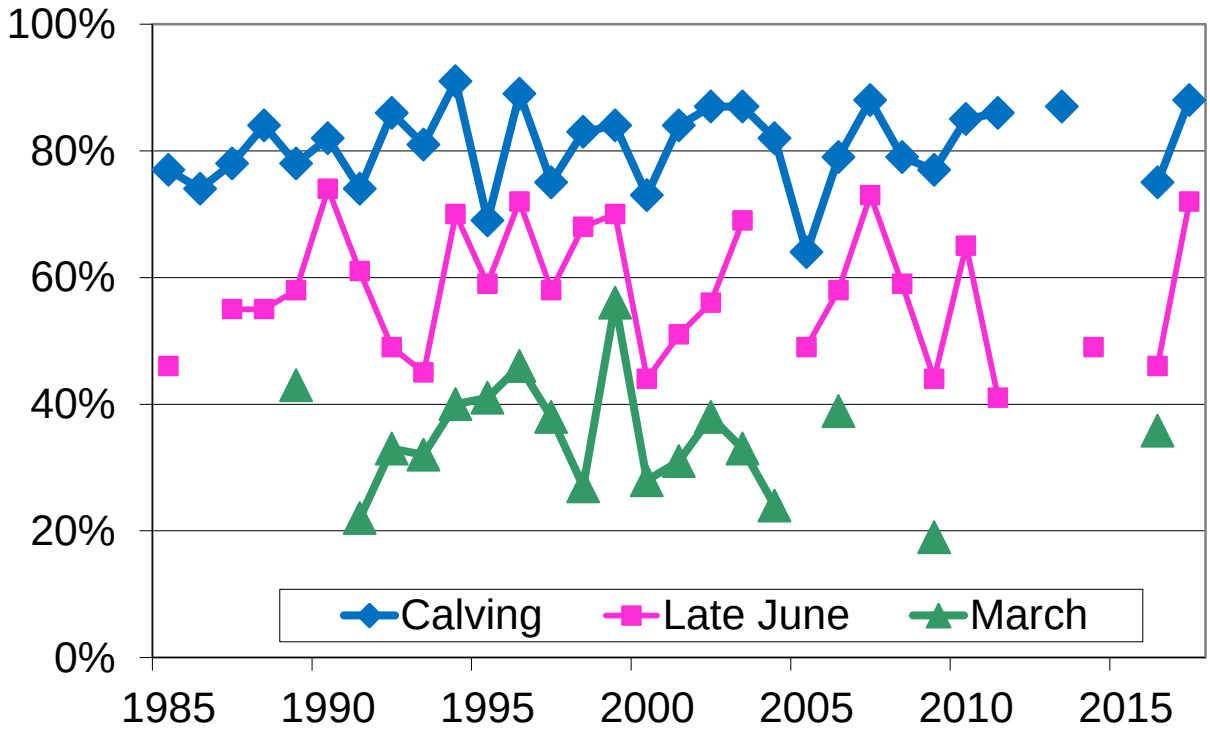

Figure 4. Estimated birth rate, calf survival indices and March composition count for the Porcupine Caribou herd from 1985-2017.

Peak of calving

Objective
To estimate the date when half of the collared adult female caribou have given birth each spring.

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

Based on the size and mobility of calves, peak of calving was likely around June 3rd (Table 1, J. Caikoski pers. comm.). Most calving occurred on the coastal plain in Alaska and the Yukon including the 1002 lands (Figure 5).

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.

We would start to worry if births were a week or more out of sync. Since 1999, the peak date of calving varies by a few days each year, but there is no indication that large numbers of cows are giving birth 'out of sync'.

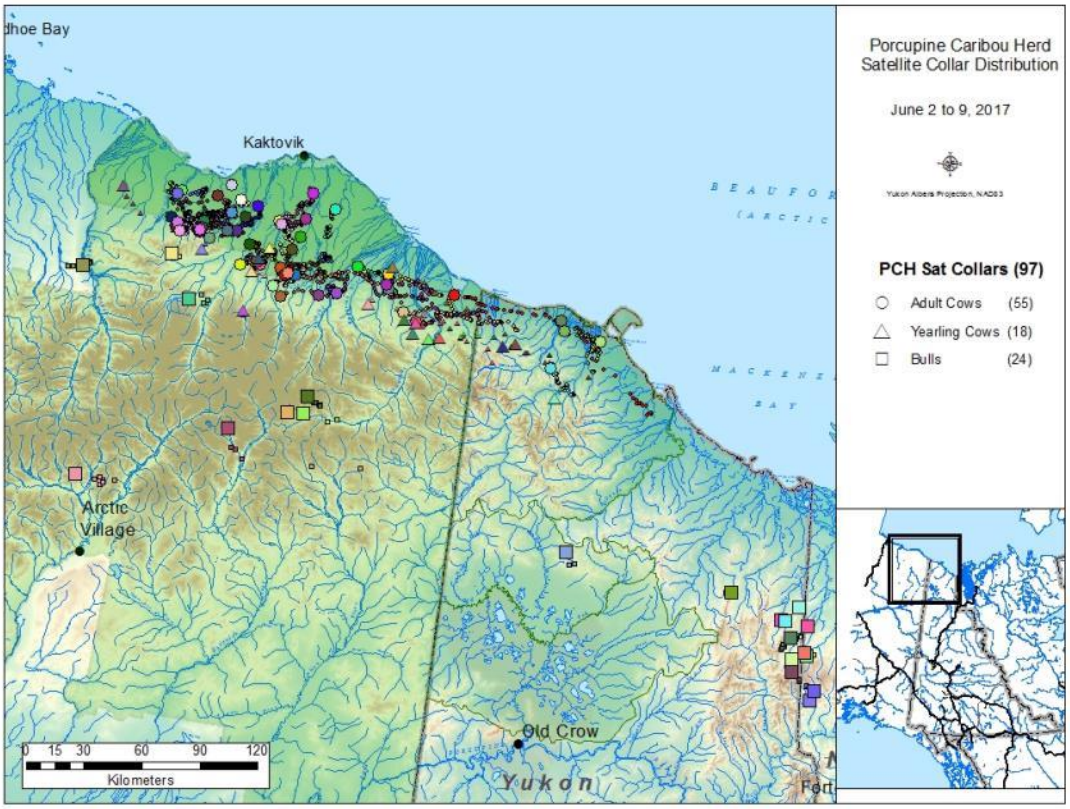

Figure 5. Distribution of satellite collars of the Porcupine Caribou herd between June 2-9, 2017.

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	
Average	1 June	

Table 1. Peak dates of calving for the Porcupine Caribou herd.

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
A survey to determine the bull ratio was attempted by ADF&G staff in mid-October 2017. The majority of the herd was located by Arctic Village, Alaska during this time. The survey 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. The PCTC still needs to determine how many collars are needed to provide the precision needed to assess the effect of harvest on the herd sex ratio, however we are aware that a sufficient number of collars are needed on bulls leading up to a rut count to provide confidence in those results as a standalone measure.

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 2016 – 2017 caribou samples were submitted by hunters in Old Crow and NWT communities (Figure 6, Figure 7). Seventy-one cows and 30 bulls received hunter rating scores where 1=poor, 2=fair, 3=good and 4=very good. Generally all caribou were in very good shape for the time of year. Cows averaged a score of 3.1, whereas bulls averaged 2.9. Seventy eight cows and 31 bulls were also measured for backfat. Cows had an average of

1.4 cm while bulls an average of 0.3 cm. Body condition for cows was above the 5 year average while bulls were slightly below in 2016-17. Backfat was below the 5 year average for both cows and bulls.

Discussion

Overall, caribou condition seems to have improved in recent 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. 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. This improving condition was also seen in the Arctic Borderlands Ecological Knowledge Co-op data (Russell et al 2013). 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.

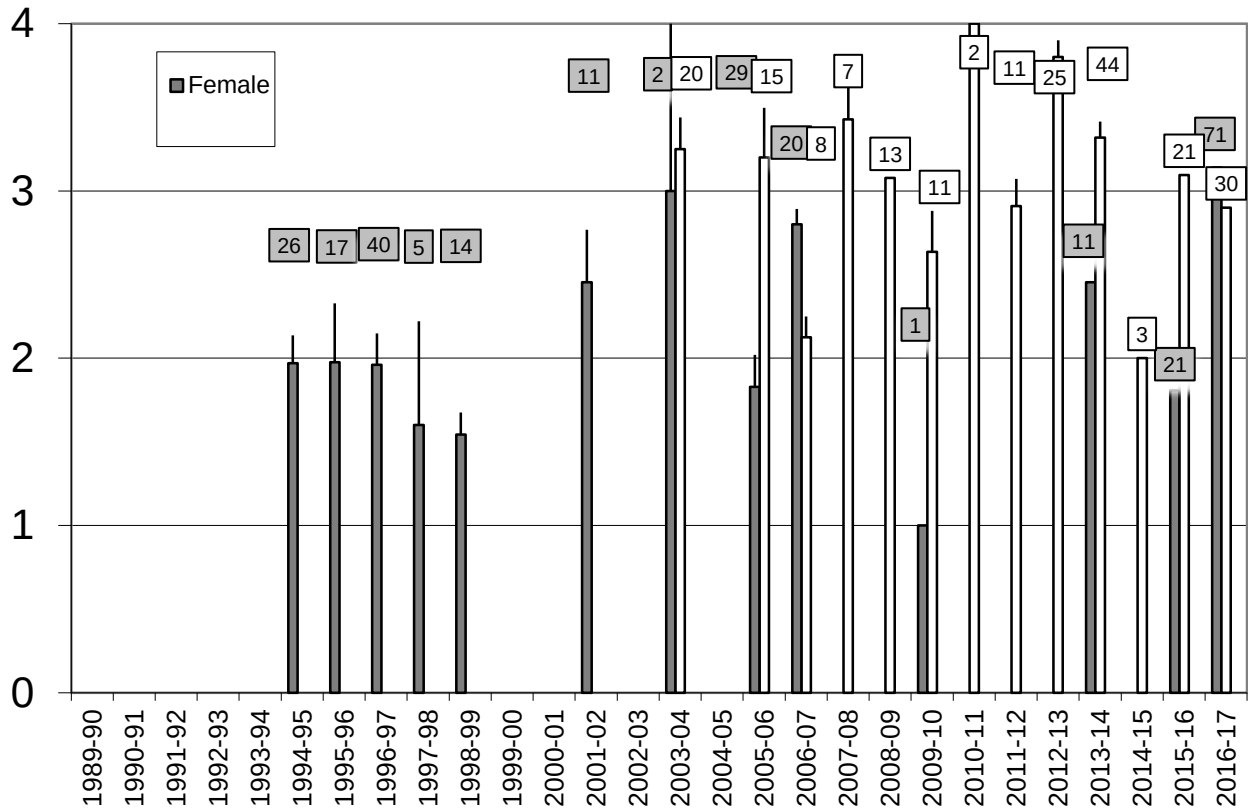

Figure 6. Average condition of harvested Porcupine caribou recorded by hunters. 1=poor 2=fair 3=good 4=very good. Error bars are standard errors. Labels indicate # of caribou sampled.

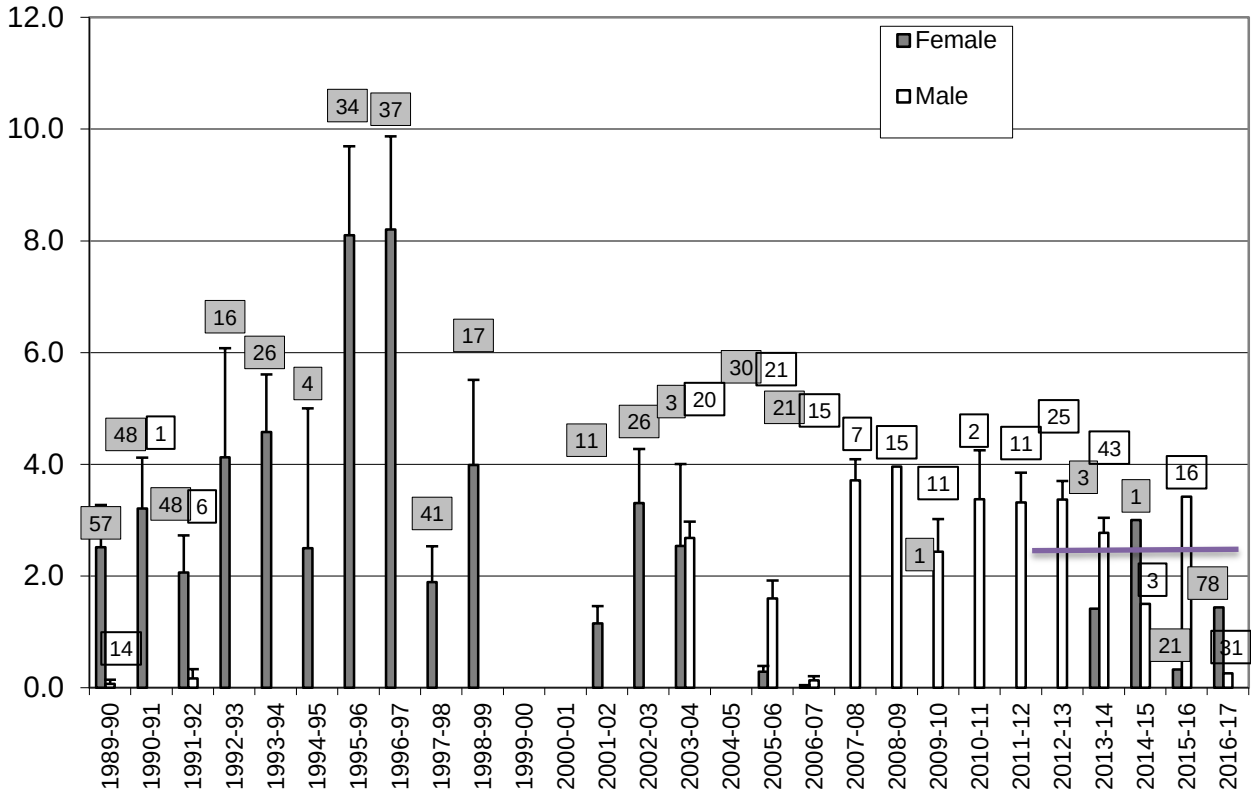

Figure 7. Average depth of backfat (cm) recorded in Body Condition Monitoring. Error bars are standard errors. Labels indicate # of caribou sampled.

HABITAT

Wildland fires

2017 season fire map data is not yet publicly available from Yukon or NWT. This section of the report contains information current to 2016 (identical to previous Status Reports).

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 1960-2016 was summarized in this report.

Results
As of the 2016 season, the total area burned by fires since 1960 is 39,036 km^2 or roughly 15% of the herd's total annual range (Figure 8). Fires in 2016 burned a total of about 17.4 km^2, a fraction of the area burned in the previous 5 years (252 km^2). In 2016 there were 9 fires in PCH

range - all of which occurred in Alaska. There were no fires in the Yukon or NWT portion of the PCH range in 2016. The largest fire in the Alaskan portion of the range was only 12 km^2. The years 2004 and 2007 show the largest number of large fires recorded in recent years (Figure 9). Fires in 2004 and 2005 resulted in record tracts of area burned (Figure 10).

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.

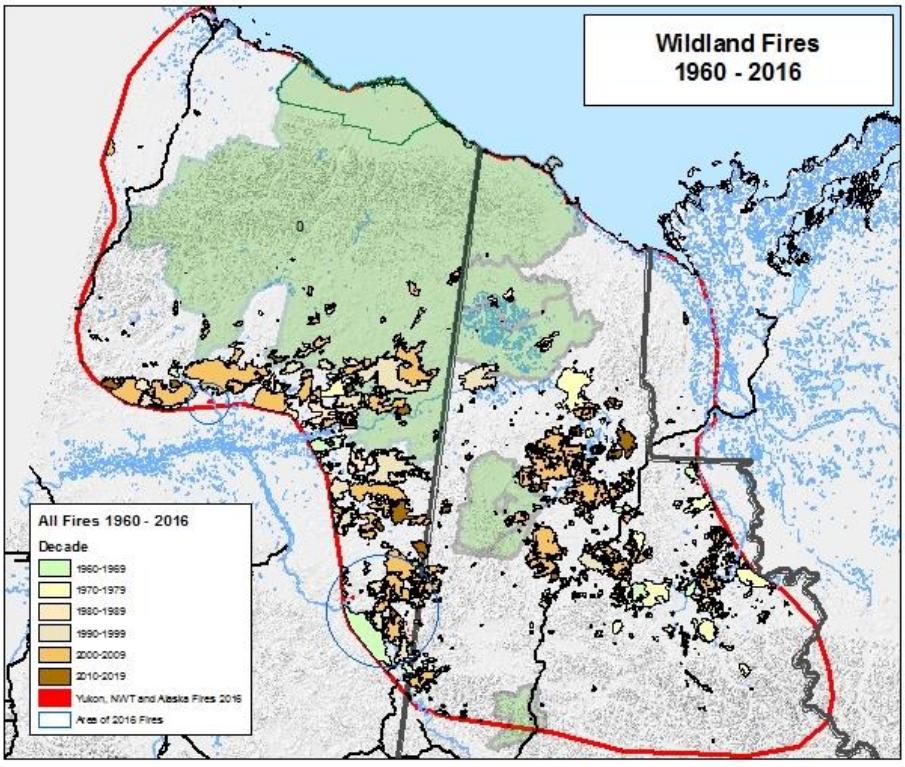

Figure 8. Areas burned within range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories from 1960 to 2016. New fires highlighted in red surrounded by blue circle. The darker green areas surrounded by a grey border represent protected areas.

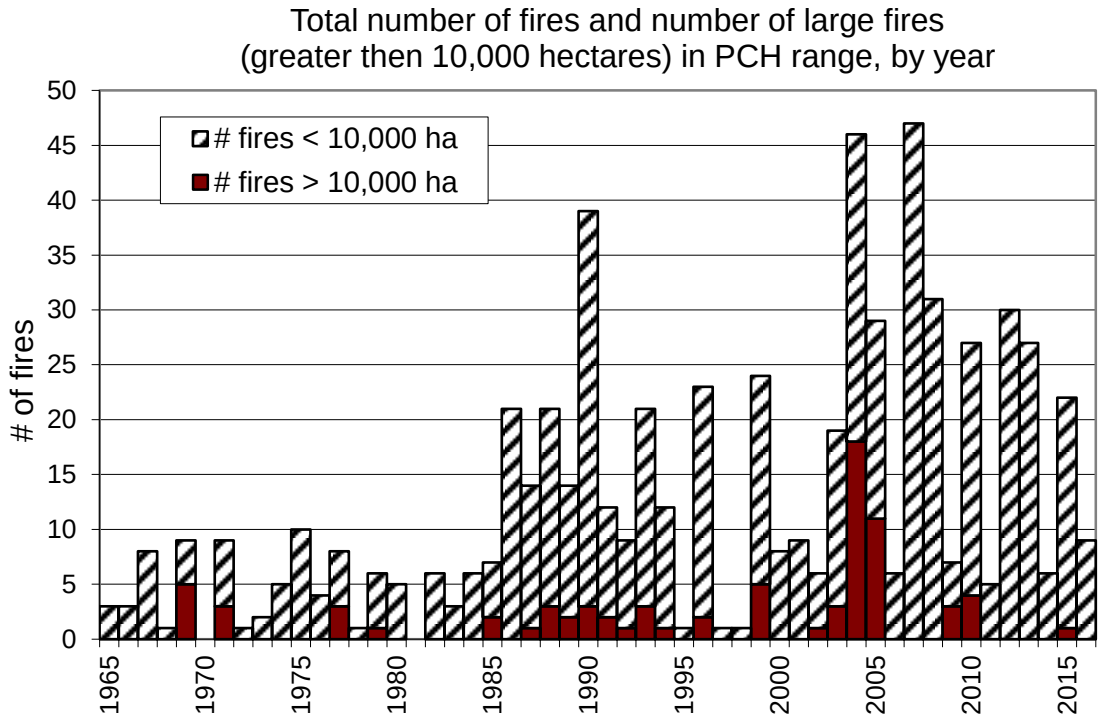

Figure 9. Total number of fires and number of large fires to 2016 within the range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories.

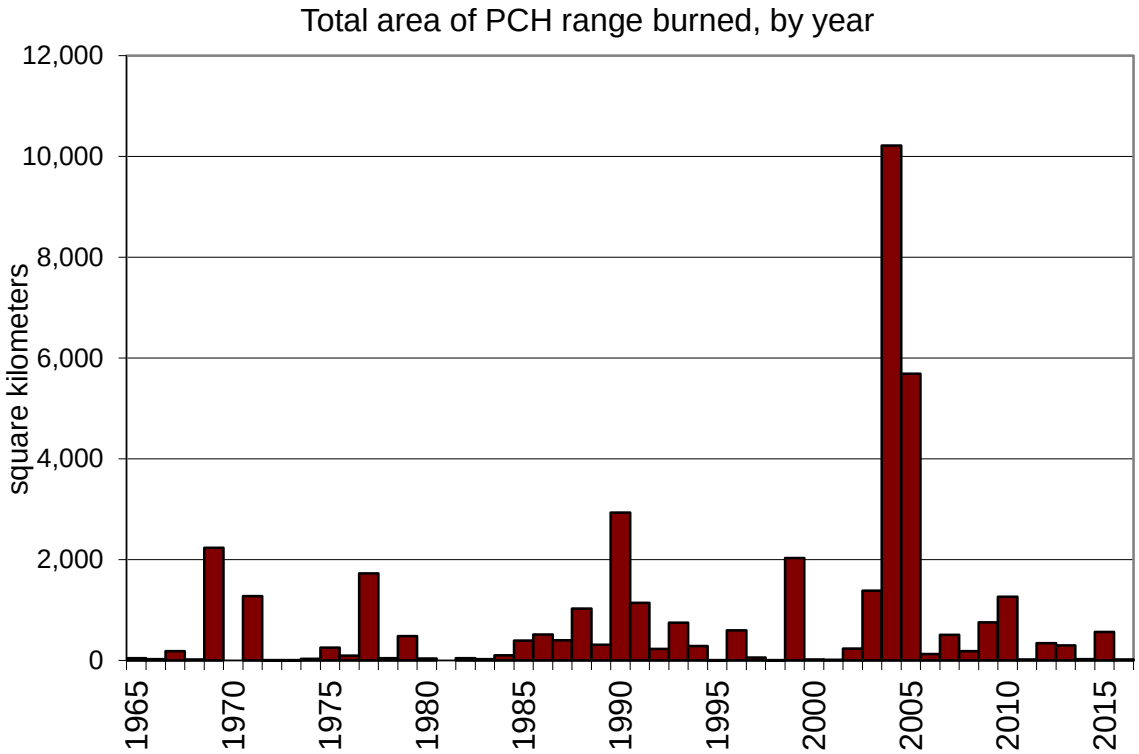

Figure 10. Total area burned by fire, by year to 2016 within the range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories.

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
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 11). 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). In 2016-17 no detectable changes occurred in linear disturbance and human footprint. A current proposal has been submitted to the Yukon Environment and Socio-economic Assessment Board to construct new all season roads, drill up to 20 wells and conduct up to 2 years of extended flow testing on each.

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.

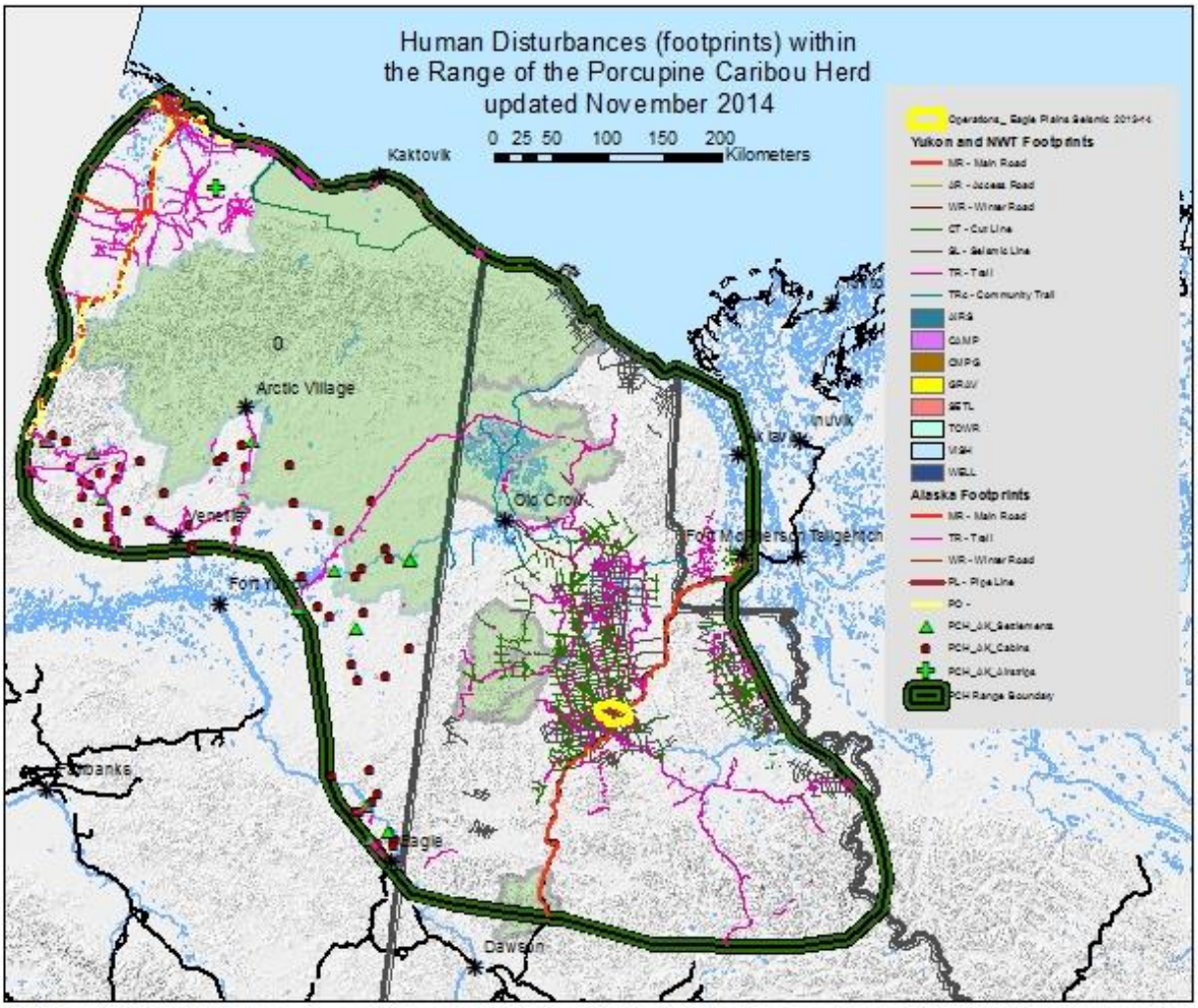

Figure 11. Human disturbance within the range of the Porcupine Caribou herd (updated Nov. 14, 2014 – November 23, 2017) in Alaska, Northwest Territories, and Yukon.

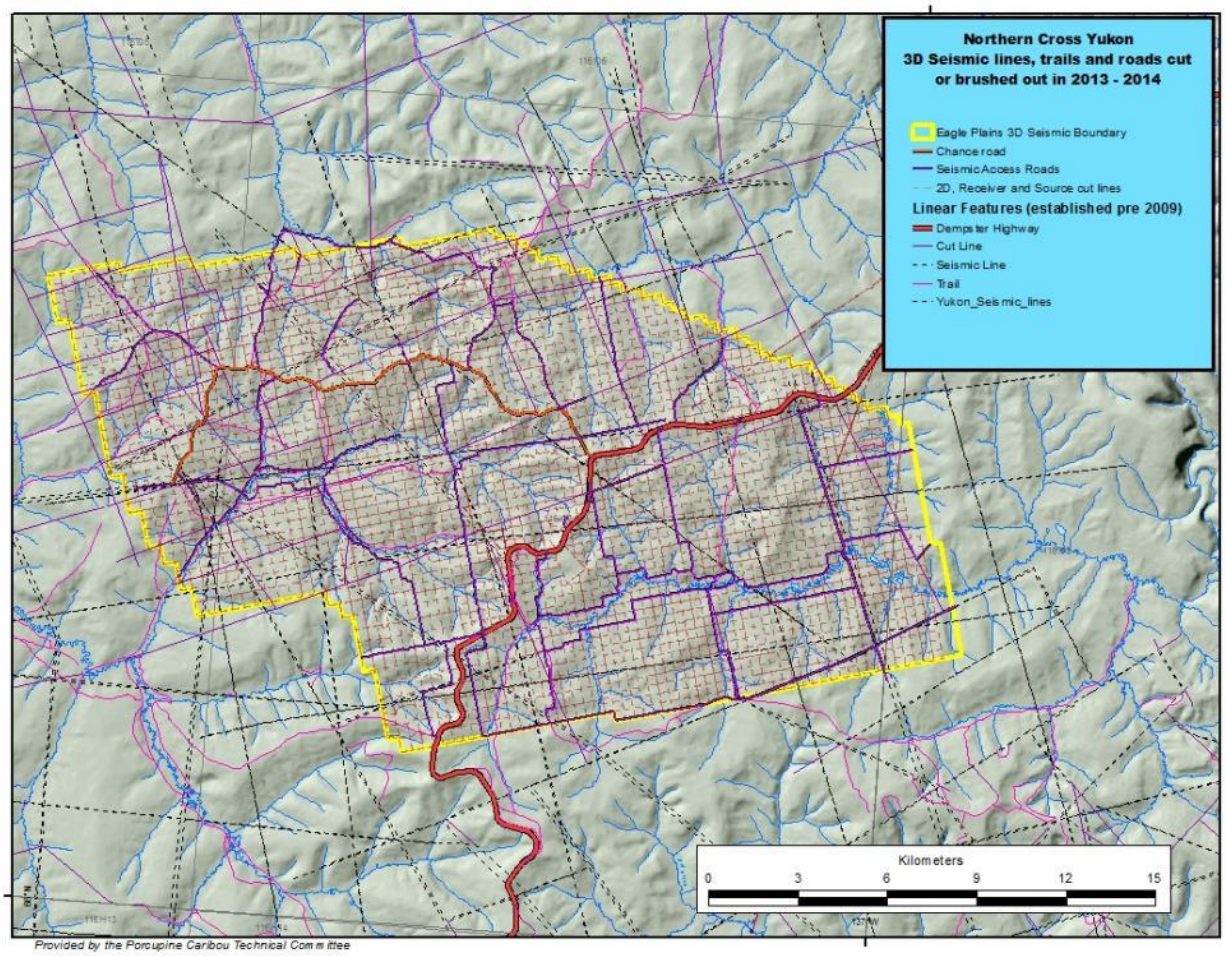

Figure 12. The extent of 3D seismic lines, trails and roads cut or brushed out in 2013-14 by Northern Cross within the range of the Porcupine Caribou Herd in Yukon

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 14.

The majority of the PCH wintered in Alaska between the Sheenjek River and the Yukon / Alaska border, with concentrations south and west of Arctic Village. In the Yukon, groups of caribou were scattered south of Old Crow, as well as north thru the Old Crow Flats and along the Firth River (Figure 13).

Results

Snow depth and density in the northern Yukon was average in the Old Crow and Ogilvie Regions (Figure 14). The Eagle Region had above average snow depth but near average snow density. Snow measures were not collected in the Richardson or North Slope regions. Recent data doesn't show any significant trends or large deviations from long term averages.

Additional caribou distribution and snow data in areas that caribou were wintering is as follows: Early winter saw concentrations of caribou in the Yukon and along the Yukon Alaska border. During mid to late winter, groups distributed in and adjacent to the Old Crow Flats shifted ~100-150 km west into Alaska, ending up along the Kones, Sheenjek, and Coleen Rivers. Almost no snow was present in the Old Crow Range although the small patches present were like concrete. Further west snow conditions were typical of the herd's range with mid-shin to knee deep snow of varying density, dependent on whether it had some wind exposure. Significant concentrations of caribou that were distributed further north during this same period did not move as far, but also drifted west into Alaska, occupying the upper Firth, Mancha and Kongakut Rivers. This is one of the first times we've documented this significant of a group wintering in this area although small groups were noted in recent years. Snow in this area was deep but with very low density in valley bottoms while mountain faces and ridges were clear of snow for the most part. As usual, bull caribou groups were segregated from cow calf groups, mainly south of the Porcupine River in Yukon and Alaska, as well as spread out southwest of Arctic Village. Snow here was deep in places but low in density. In all areas that we sampled caribou we did not encounter any ice layers.

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.

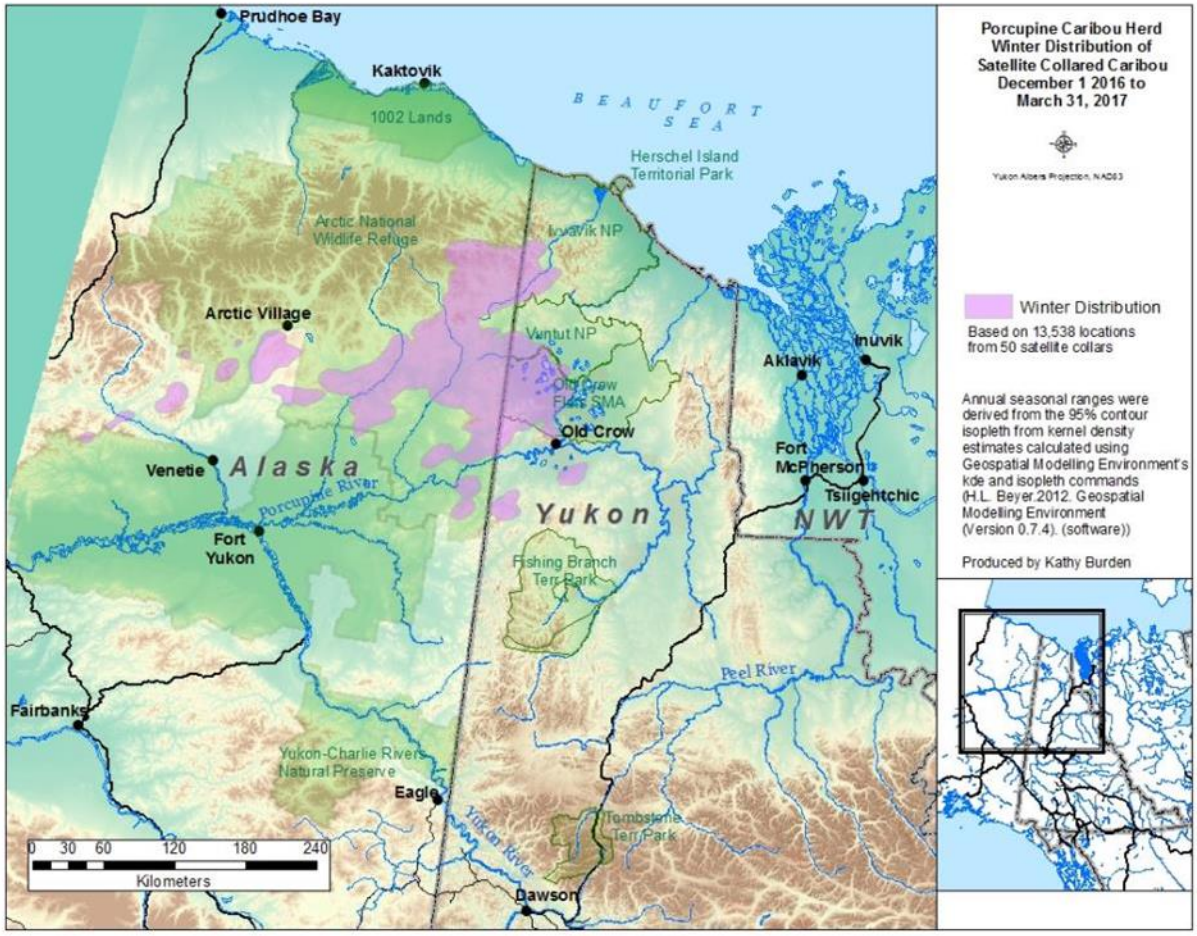

Figure 13. Winter distribution of Porcupine Caribou from Dec. 1, 2016 to March 31, 2017.

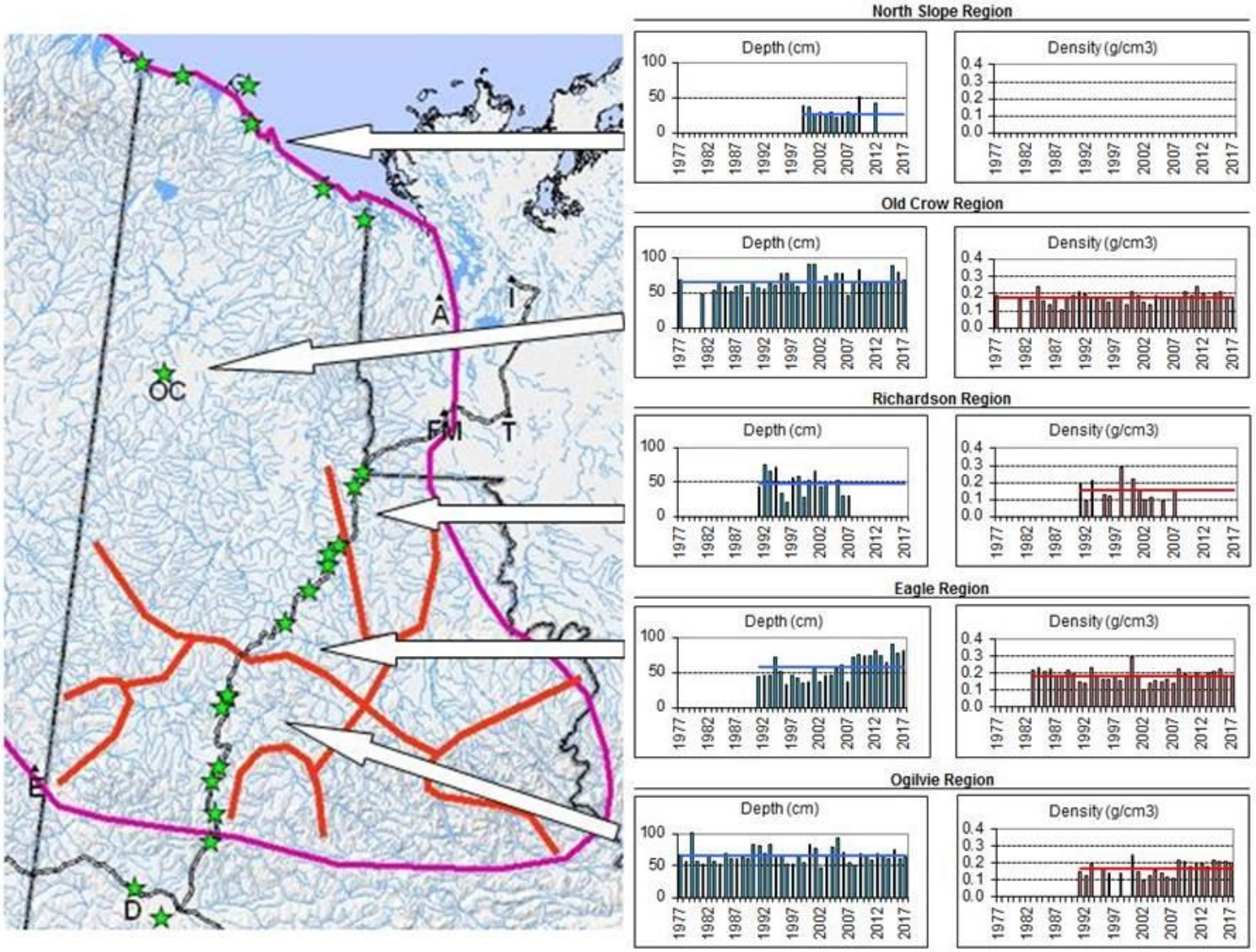

Figure 14. Summary of snow depth and density by snow region from permanent stations (indicated by green stars) for the Yukon portion of the Porcupine Caribou Herd range. Red lines on the map delineate snow regions relevant to caribou (Russell et al 1993).

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Appendix A. Summary of biological parameters

Year	Cows Observed[b]	Parturition Rate	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	51	0.78	0.71		0.55		165,000		
1988	91	0.84	0.65		0.55				
1989	74	0.78	0.74		0.58	0.43	178,000		
1990	74	0.82	0.90		0.74				
1991	77	0.74	0.82		0.61	0.22			
1992	78	0.86	0.57		0.49	0.33	160,000		
1993	63	0.81	0.56	0.83	0.45	0.32			
1994	98	0.91	0.77	0.93	0.70	0.40	152,000		
1995	95	0.69	0.85	0.92	0.59	0.41			
1996	74	0.89	0.81	0.91	0.72	0.46			
1997	48	0.75	0.77	0.90	0.58	0.38			
1998	58	0.83	0.82	0.94	0.68	0.27	129,000		
1999	39	0.84	0.83	0.86	0.70	0.56		3-Jun	1-5 June
2000	44	0.73	0.61	0.82	0.44	0.28		7-Jun	
2001	70	0.84	0.61	0.79	0.51	0.31	123,000	8-Jun	5-10 June
2002	68	0.87	0.65	0.85	0.56	0.38		5-Jun	
2003	70	0.87	0.79	0.85	0.69	0.33		1-Jun	
2004	74	0.82	g	g	g	0.24		3-Jun	3-4 June
2005	55	0.64	0.77	0.88	0.49	h		2-Jun	1 - 4 June
2006	66	0.79	0.73	0.86	0.58	0.39		2-Jun	
2007	67	0.88	0.83	0.90	0.73	h		30-May	
2008	63	0.79	0.73	0.92	0.59	h		30-May	29 or 30 May
2009	65	0.77	0.57	0.75	0.44	0.19		2-Jun	
2010	41	0.85	0.76	0.87	0.65	h	169,000	1-Jun	prior to 2 Jun

Year	Cows Observed[b]	Parturition Rate	June Calf Survival[c]	Post-calving Survival[d]	Late June Calf:Cow[e]	March Calf:Cow[f]	Population Estimate	Peak of calving	Calving note
2011	59	0.86	0.48	0.59	0.41	h		30-May	prior to 1 Jun
2012	g	g	g	g	g	g		30-May	prior to 1 Jun
2013	42	0.86	i	i	i		197,000	04-Jun	3-4 June
2014	39	g	g	g	0.49			no data	
2015	g	g	g	i	i			no data	
2016	28	0.75	0.61	1.00	0.46	0.36		3-Jun	
2017	42	0.88	0.81	0.90	0.72			3-Jun	
Mean		0.81	0.72	0.86	0.58	0.35			
5 yr mean		0.83	0.71	0.95	0.56	0.36			

[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.

Appendix B. Previous research findings

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 15). 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.

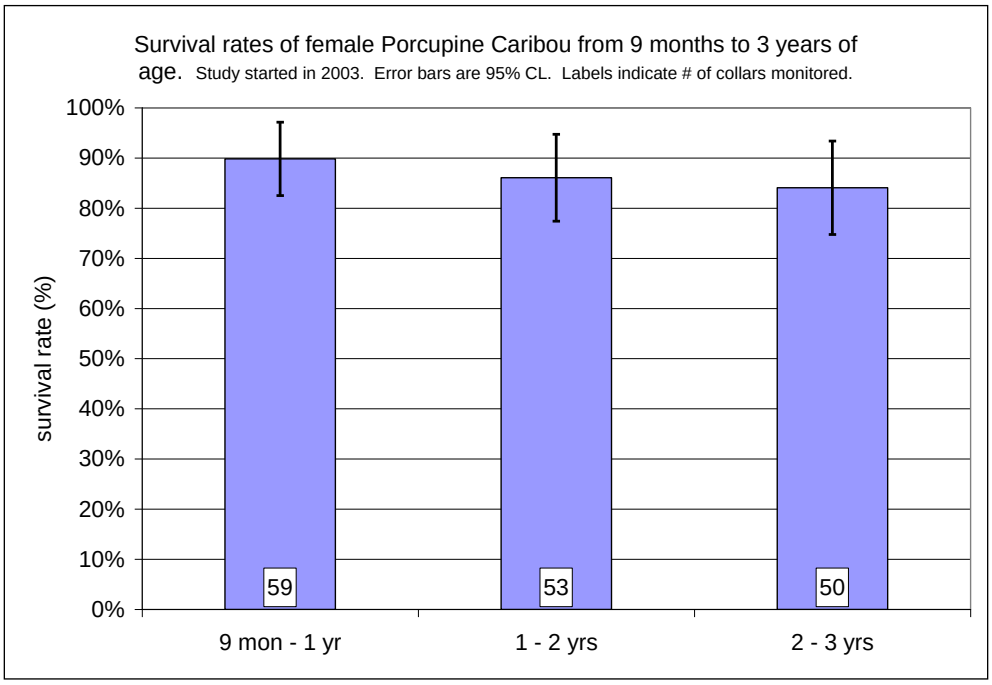

Figure 15. Survival of Porcupine Caribou females from 9 months to 3 years of age from 2003-2010.

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 16). 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.

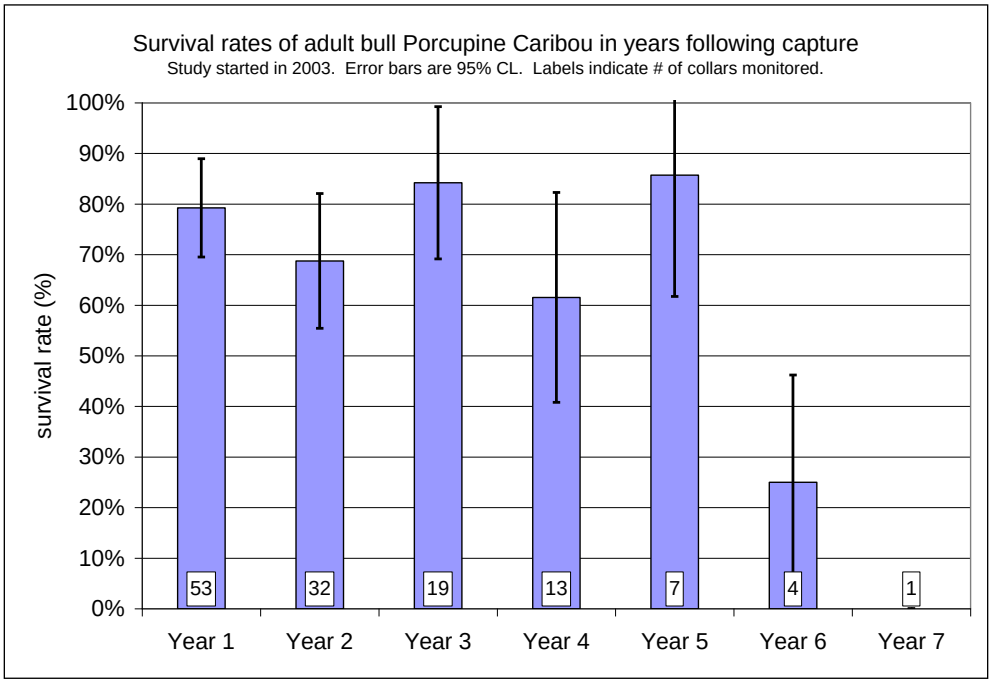

Figure 16. Survival of male Porcupine Caribou from 2003 to 2010.