PORCUPINE CARIBOU

ANNUAL SUMMARY REPORT
2014 - 2015

Porcupine Caribou, Photo by Peter Mather

DRAFT

Submitted to: Porcupine Caribou Management Board

Submitted by: Porcupine Caribou Technical Committee

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Indicator Table

Annual Summary Report - November 2015

Prepared for the Porcupine Caribou Management Board

Indicator	Value	5 year average	Notes	Assessment and Year Represented
Population size and trend				
Population size	2015 = no data	--	Last census in 2013 (197,000).	No assessment (2014-15)
Estimated population	2015 = no data	--	The Herd Estimator requires caribou harvest data as a parameter in the model. Harvest data was not completed in time to be incorporated into the model.	No assessment (2014-15)
Population trend	2015 = no data	--	Declined by 55,000 caribou between 1989 and 2001. Recovered to 169,000 by 2010 and continued to increase to 197,000 in 2013.	No assessment (2014-15)
Adult cow survival	2015 = no data	0.879	Small differences in the annual survival of adult cows is key in determining the population trend for the herd. The last estimated survival rate (2011-12) was relatively high and was indicative of a growing population at that time. No new data has been collected since this last estimate.	No assessment (2014-15)
Calf birth rate	2015 = no data	0.838	24-year average = 0.81 No data due to adverse weather conditions	No assessment (2014-15)
Late June calf:cow ratio	2015 = no data	0.58	29-year average = 0.55 Lower than average in 2014.	No assessment (2014-15)
Bull Ratio	2015 = no data	--	Cancelled in 2013 due to caribou mixing with Central Arctic Herd. Poor results in 2012. Next survey scheduled for 2017.	No assessment (2014-15)

Indicator	Value	5 year average	Notes	Assessment and Year Represented
Peak of calving	2015 = no data	1 June	No data due to adverse weather conditions. Average is within normal range.	No assessment (2014-15)
Body condition				
Average backfat	No data	No data	Caribou were available to hunters in Old Crow during August and first week of September. No samples were collected during this time; 3 caribou were sampled along the Dempster Highway but not included in this report.	No assessment (2014-15)
Hunter assessment	No data	No data		No assessment (2014-15)
Condition of caribou	No data	No data		No assessment (2014-15)
Habitat and other considerations				
Snow conditions winter 2014 – 15	<u>Snow Depth</u> Eagle = 89.7 cm Ogilvie = 75.7 cm Old Crow = 89.0 cm North Slope = no data Richardson = no data <u>Snow Density</u> Eagle = 0.23 g/cm^3 Ogilvie = 0.21 g/cm^3 Old Crow = 0.21 g/cm^3 Richardson = no data North Slope = no data	<u>Depth</u> 76.3cm 66.2 cm 69.7 cm no data no data <u>Density</u> 0.21 g/cm^3 0.20 g/cm^3 0.20 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.	Significantly deeper than average snow depth in Eagle and Old Crow regions, above average snow depth in Ogilvie (2014-15) Slightly above average snow density in all areas (2014-15) Anecdotal reports suggest snow was less than normal in areas the majority of the herd wintered in.
Wildland fires	2015 data not yet available 2014 = 23.9 km^2	392 km^2	2004 and 2005 largest burned area ever. Total of 15% of range affected by fires since 1960	Lower than average area burned in 2014; 5 year average continues to decrease.
Linear disturbance and human development	2014 No major increases	N/A	New seismic project completed in 2013-14 south of Eagle Plains created the following: 2124 km new seismic lines 228 km new access roads	Increased in 2013-14; no additional increases in 2014-15 although proposals have been forwarded to build all season roads, conduct extended flow testing, and drill up to 20

Indicator	Value	5 year average	Notes	Assessment and Year Represented
				additional wells at present.
Traditional Knowledge				
Hunters' needs met?	2013-14 = 39% of hunters met needs	58%	Borderlands data available from 2000-01 to 2013-14. New indices in development.	Significantly lower than all years except 2000-01. Lower than 5-year average.
Specify caribou abundance	2013-14 = 46% fewer, 5% increased, 27% changed migration route, 21% not in area	N/A	Borderlands data available 2013-14.	
Unusual, extreme and rare weather events	FALL More snow than normal = 42% More ice than normal = 3% WINTER More snow than normal = 28% More ice than normal = 5%	FALL Snow = 18% Ice = 14% WINTER Snow = 23% Ice = 10%	Borderlands data available from 2005-06 to 2013-14. New indices in development.	FALL (2013-14) Snow = much higher than average Ice = lower than average WINTER (2013-14) Snow = higher than average Ice = less than average
Observed body condition by season	2013-14 = Good in winter, spring and fall Fair in summer.	Good	Borderlands data available from 2000-01 to 2013-14. New indices in development.	Good but animals in Fair condition in the summer warrants further investigation (2013-14).
Climate Indicators				
Winter Range Snow Depth (3-year running average)	2014 = 24.9	25.2 cm (2008-2014)	CARMA Network's climate database (Appendix C; Russell et al 2015)	Declining since 1990
Spring Range Snow Depth	2014 ~ 9	10.2 cm (2008-2014)	CARMA Network's climate database (Appendix C; Russell et al 2015)	Slow increase in depth (2008-2014) Declining trend (2001-2007)
Growing degree-days on June 10	2014 ~ 29		CARMA Network's climate database (Appendix C; Russell et al 2015)	Declining (2012-2014) Increasing (2001-2011)
Summer drought index	2014 ~ 4		CARMA Network's climate database (Appendix C; Russell et al 2015)	Declining (1979-2014) More favorable conditions compared to 1980's and 1990's
Oestrid Index (insect harassment)	2014 ~ 13		CARMA Network's climate database (Appendix C; Russell et al 2015)	Slight increasing trend since 1979. Generally increasing (2008-2014)

Scientific and Traditional Knowledge Comparison Table

Indicator	Scientific	Traditional Knowledge
Population trend	No data	Reported fewer caribou, although result complicated by changing migration routes and location.
Adult cow survival	No data	Significantly less adult females in all seasons in 2014.
Total harvest (2013/14)	No data at time of report	Hunters needs not met although complicated by other factors
Snow conditions winter 2013-14	Significantly deeper than average snow depth in Eagle and Old Crow regions, above average snow depth in Ogilvie No deviation from long term average No icing event data collected	More snow than normal in fall and winter, above 5 year average Average number of icing events
Condition of caribou	No data	Winter, spring, fall: good Summer: fair

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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) and the Arctic Borderlands Ecological Knowledge Co-op (ABEKC). 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. Community researchers conduct yearly interviews with local experts in each community on important indicators that can be used to track ecosystem change. Note that interviewees are selected by communities and the monitors with the intention of interviewing a select number of land users engaging with a suite of ecological indicators (i.e., this should not be considered a random sample of caribou harvesters and should not be extrapolated to sampled communities). A new suite of indices will be available in 2015-2016. Information from yearly interviews are currently available from 1996-2014 on the new ABEKC data portal.

Herd background

The Porcupine Caribou Herd's (PCH) known range covers about 250,000 square kilometers (100,000 square miles) over areas in 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 informal Porcupine Caribou Technical Committee (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 2012-13 to 2014-15* and the *International Plan for the Conservation of Porcupine Caribou* (1987). 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 are taken from the *Porcupine Caribou Herd Strategic Framework 2012-13 to 2014-15* 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.

These goals are taken from the objectives listed in the *International Plan for the Conservation of Porcupine Caribou*.

- 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 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.

SCIENTIFIC KNOWLEDGE

POPULATION

Population size – photocensus

Objective
To estimate the size of the herd every 2 to 3 years (last completed 2013).

Methods
A technique called an Aerial Photo Direct Count Extrapolation has been used to estimate the herd size since 1972 (Urquhart 1983). 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
A photocensus was not attempted in 2015 because the PCH overlapped with the Central Arctic herd in Alaska.

Discussion
When the herd was first counted with this technique in 1972, the herd was estimated at about 102,000 caribou (Figure 1). The 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 (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.

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 count 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.

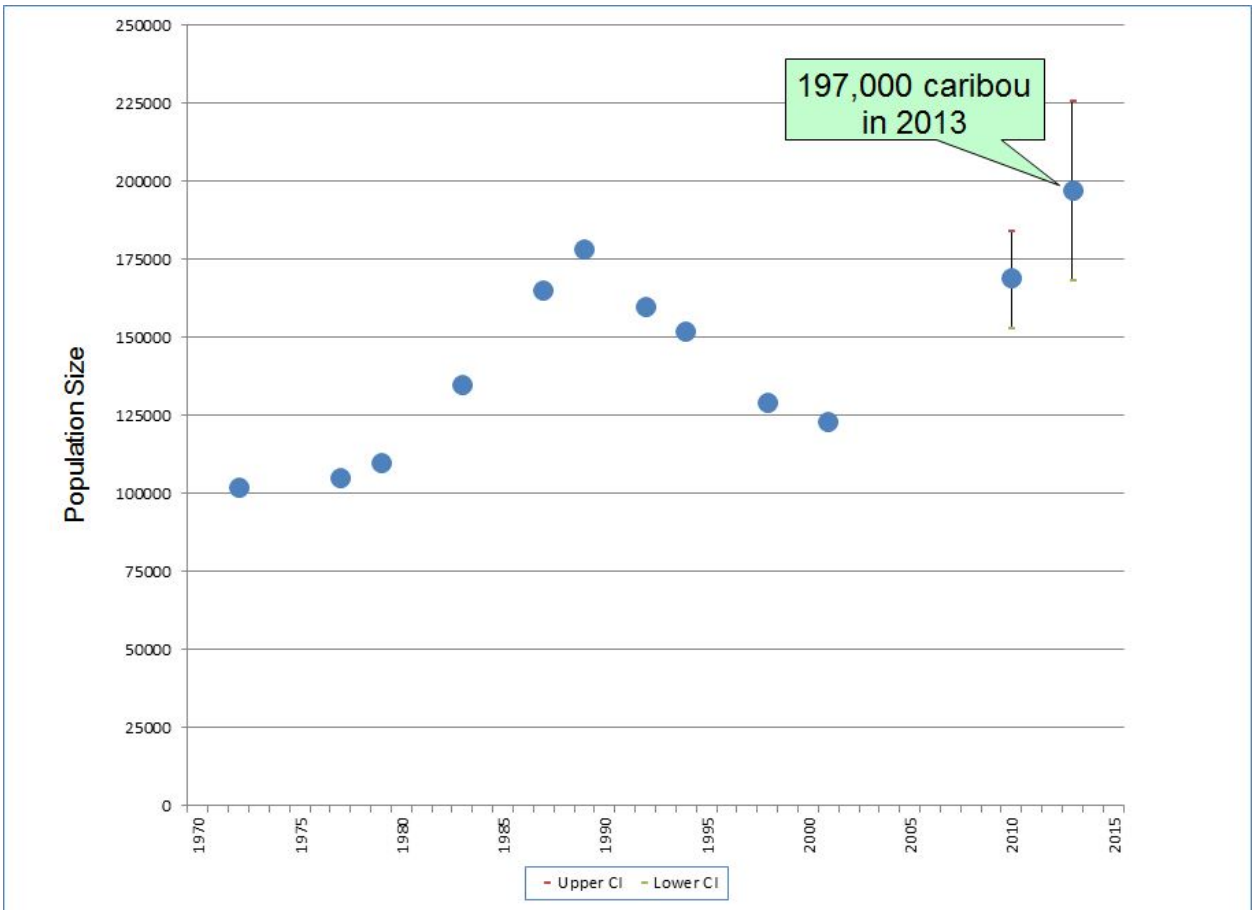

Figure 1. Estimated herd size of the Porcupine caribou herd size and 95% confidence intervals 1972 to 2013. Confidence intervals are only available for 2010 and 2013 photocensus attempts. Blue dots indicate successful survey attempts. There were no successful census attempts in 2014 or 2015.

Population size – computer modeling

This section does not include updated information from 2014/15. Additional demographic and harvest information is required.

Adult female survival

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

Methods
In response to the continued population decline, researchers started a project in 2003 to get an updated estimate of adult female survival (Wertz et al 2007). As with many populations, the survival of breeding females is very important to the potential growth of the herd. 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.

Researchers flew monthly over the winter to locate all the radio collared females and determine whether they were alive or not. Results showed that adult females survived at a similar rate as they did from 1989 to 1991 when the herd started to decline. Assuming that female survival was driving the decline, this suggested that the herd had continued its declining trend.

After the 3 year project was done, the number of flights was reduced but we continued to calculate an estimate of adult female survival for each winter. It should be noted that these calculations have low statistical power due to small sample size of collared caribou.

Results

There is no new data from 2015. However, an annual estimate of survival was calculated from June, 2003 to May, 2012 (Figure 2). Survival varied between years with the point estimates for 2004-05 and 2005-06 the lowest (0.739 and 0.807 respectively), and conversely the highest rate was estimated for the caribou year 2010-11 at 0.905. The overall average survival rate during this time period was 0.852. Although variability within years ranged from 0.065 to 0.097 of the point estimates the annual rate indicated a general trend of increased survival.

Discussion

Estimates of survival are variable from year to year (Figure 2). It should be noted that these calculations have low statistical power due to small sample size of collared caribou. A sustained change of 2 or 3 percent in survival can make the difference between a herd increasing and decreasing. We would need approximately 300 collars deployed on caribou in order to statistically detect such a small change. Although this may be unfeasible, monitoring the trend and incorporating the variability of survival estimates into the Herd Estimator model will improve population estimates and help us understand the importance of survival data.

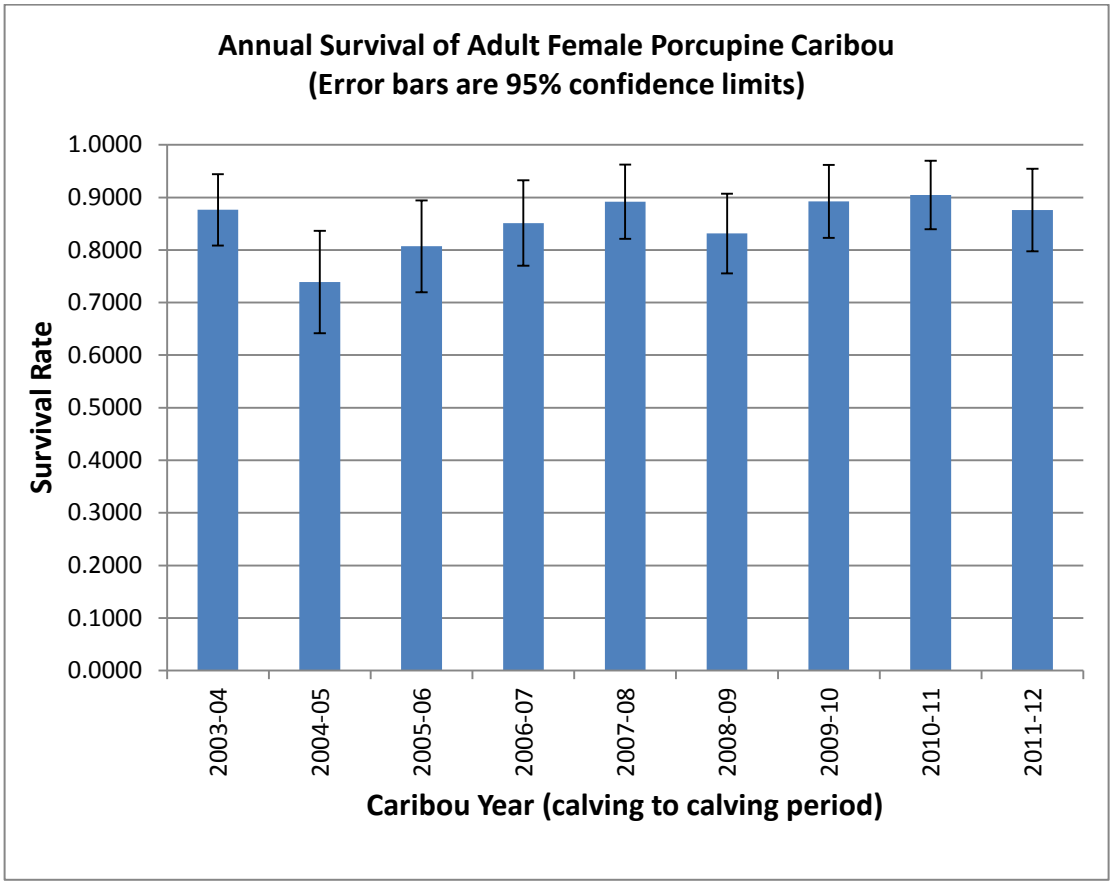

Figure 2. Annual survival estimates for adult female Porcupine Caribou, May 2003 – June 2012. Source: USFWS unpublished data. No data was collected in 2014-2015 to report

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. They 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.

Because the majority of calves will have weaned by March, we do not use the radio collared females in late winter but instead estimate the number of calves for every 100 adult cows, called a calf:cow ratio. In many of the recent years, overlap with other herds on winter range has prevented researchers from conducting the March composition count.

Results
A calving survey was attempted by ADF&G staff during late May – early June, 2015 to estimate calving rate (parturition rate). ADF&G were unable to successfully conduct the survey due to adverse weather conditions.

A post calving survey was attempted during late June by ADF&G staff to estimate the calf:cow ratio for adult cow caribou. This survey could not be completed because the caribou groups were too closely aggregated to get an accurate count.

Discussion
Since 1985, birth rates and the proportion of cows with a live calf in late June were similar during the population decline as during the population increase (Figure 3). Therefore, there is no apparent pattern in the estimates. Years of low survival in certain years are linked to deep snow years and / or a late spring melt. 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. 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.

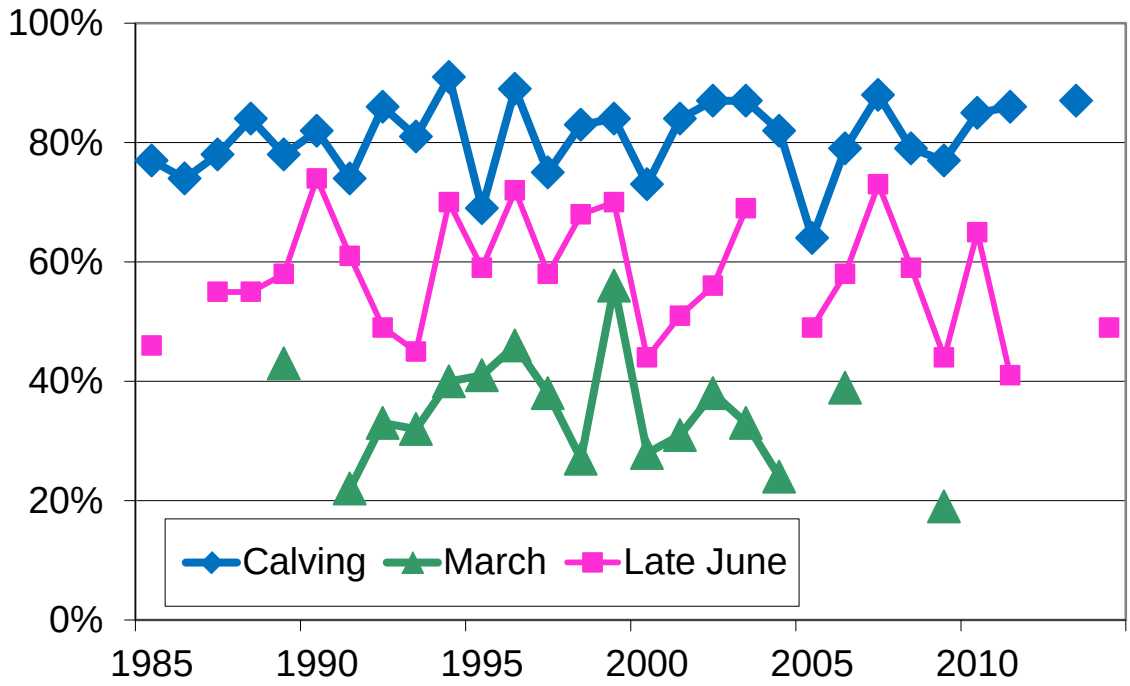

Figure 3. Estimated birth rate and calf survival indices for the Porcupine Caribou herd from 1985-2014. No data was collected in 2014-2015 to report.

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.

Results
Peak of calving in 2015 could not be estimated due to adverse weather conditions during the survey (Table 1).

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' (Table 1).

Table 1. 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	
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
A rut count was not attempted in 2015; however, 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. The next rut count is planned for October 2017.

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
In 2014-2015 we were unable to obtain samples for this measure. Three samples were collected along the Dempster Highway however the timing of these samples was not aligned with the monitoring period usually reported. Past results are shown in Figure 4 and Figure 5.

Discussion
No data was available for this reporting year.

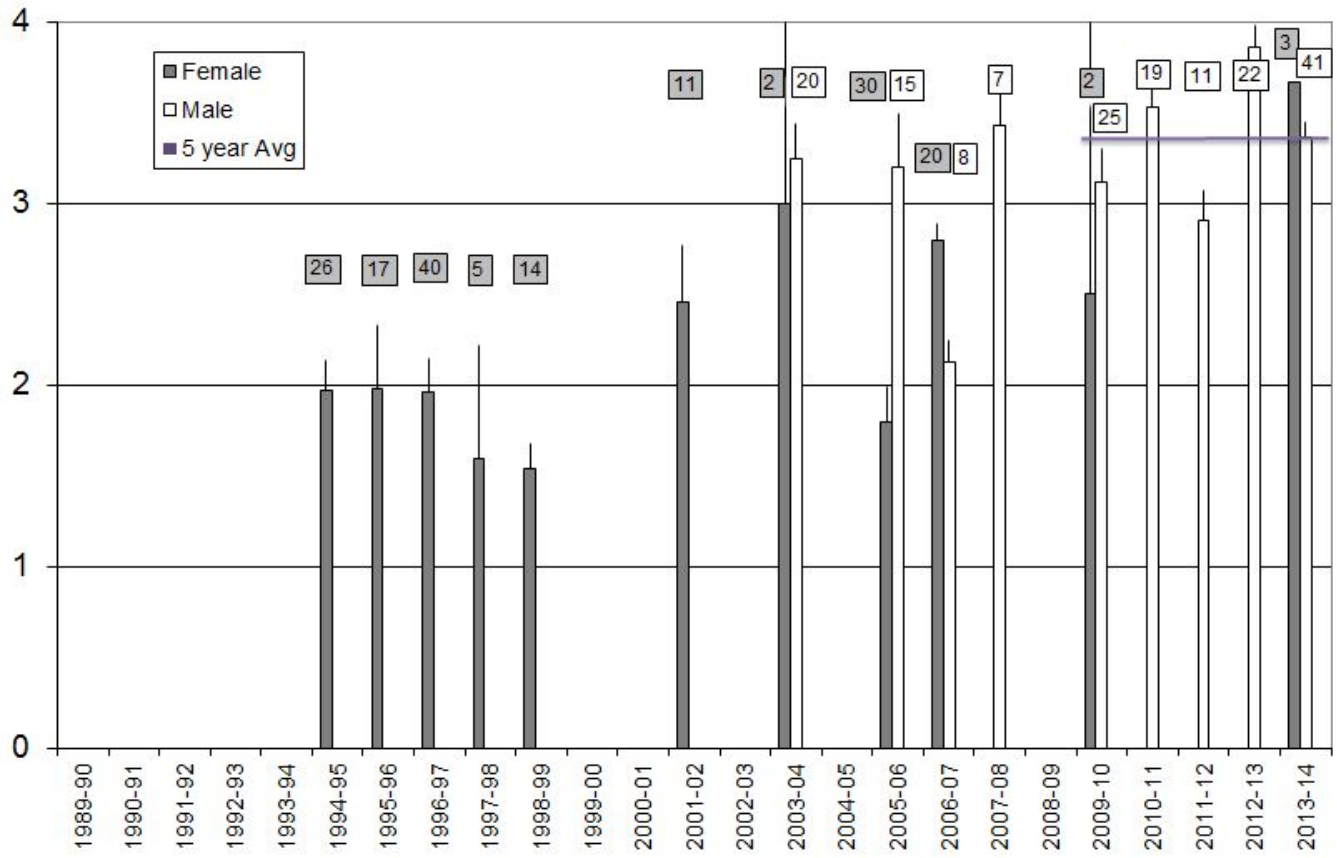

Figure 4. Average condition of harvested Porcupine caribou recorded by hunters. 1=poor 2=fair 3=good 4=very good. Error bars are standard errors. Labels indicate # of caribou sampled. No data was collected in 2014-2015 to report.

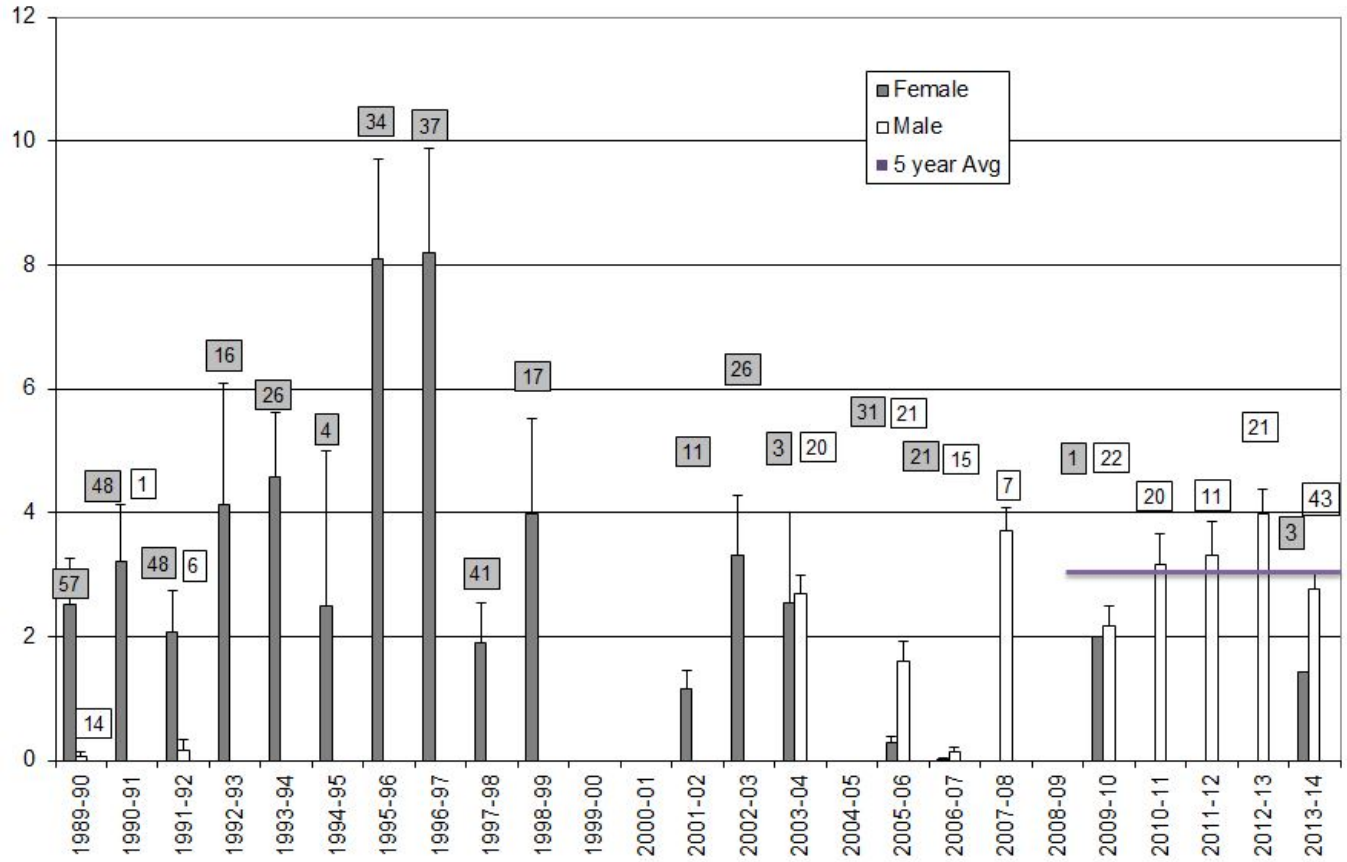

Figure 5. Average depth of backfat (cm) recorded in Body Condition Monitoring. Error bars are standard errors. Labels indicate # of caribou sampled. No data was collected in 2014-2015 to report.

HABITAT

Wildland fires

2015 season fire map data is not yet publicly available from Yukon or NWT. This section of the report contains information current to 2014 (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 1960-2014 was summarized in this report.

Results
As of the 2014 season, the total area burned by fires since 1960 is 38,452 km^2or roughly 15% of the herd's total annual range (Figure 6). Fires in 2014 burned a total of about 23.9 square kilometers, lower than the 5 year average area burned (392sq km) in the previous 5 years and significantly less area than the largest fire years in the 2000's (e.g., area burned in 2004 was 10,213 km^2 and in 2005 was 5691 km^2). In 2014 there were 5 fires in the Yukon, the largest of which was only about 19 km^2, no fires in Alaska, and 1 fire within the NWT portion of the PCH range that was less than 0.08 km^2. The years 2004 and 2007 show the largest number of large fires recorded in recent years (Figure 7). Fires in 2004 and 2005 resulted in record tracts of area burned (Figure 8).

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 that they 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.

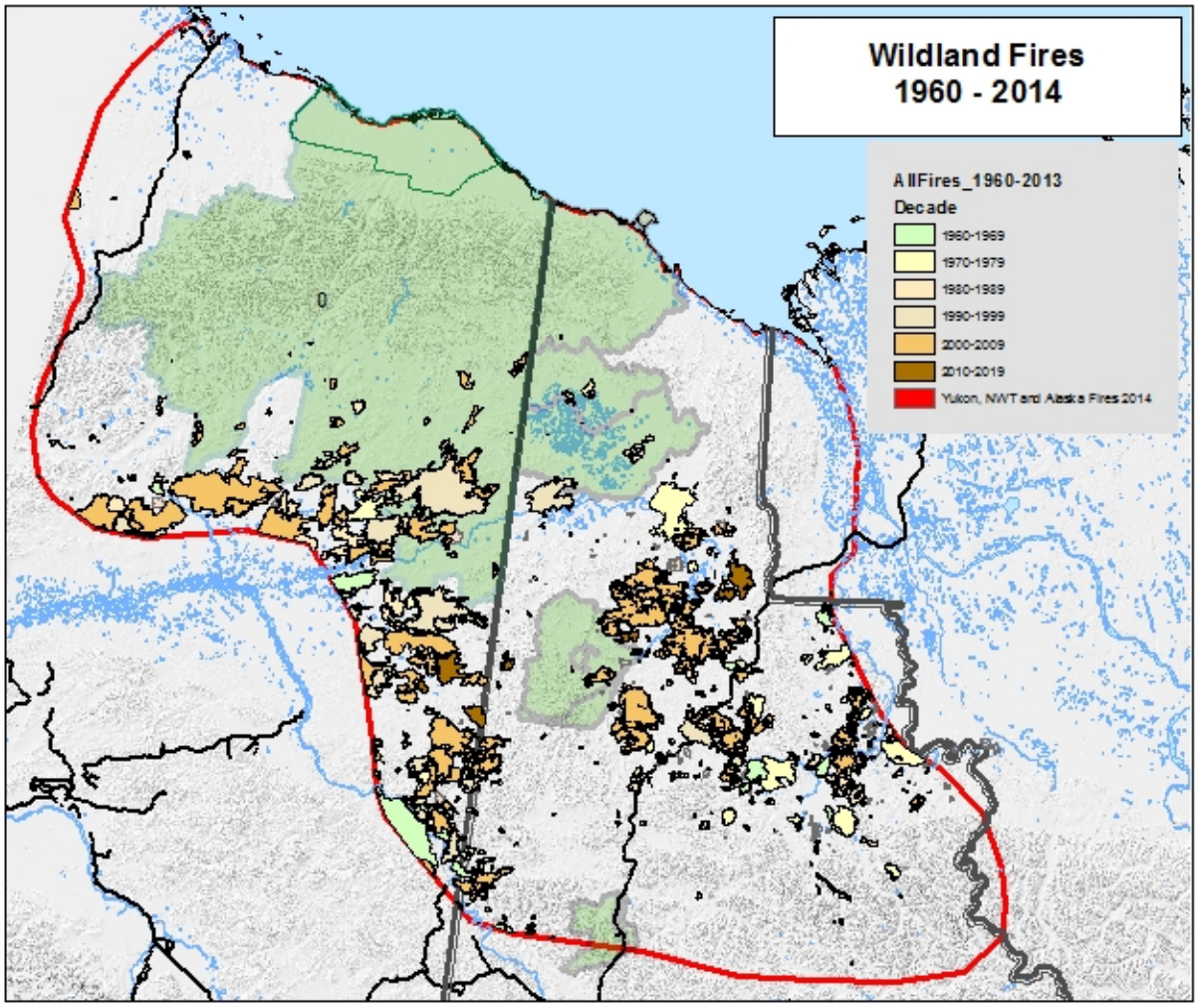

Figure 6. Areas burned within range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories from 1960 to 2014. The darker green areas surrounded by a grey border represent protected areas.

Includes NWT fire data (© 2002-14). Alaska and Yukon fire data 1960 to 2014.

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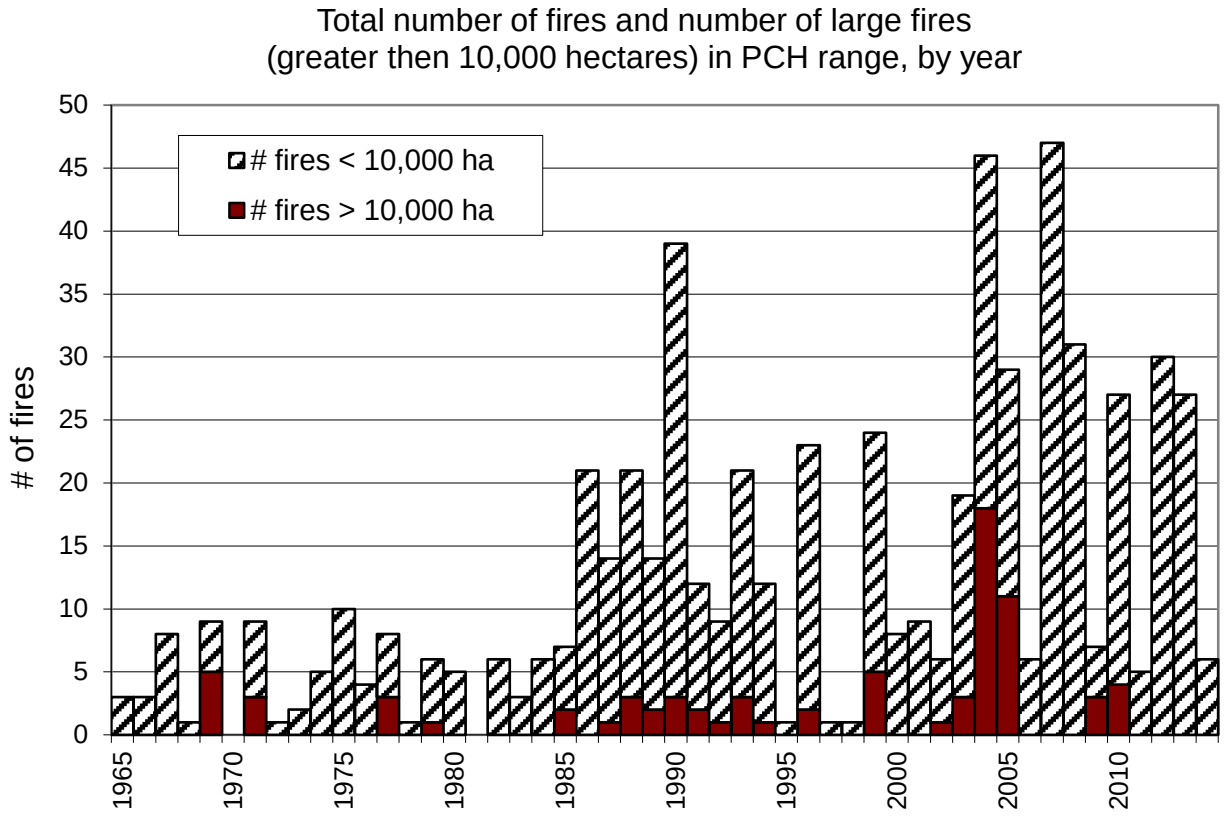

Figure 7. Total number of fires and number of large fires to 2014 within the range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories.

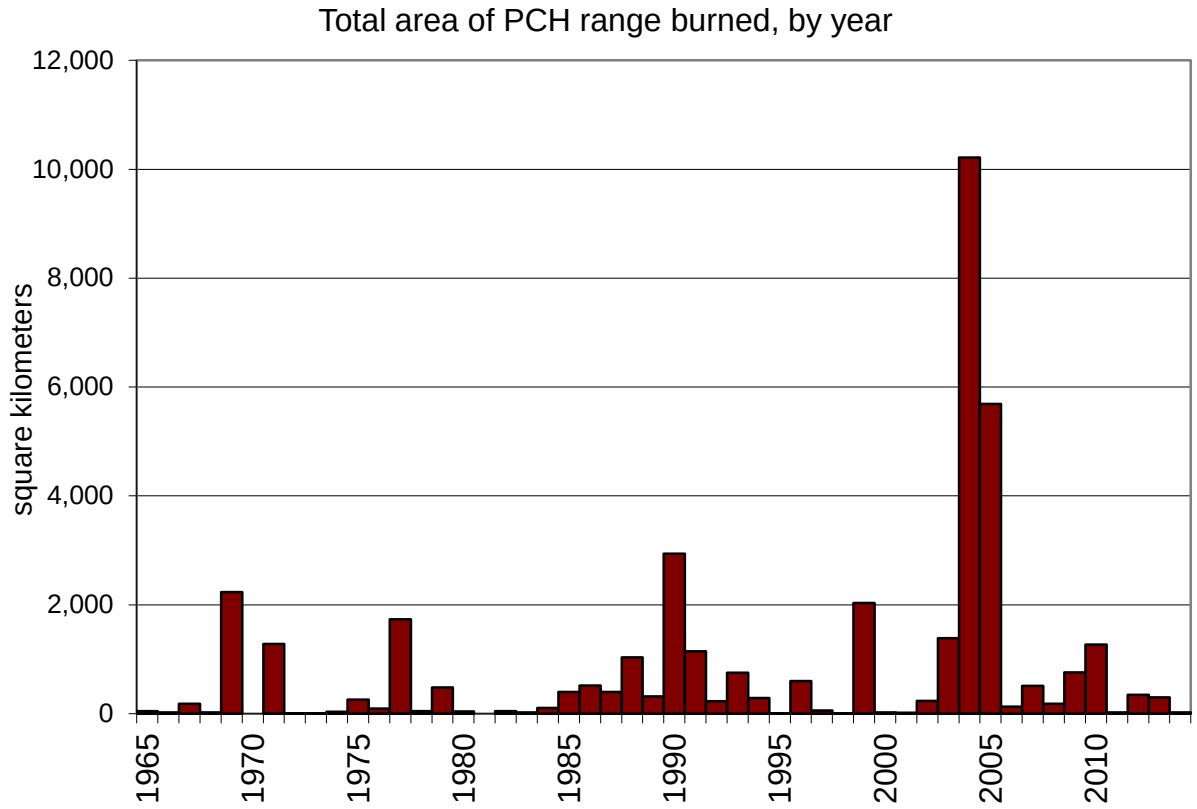

Figure 8. Total area burned by fire, by year to 2014 within the range of the Porcupine Caribou Herd in Alaska, Yukon and Northwest Territories.

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 9). 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 10). In 2014-2015 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.

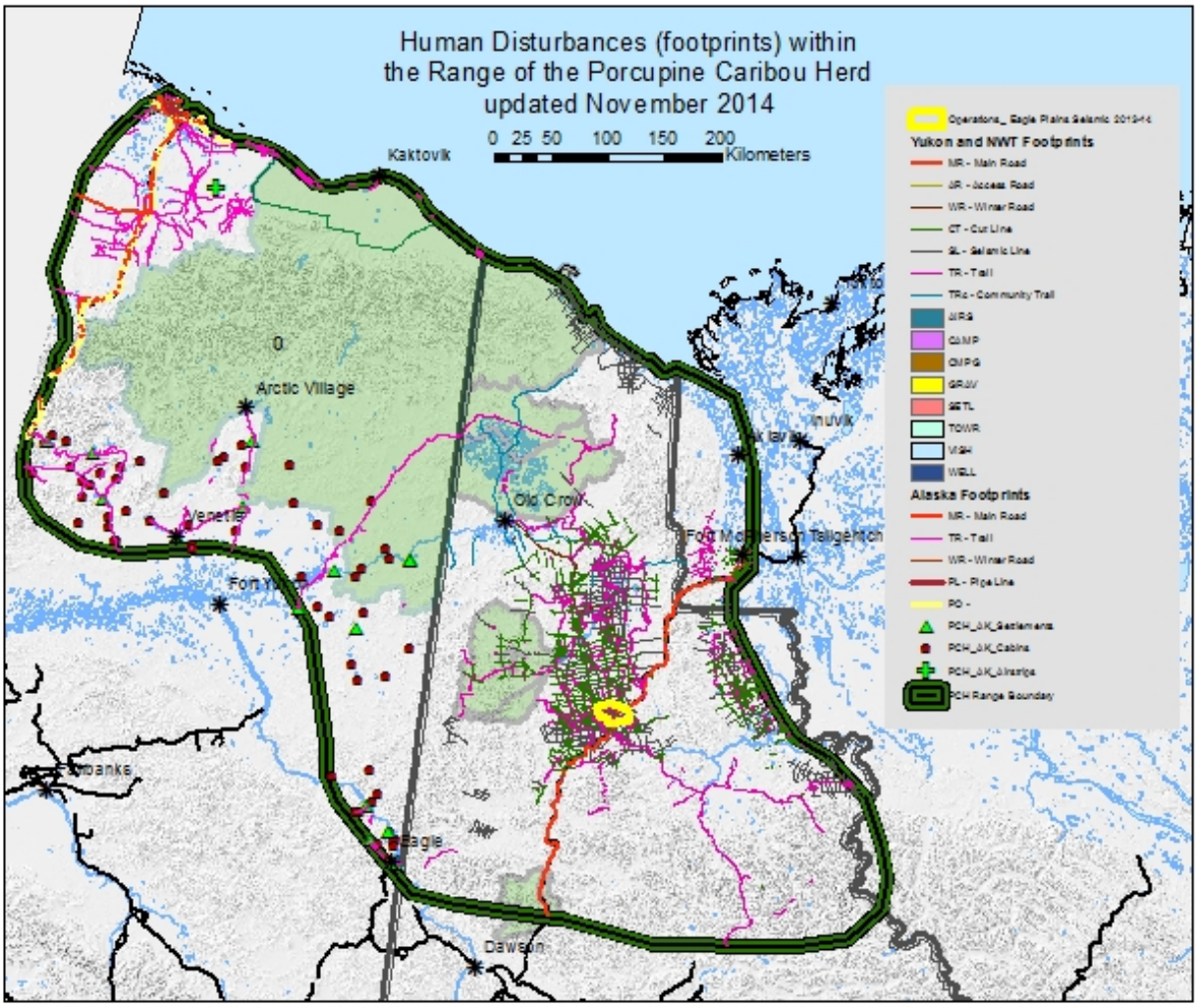

Figure 9. Human disturbance within the range of the Porcupine Caribou herd (updated Nov. 14, 2014) in Alaska, Northwest Territories, and Yukon.

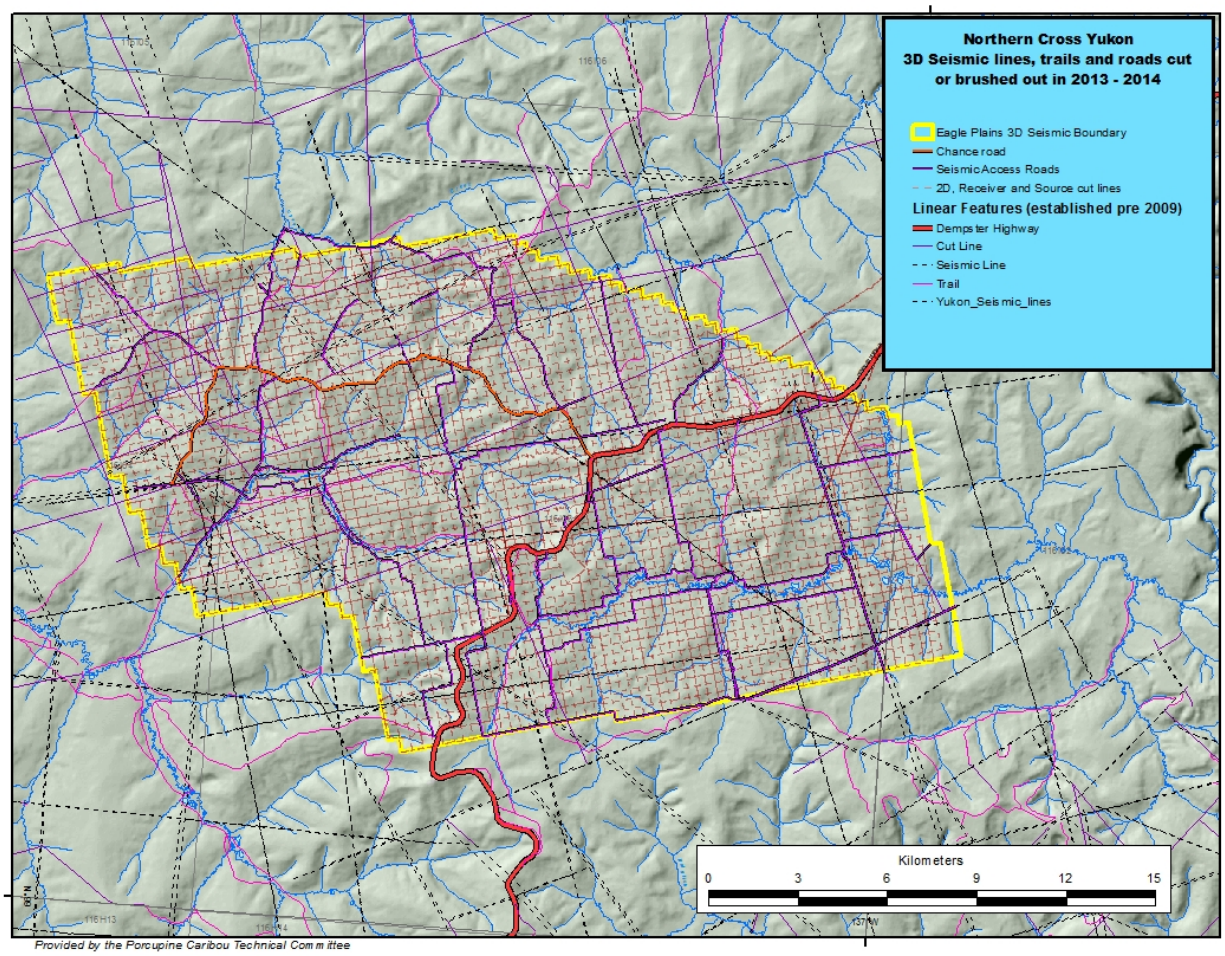

Figure 10. The extent of 3D seismic lines, trails and roads cut or brushed out in 2013-14 by Northern Cross within the range of the Porcupine Caribou Herd in Yukon

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 11.

A very small portion of the PCH wintered in the Yukon, in the upper Ogilvie and Miner, and lower Blackstone drainages. The majority of the PCH wintered in Alaska adjacent to Arctic Village and the Dalton Highway.

Results

Snow depth in the northern Yukon was above to well above average in 2014-15 while density was only slightly above average (Figure 11). The Porcupine River drainage (Old Crow and Eagle Plains Regions) experienced well above average snow depth, while the Peel River drainage (Ogilvie and Blackstone Regions) had above average snow depth. 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.

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.

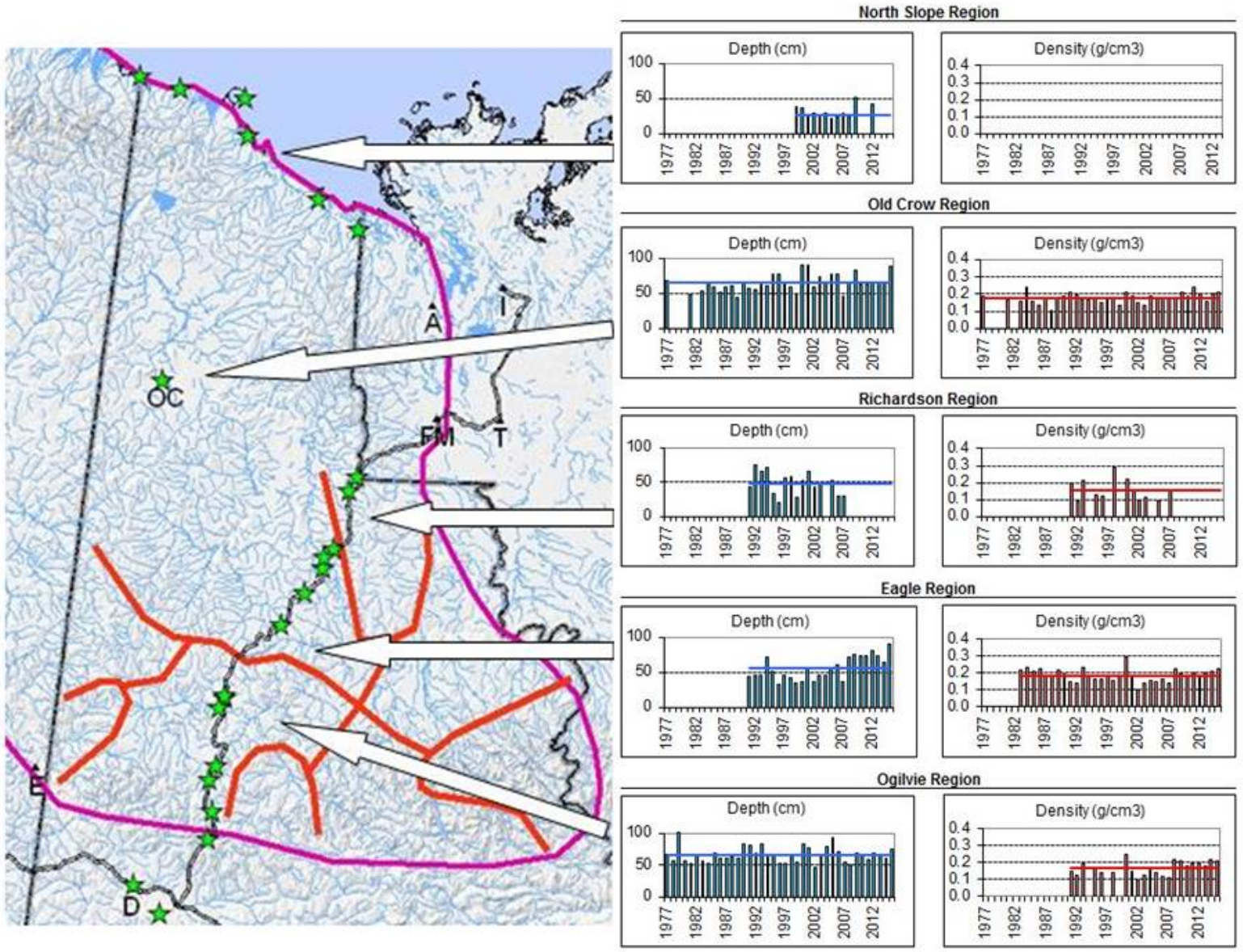

Figure 11. Summary of snow depth and density by snow region from permanent stations (indicated by green stars) for the Yukon portion of the Porcupine Caribou Herd range. Red lines on the map delineate snow regions relevant to caribou (Russell et al 1993).

TRADITIONAL KNOWLEDGE

POPULATION

Were hunters' needs met?

Objective
To determine if hunter's met their needs for caribou that year.

Methods
The ability of hunters to meet their needs for caribou is an important indicator tracked during yearly ABEKC interviews. Data summaries were provided for all seasons from 2013-14 to 2000-01. (ABEKC 2014). Interviewees were asked whether they met their needs for caribou for that years' hunting period with answers of "yes" or "no".

Results
The majority of respondents (61%) did not meet their needs for caribou in 2013-14 (Figure 12). This represents the first year since 2001-02 where hunters that were interviewed did not meet their needs for caribou. This result is significantly different than all years with the exception of 2001-02. There are a number of reasons cited by respondents. Approximately 33% of respondents did not go hunting because they bought reindeer, had no transportation, the caribou were late or too far. If hunters did go hunting (67%) they were not successful due to a lack of trasportation, low availability in hunting area or changes to traditional migration routes of caribou, purchase of commerical reindeer meat, low water for boating and poor health or advanced age of hunter (ABEKC 2015).

Discussion
An analysis of ABEKC data based on interviews from 2000-2007 was recently completed by Russell et al. (2013). Researchers found that there was a general increasing trend in meeting needs in both spring and fall hunting periods over time (Russell et al. 2013). From 2005-2007, respondents met their needs on average 70% and 80% during fall and spring, respectively. There was a significant but weak relationship between meeting needs and caribou availability in both seasons during this time period.

The percentage of respondents that met their needs for caribou from 2013-14 was approximately half that compared to the timespan that Russell et al. (2013) investigated. If this indicator is correlated with how available caribou are on the landscape then it suggests that caribou availability in 2013-14 was much lower than 2005-2007. Many factors can affect the ability of hunters to meet their needs including changing distributions, caribou migration routes and social factors.

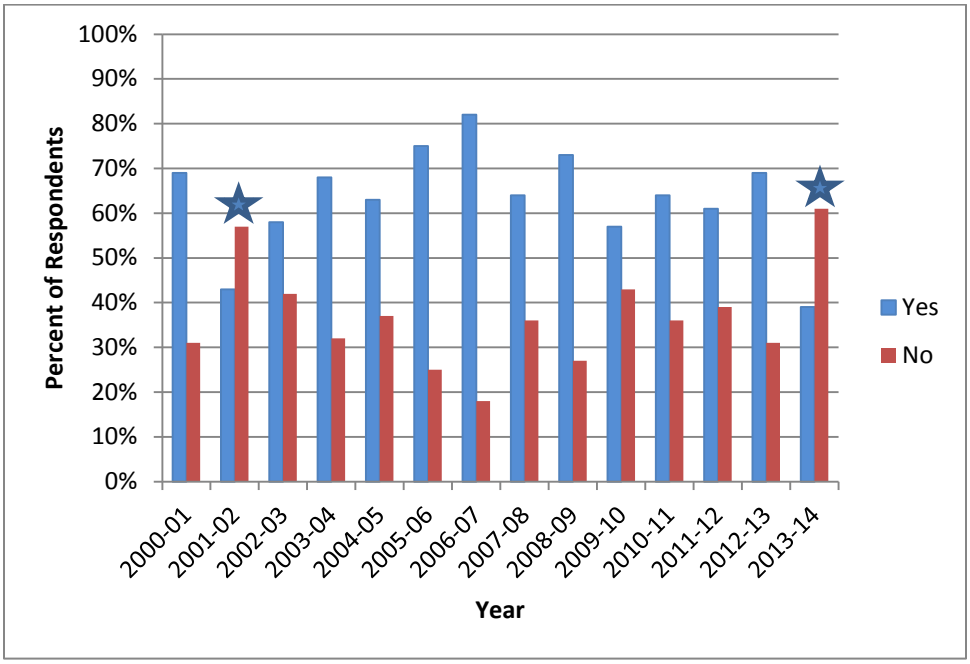

Figure 12. The percentage of respondents that met their needs for caribou from 1996-97 to 2013-14. Stars indicate years that are significantly different than other years.

Specify Caribou Abundance?

Objective
To determine if there was anything in particular that people who were interviewed by ABEKC noticed about caribou abundance in the past year?

Methods
Questions about caribou abundance is an important indicator tracked during yearly ABEKC interviews. Interviewees were asked if there was anything in particular they noticed about caribou abundance in the past year (ABEKC 2015). They were asked to specify their answer and we grouped these responses into four main groupings.

Results
Of the 63 people that responded to this question almost half of the respondents reported seeing fewer caribou than previous years (Figure 13). Other respondents commented that caribou had changed their migration route (27%) and the caribou were not in their area (21%). A few respondents suggested that there were too many muskox, too much traffic on Dempster and forest fires were affecting caribou abundance and movement. Only 5% of respondents stated that caribou increased over 2013-14.

Discussion
With the absence of a census result we can look at a number of indicators that ABECK is tracking on a yearly basis. Although they do not have a question specifically asking whether or not you think the herd is increasing or decreasing overall there is a data that may suggest overall population trends. However, in this case although respondents reported fewer caribou in 2013-14 this result may be complicated other factors such as changing distribution or migration

patterns making them unavailable to hunters. What we can say with this data is that overall the people interviewed saw fewer caribou (due to population decrease or caribou where not in their area) and noticed changes to normal migration routes.

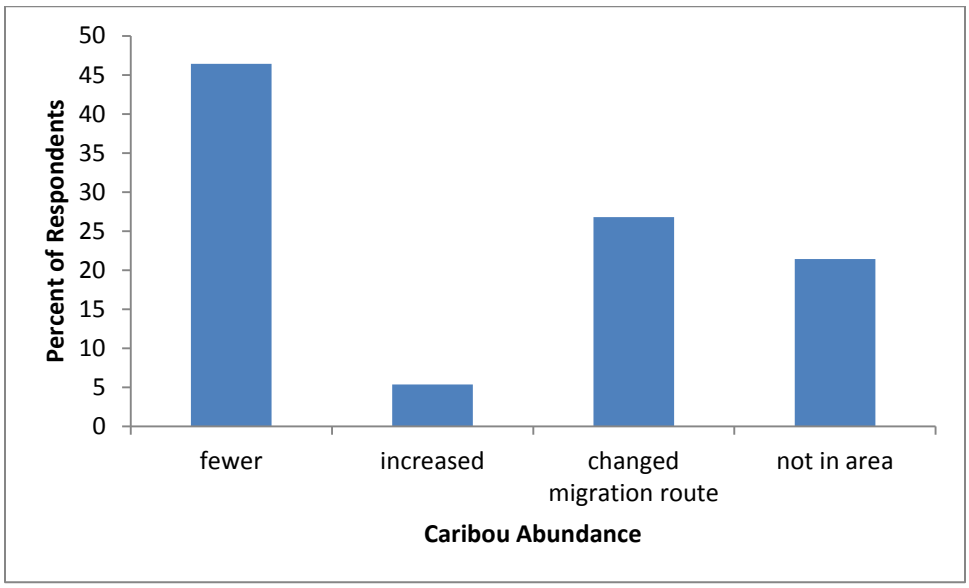

Figure 13. The percentage of respondents determine if there was anything in particular that people who were interviewed by that met their needs for caribou from 1996-97 to 2013-14. All responses were grouped into four categories.

Adult female abundance

Objective
To determine trends in the abundance of adult female caribou in each season.

Methods
Adult female survival is an important indicator and represents the ability of the herd to reproduce and grow. Interviews conducted by ABEKC (2015) asked "In your observations for each season, were there more, equal or fewer Porcupine Caribou over the last year than usual?" ABECK summarized and analyzed data from 2009 – 2014 for significant differences between seasons. Seasons included winter, spring, summer and fall. Interviewees were asked to separate their observations by male bulls, adult females, calves, young males and young females. There are four possible responses to this question: More, Same, Less and Don't Know. The response "Don't Know" was only present in 2009-10 and 2012-13, and 2013-14 questionnaires. Other years without this response cannot be compared.

Results
In all seasons respondents (121) observed significantly "Less" adult female caribou than in 2012-13 and 2009-10 (Figure 14). Other responses were not found to be significantly different than other years although show a slight downward trend. Data from 2010-2012 cannot be included in a comparison across years.

Discussion

The survival of adult females is important to ensure that calves are born into the next generation and the population can continue to grow in the face of predation, hunting, and changes in climate that affects insects, food availability and energy use of caribou. Fancy et al. (1994) found that the growth of the herd is most sensitive to the survival of females 3 years of age and older followed by calf production and survival. A decline in the annual adult female survival from 0.8781 to 0.847 would cause a decline in the population (Walsh et al. 1995).

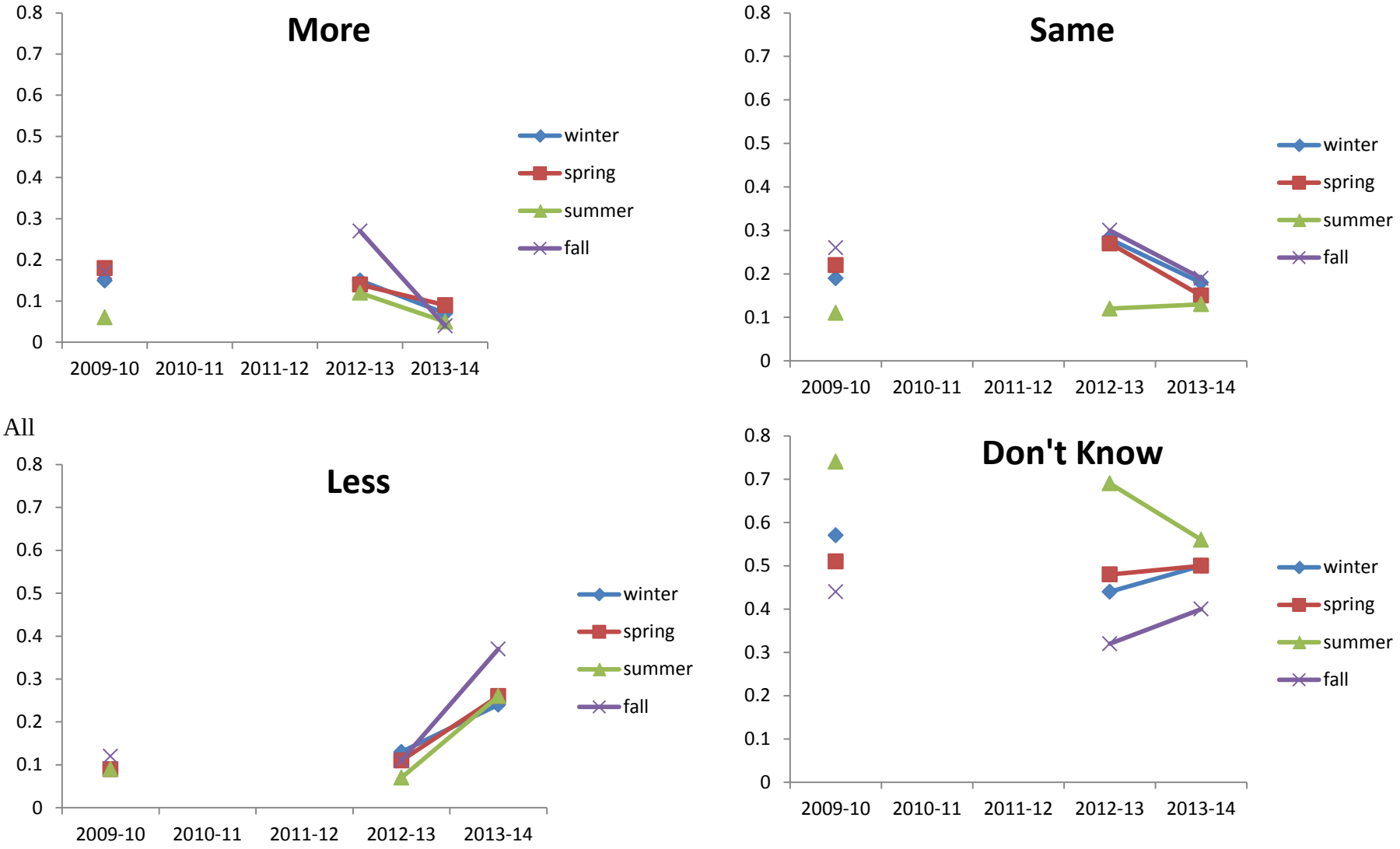

Figure 14. A summary of Arctic Borderlands Ecological Knowledge Coop interview results from 2009-2014. Respondents were asked if they saw more, equal or fewer adult female Porcupine over the last year than usual by season.

CARIBOU BODY CONDITION

Observed body condition and health of caribou

Objective
To determine trends in body condition of Porcupine caribou between years and seasons.

Methods
Body condition and health of caribou are important indicators tracked during their yearly ABEKC interviews. Data summaries were provided for all seasons from 2009 to 2014 (ABEKC 2015). Interviewees were asked to about the condition of caribou they observed each season over the past year. There are six possible responses to this question: Don't Know; Excellent; Good; Fair; Mixed; and Poor. Interviews for 2015 will be completed from January to Feb 2016.

Results
Respondents observed caribou most often in "Good" condition in winter, spring and fall in 2013-14, consistant with the past four years (Figure 15). However, the majority of respondents reported that caribou were in "Fair" condition in the summer.

Discussion
The ABEKC data is useful because provides additional body condition information on the entire herd that might not be captured with the body condition monitoring of harvested caribou only (e.g. males only in some management regimes). Data from interviewees suggest that the overall body condition in all seasons of Porcupine caribou were "Good" in 2013-14 with the exception of "Fair" in the summer.

Poor summer body condition may be related to inadequate foraging conditions possibly due to poor summer range conditions. Climate indicators summarized by Russel et al. (2015) show potentially better forage conditions in the summer (Appendix C; Figure 12.) in addition to a declining number of growing degree-days on June 10. Growing degree-days indicate the potential stage of growth plants are just after the peak of calving which is a critical time for females and calves. Poor range conditions during the first month of lactation may deplete female fat reserves resulting in lighter, slower growing calves and may impact female body development (shorter and lighter). Russel et al. (2015) also found initial signs of decline in caribou body size, a possible sign that the herd is nearing peak abundance. If females are unable to accumulate enough body reserves in autumn or early winter gestation may be interrupted resulting in decline in pregnancy rate and autumn cow:calf ratio (Crete and Huot 1993).

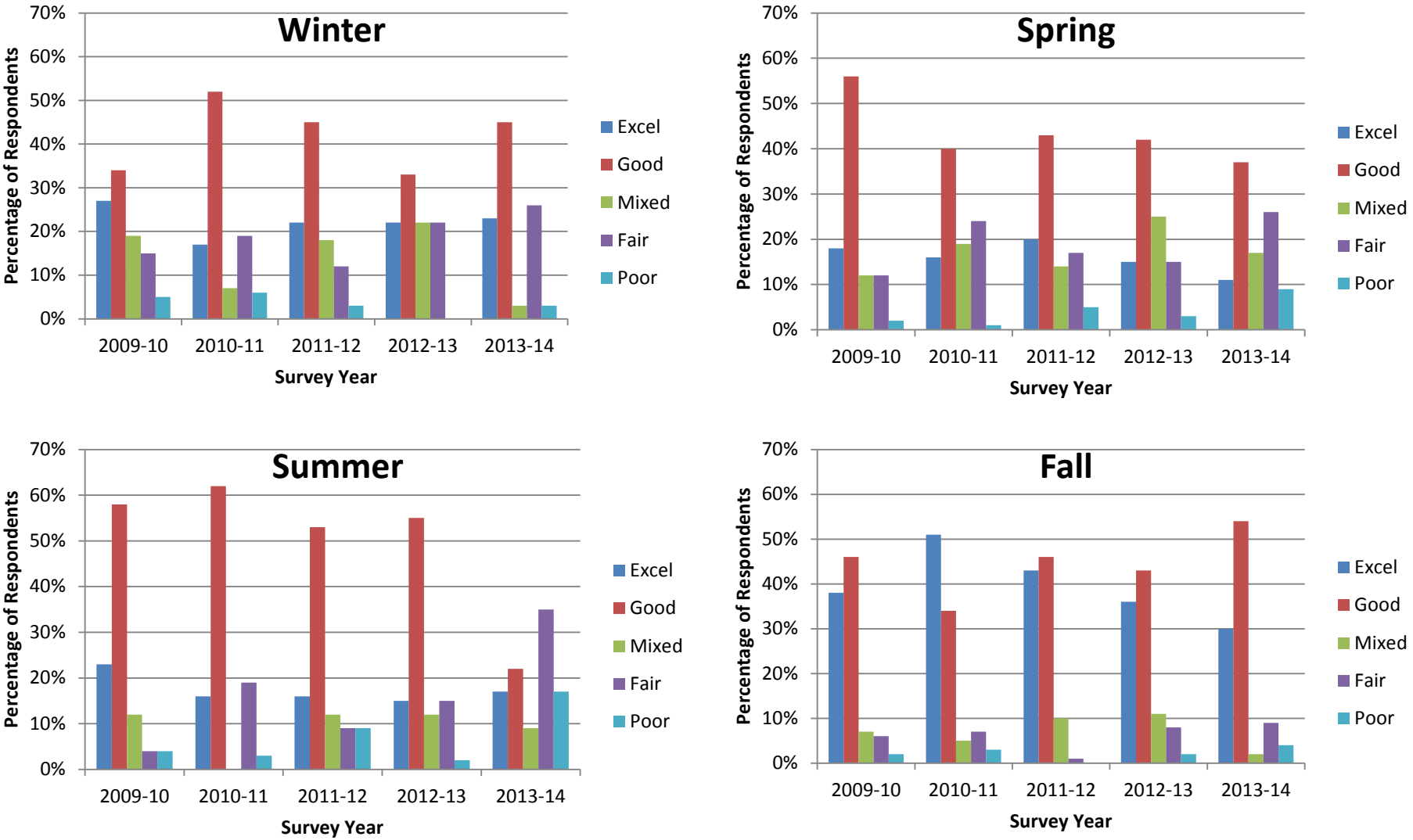

Figure 15. A summary of Arctic Borderlands Ecological Knowledge Coop interview results from 2009-2014. Respondents were asked about the overall condition of Porcupine caribou that they observed in each of the four seasons.

HABITAT

Extreme weather events

Objective
To gather information on unusual and rare weather events (icing and more snow than normal) that may affect Porcupine caribou.

Methods
Unusual, extreme and rare weather related events are important indicators tracked during yearly ABEKC interviews. Data summaries were provided for all months for 1999-2000 to 2012-13 with some years lacking certain data (ABEKC 2014). Interviewees were asked to identify the months when they observed any of the following usual, extreme or rare weather-related events; torrential rain, icing, really frosty, more thunderstorms, more wind, colder or hotter than normal, more or less snow than normal, drought, and other (specified) or none. Each month could have one or more options checked. "More snow than normal" and "more snow than normal" were analyzed for significant differences between years and summarized by season. Fall (October, November and December) and winter (January, February, and March) results are presented. Note that interviewees are selected by communities and the monitors with the intention of interviewing a select number of land users engaging with a suite of ecological indicators (i.e. this should not be considered a random sample of caribou harvesters and should not be extrapolated to unsampled communities). Interviews for 2014 will be completed from January to Feb 2015.

Results
Fall (October, November and December):

There was a significant increase in the percent of people interviewed that reported that there was "more snow than normal" in 2014 (Figure 16). This represents a 24% increase when compared to the 5 year average. Similar increases indicating "more snow than normal" also occurred in 2009-10 and 2005-06. Very few respondents reported "more ice than normal" during the same time (Figure 16).

Winter (January, February, and March):

Interviewees commented that there was more snow than usual in 2013-14 (12% higher than the 5 year average). The percentage of respondents there was more ice than normal (Figure 17).

Discussion
Deep snow and periodic icing events on the winter range can restrict the ability of caribou to access their food and travelling through deep snow can expend limited energy reserves. These weather events are often suggested to be the cause of mass starvation, catastrophic declines and extirpation of local populations in reindeer and caribou herds. However, a comprehensive review of the impact of climate, snow and ice in the declines of reindeer and caribou populations states that there is little evidence to suggest that this is true across the extent of caribou distribution (Tyler 2010). In some cases there was a lack of data on weather and ground conditions at the same time as changes in population size so it was difficult to determine the cause of the decline. Therefore, it is important to track snow and icing conditions in conjunction with other population indicators. Unusual, extreme and rare weather may become increasingly important with long-term changes in climate.

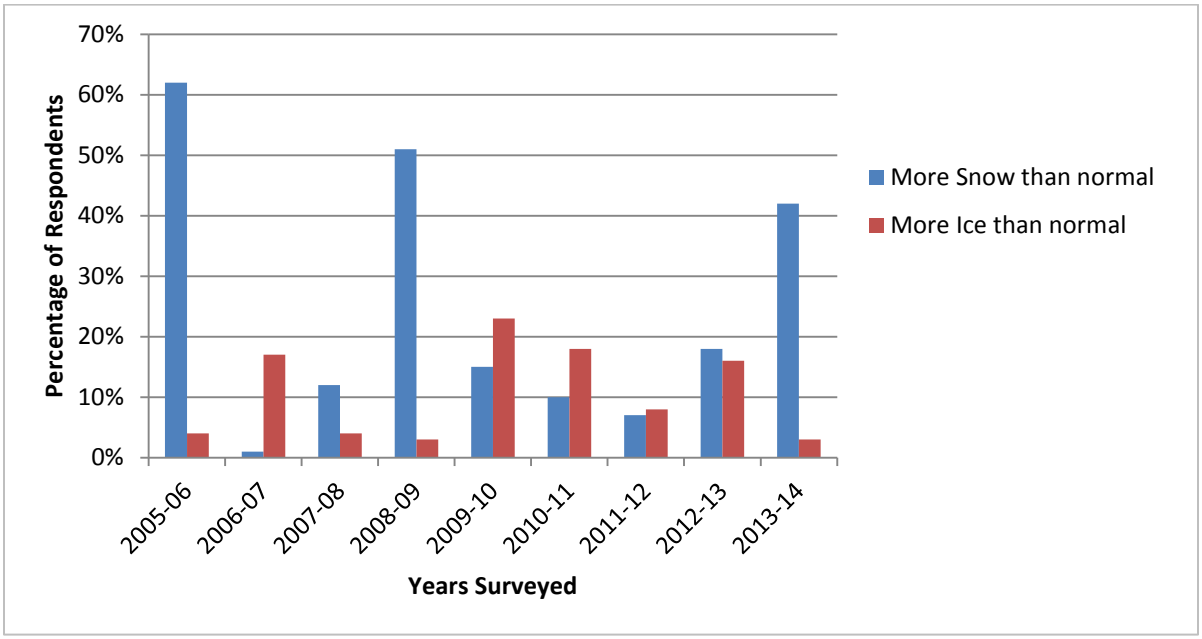

Figure 16. The percentage of respondents that identified icing events or more snow than normal in the fall (October, November and December) of that year during Arctic Borderlands Ecological Knowledge Coop interviews from 2005 - 2014.

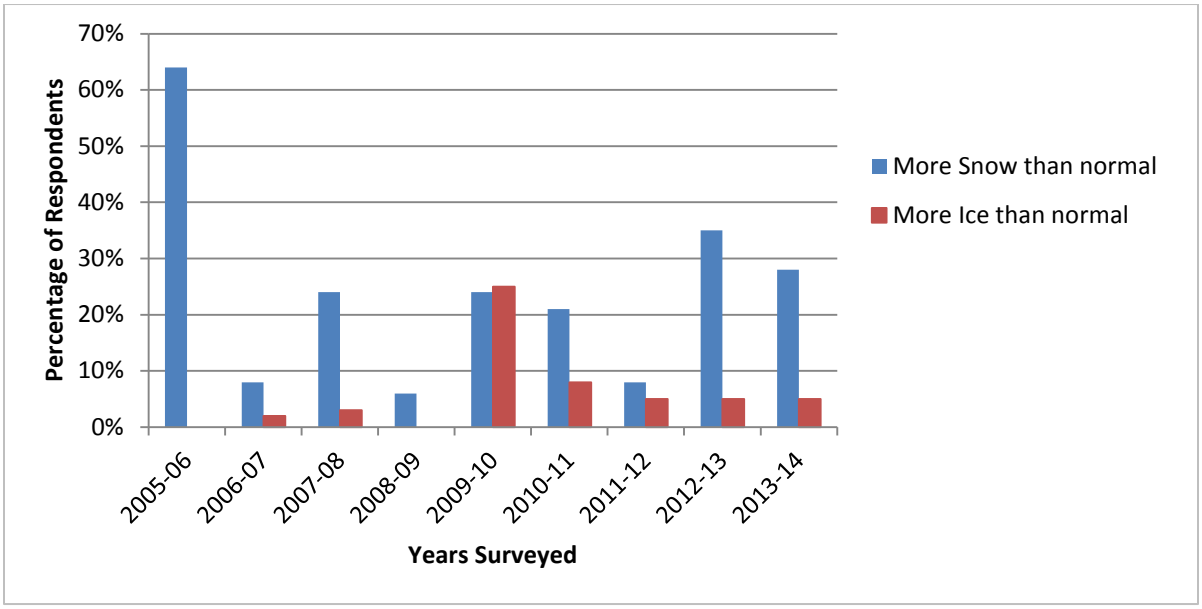

Figure 17. The percentage of respondents that identified icing events or more snow than normal in the winter (January, February and March) of that year during Arctic Borderlands Ecological Knowledge Coop interviews from 2005 - 2014.

LITERATURE CITED

Allaye-Chan, A.C. 1991. Physiological and ecological determinants of nutrient partitioning in caribou and reindeer. Ph.D. Thesis. University of Alaska Fairbanks, AK. 125 pp.

Arctic Borderlands Ecological Knowledge Co-op. 2015. 2013-14 Annual Community Data Summary Report. .

Arthur, S. 2001. Alaska Department of Fish and Game memo dated 13 November 2001

Arthur, S. M., K. R. Whitten, F. J. Mauer and D. Cooley. 2003. Modeling the decline of the Porcupine Caribou Herd, 1989-1998: the importance of survival vs. recruitment. Rangifer. Special Issue 14:123-130.

Crete, M. and J. Huot. 1993. Regulation of a large herd of migratory caribou: summer nutrition affects calf growth and body reserves of dams. Canadian Journal of Zoology. 71: 2291-2296.

Fancy, S. G., K. R. Whitten and D. E. Russell. 1994. Demography of the Porcupine caribou herd, 1983-1992. Canadian Journal of Zoology. 72:840-846.

Gunn, A. and W. Nixon. 2007. Rangifer Health & Body Condition Monitoring Manual. Circum Arctic Rangifer Monitoring and Assessment (CARMA) Network.

International Plan for the Conservation of Porcupine Caribou. *1987.*.

Lenart, E.A. 2007. Game Management Units 25A, 25B, 25D and 26C. Pages 232 – 248. In P. Harper, editor. Caribou management report of survey-inventory activities, 1 July 2004 to 30 June 2006. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska, USA.

Porcupine Caribou Management Board. 2010. Harvest Management Plan for the Porcupine Caribou Herd in Canada. March 2010. 45 pp.

Russell, D.E., A.M. Martell and W.A.C. Nixon. 1993. Range ecology of the Porcupine Caribou Herd in Canada. Rangifer Special Issue No 8. 168 pp.

Russell, D.E., M.Y. Svoboda, Arokium J. ,Cooley D. 2013. Arctic Borderlands Ecological Knowledge Cooperative: can local knowledge inform caribou management? Rangifer (33) Special Issue No 21 71-78

Russell, D.E. and M.Y. Svoboda. 2015. Analysis of caribou related questions (2008-2014) and update of key climate indicators. Prepared for Arctic Borderlands Ecological Knowledge Cooperative. Manuscript in preparation.

Thomas, D. C. and H. P.L. Kiliaan. 1998. Fire-caribou relationships: (IV) Recover of habitat after fire on the winter range of the Beverly Herd. Technical Report Series No. 312. Canadian Wildlife Service, Environment Canada, Prairie and Northern Region.

Tyler, N.J.C. 2010. Climate, snow, ice, crashes and declines in populations of reindeer and caribou (*Rangifer tarandus L.).* Ecological Monographs, 80(2): 197-219.

Urquhart, D. R. 1983. The Status and Life History of the Porcupine Caribou Herd. Yukon Department of Renewable Resources. 78 pp.

Walsh, N. E., B. Griffith and T. R. McCabe. 1995. Evaluating growth of the Porcupine Caribou Herd using a stochastic model. Journal of Wildlife Management. 59(2):262-272.

Wertz, T.L., S.M. Arthur, D. Cooley, B. Griffith, and M. Kienzler. 2007. Seasonal Survival of The Porcupine Caribou Herd In Alaska And Northern Yukon Territory, 2003-2006. Project report to the Porcupine Caribou Management Board.

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			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	
Mean	64.55	0.81	0.72	0.85	0.58	0.36			
5 yr mean	50.00	0.84	0.60	0.74	0.50	0.19		1-Jun-13	

[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 4). 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.

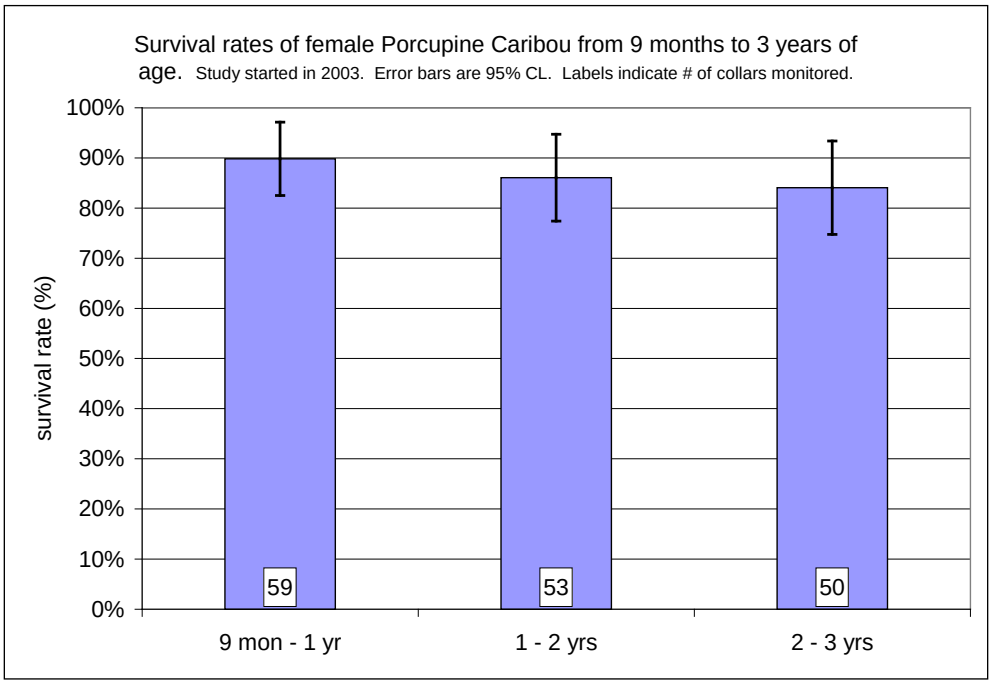

Figure 18. Survival of Porcupine Caribou females from 9 months to 3 years of age from 2003-2010.

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 5). 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.

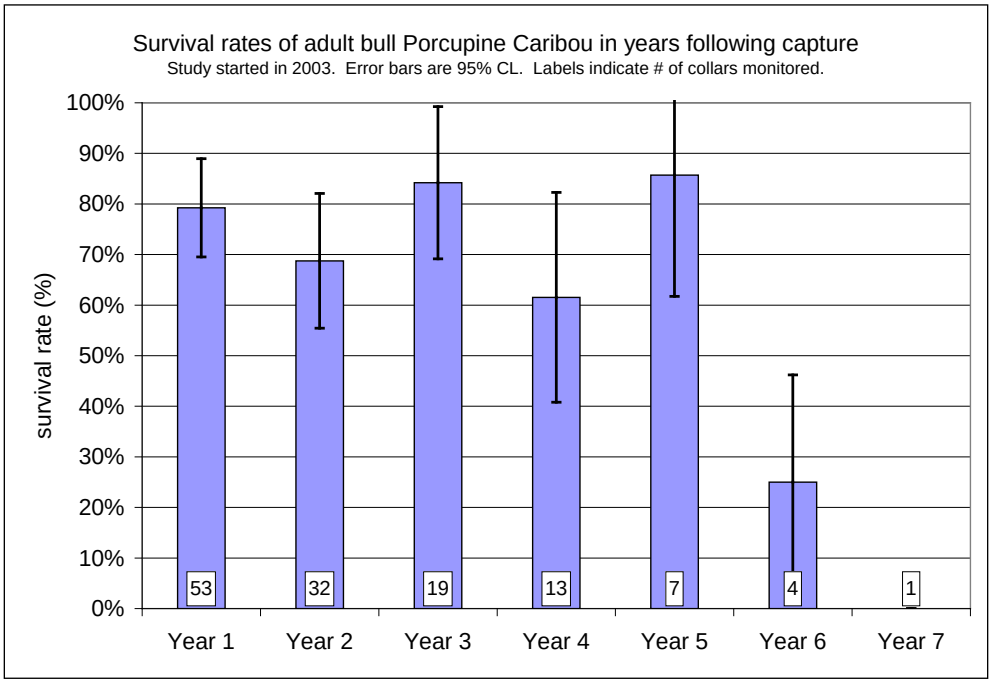

Figure 19. Survival of male Porcupine Caribou from 2003 to 2010.