Porcupine Caribou Herd Management Report and Plan, Game Management Units 25A, 25B, 25D, and 26C:

Report Period 1 July 2012–30 June 2017, and

Plan Period 1 July 2017–30 June 2022

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Alaska Department of Fish and Game Division of Wildlife Conservation

Species Management Report and Plan ADF&G/DWC/SMR&P-2020-22

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Hunters are important founders of the modern wildlife conservation movement. They, along with trappers and sport shooters, provided funding for this publication through payment of federal taxes on firearms, ammunition, and archery equipment, and through state hunting license and tag fees.

Species management reports and plans provide information about species that are hunted or trapped and management actions, goals, recommendations for those species, and plans for data collection. Detailed information is prepared for each species every 5 years by the area management biologist for game management units in their areas, who also develops a plan for data collection and species management for the next 5 years. This type of report is not produced for species that are not managed for hunting or trapping or for areas where there is no current or anticipated activity. Unit reports are reviewed and approved for publication by regional management coordinators and are available to the public via the Alaska Department of Fish and Game's public website.

This species management report and plan was reviewed and approved for publication by Doreen Parker McNeill, Management Coordinator for the Division of Wildlife Conservation.

Species management reports and plans are available via the Alaska Department of Fish and Game's public website (www.adfg.alaska.gov) or by contacting Alaska Department of Fish and Game's Division of Wildlife Conservation, PO Box 115526, Juneau, AK 99811-5526; phone: (907) 465-4190; email: dfg.dwc.publications@alaska.gov. The report may also be accessed through most libraries, via interlibrary loan from the Alaska State Library or the Alaska Resources Library and Information Services (www.arlis.org).

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Contents

List of Figures

List of Tables

List of Appendices

Purpose of this Report

This report provides a record of survey and inventory management activities for caribou (*Rangifer tarandus granti*) in Units 25A, 25B, 25D and 26C for the previous 5 regulatory years and plans for survey and inventory management activities in the 5 years following the end of that period. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY14 = 1 July 2014–30 June 2015). This report is produced primarily to provide agency staff with data and analysis to help guide and record its own efforts, but is also provided to the public to inform them of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G, the department) Division of Wildlife Conservation (DWC) launched this 5-year report to more efficiently report on trends and describe potential changes in data collection activities over the next 5 years. It replaces the caribou management reports of survey and inventory activities that were previously produced every 2 years and supersedes the 1976 draft management plans (Alaska Department of Fish and Game, 1976).

I. RY12–RY16 Management Report

Management Area

The management area includes the eastern portions of the Arctic Slope, the Brooks Range, and northeastern Interior Alaska, including game management units 25A, 25B, 25D, and 26C (59,400 mi^2, Fig. 1).

Summary of Status, Trend, Management Activities, and History of the Porcupine Caribou Herd in Units 25A, 25B, 25D, and 26C

The Porcupine caribou herd (PCH) migrates between Alaska and both the Yukon, and Northwest Territories in Canada. Most of the herd's 78,000-mi^2 range is remote, roadless wilderness (Fig. 2). The PCH is an important subsistence resource for people in Alaska and Canada. Additionally, PCH provides valued hunting and wildlife viewing opportunities for nonlocal Alaska residents and nonresidents of Alaska. Because the PCH often calves in promising onshore petroleum prospects in Alaska (Clough et al. 1987), various state and federal agencies and their Canadian counterparts collaborated on baseline ecological studies of the PCH in the 1980s and 1990s (Fancy and Whitten 1991; Fancy et al. 1994; Garner and Reynolds 1986; Griffith et al. 2002; Whitten and Regelin 1988; Whitten and Fancy 1991; Whitten et al. 1992). These studies are expected to provide baseline information for development of additional studies, planning, and mitigation should petroleum development occur in the future. Since these studies, research of the PCH has been substantially reduced and efforts have been focused on monitoring population parameters to evaluate management objectives.

In 1987 the United States and Canada established the International Porcupine Caribou Board (IPCB) to coordinate management and research among governments and user groups (Appendix A). The IPCB includes a representative from each of the governments of the United States and Canada, the Alaska Department of Fish and Game (ADF&G), the Yukon Department of Environment, and members of communities in Alaska and Canada that use the herd.

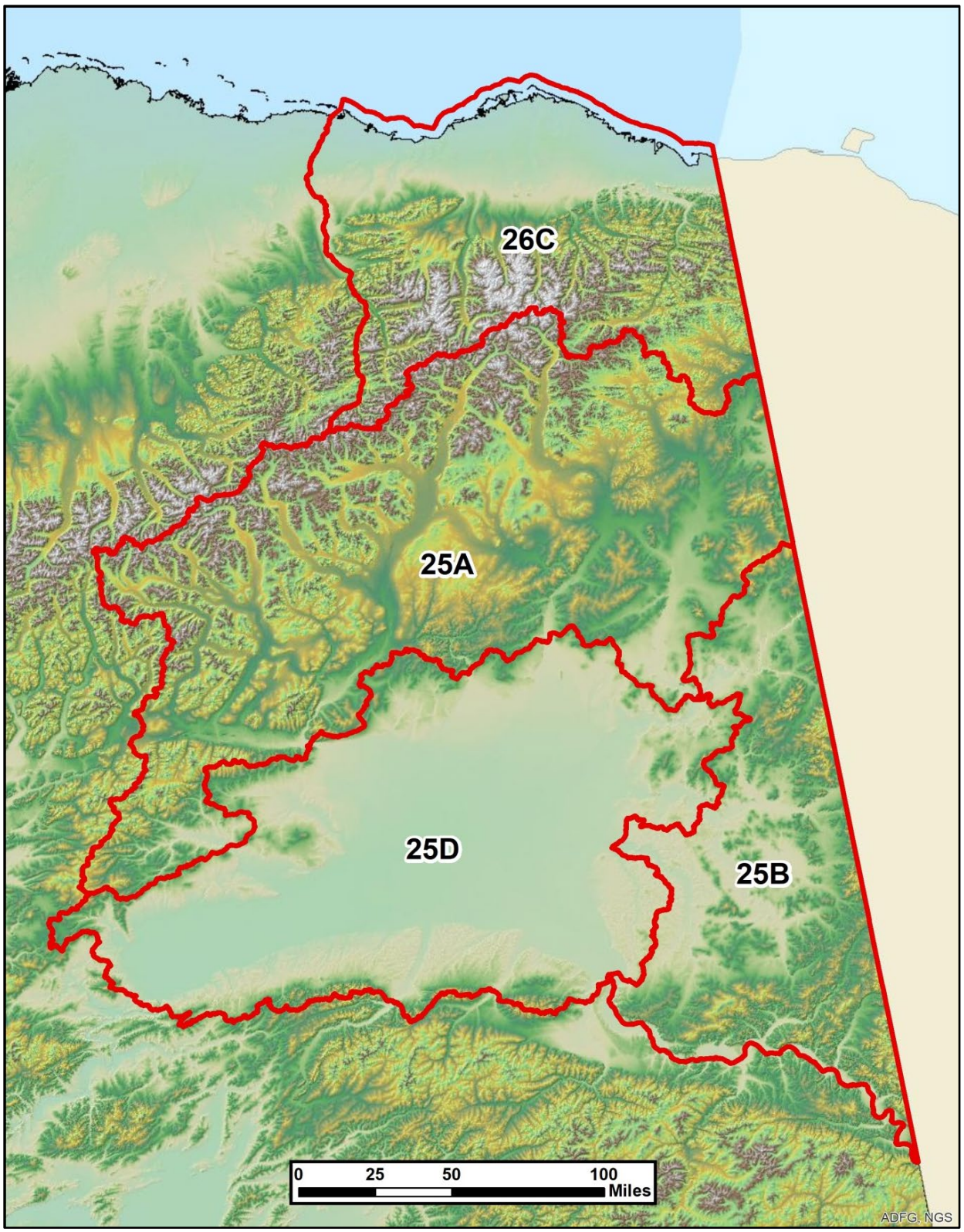

Figure 1. Map showing Units 25A, 25B, 25D, and 26C, eastern portion of the Arctic Slope, the Brooks Range, and northeastern Interior Alaska.

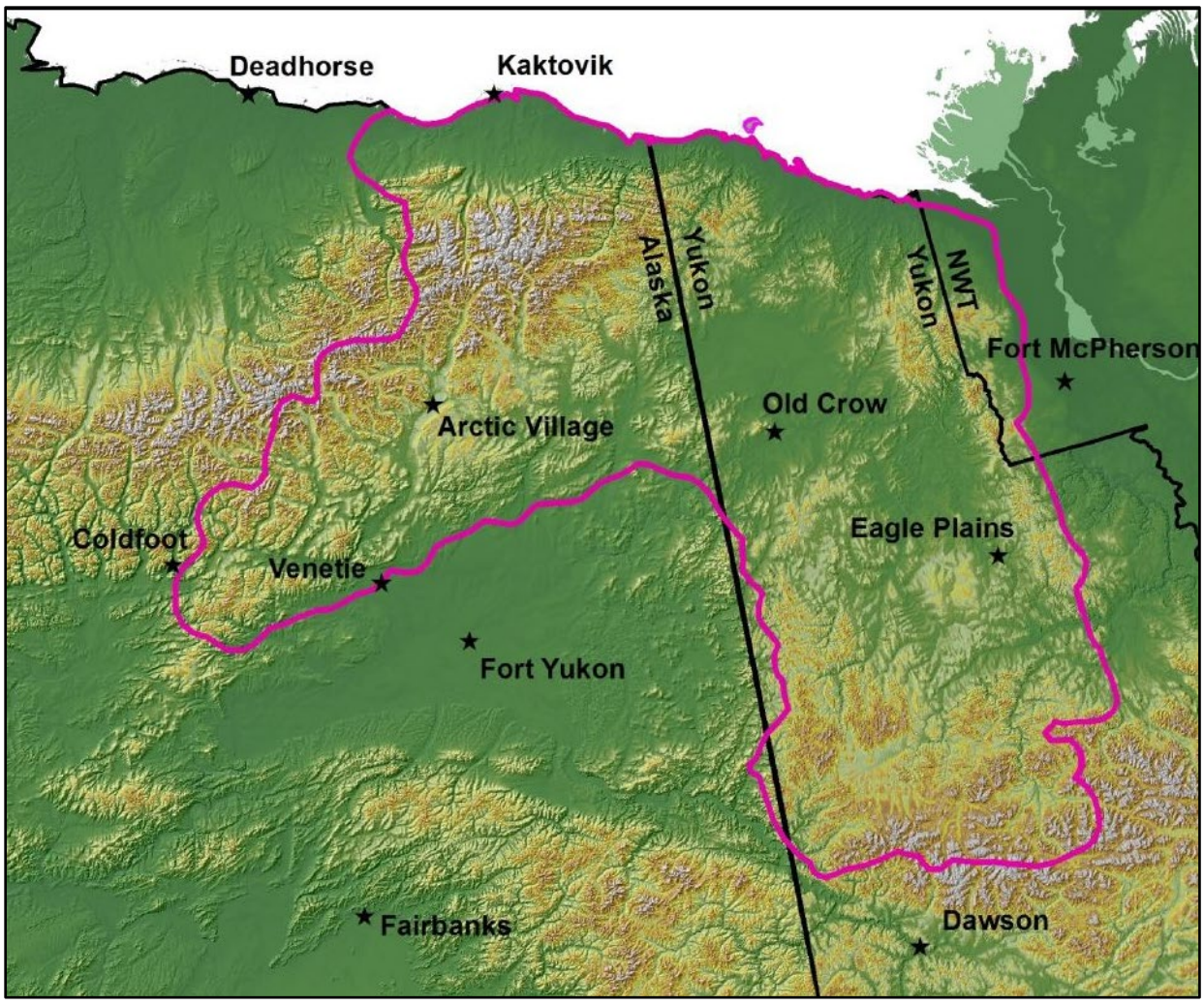

Figure 2. Estimated annual range of the Porcupine Caribou Herd based on GPS locations from 1999–2015 and VHF locations described in Russell and Nixon (1986).

Additionally, ADF&G is a member of the Porcupine Caribou Technical Committee (PCTC), an ad hoc committee operating under the IPCB, with representatives of the various management and research agencies with responsibilities for PCH. These include the U.S. Fish and Wildlife Service, Yukon Department of Environment, Northwest Territories Department of Environment and Natural Resources, Canadian Wildlife Service, Parks Canada, and U.S. Geological Survey. The Porcupine Caribou Technical Committee meets regularly to coordinate research and management activities and sets priorities for future work.

A variety of factors affect PCH management, including IPCB and Porcupine Caribou Technical Committee recommendations, advisory boards and committees, biological studies, subsistence harvest, and congressional actions regarding the opening of the Arctic National Wildlife Refuge (ANWR) to petroleum exploration and development.

The PCH remained more stable than other Alaska herds during the 1960s and 1970s at about 100,000 caribou. Based on photocensus minimum counts (Fig. 3), the population began a steady

increase in 1979 and grew to 178,000 caribou by 1989. Annual rates of growth averaged 3.5% from 1972 to 1989. The PCH then decreased to a minimum count of 160,000 caribou in 1992, probably in response to lower yearling recruitment after harsh winters (Arthur et al. 2003). The minimum count for the herd continued to decline to an estimated 129,000 caribou in 1998 and 123,000 caribou in 2001. This decline was likely a result of increased adult mortality (Arthur et al. 2003). Estimates of population size could not be obtained during 2002–2009 due to inadequate survey conditions. In 2010, a successful photocensus survey was completed which resulted in a modeled population estimate of 169,000 (SE = 7,384; 95% CI = 153,493–184,403) caribou. Since 2010, the PCH continued to grow to an estimated 197,000 (SE = 13,772; 95% CI = 168,667–225,789) caribou in 2013 and 218,000 (SE = 7,750; 95% CI=202,106–234,808) caribou in 2017. The herd is currently at a historic high since the early 1970s when the first photocensus survey was conducted on this herd. The current estimated annual growth rate is 3.7% and is very similar to that observed from 1972 to 1989.

Historical information on PCH distribution, movements, biological monitoring, and harvest are reported in Caikoski (2011, 2013, 2015), Stephenson 2005, Golden (1989 and 1990), Fancy et al. 1989, and Whitten (1981, 1987, 1992, 1993a, 1993b, 1995b).

Management Direction

Existing Wildlife Management Plans

The plan section of this document outlines the current plan for the PCH in Units 25A, 25B, 25D, and 26C. Previous management direction has been documented in the Porcupine caribou herd management reports of survey and inventory activities and can be found in Caikoski (2011, 2013, 2015).

Goals

The following goals are based on objectives listed in the International Agreement Between the Government Of Canada and the Government of the United States Of America on the Conservation of the Porcupine Caribou Herd, 1987 (Appendix A).

G1. Conserve PCH and its habitat through international cooperation and coordination so the risk of irreversible damage or long-term adverse effects as a result of the use of caribou or their habitat is minimized.

G2. Ensure opportunities for customary and traditional uses of PCH.

G3. Enable users of PCH to participate in international efforts to conserve PCH and its habitat.

G4. Encourage cooperation and communication among governments, users of PCH, and others to achieve objectives.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

C1. The Porcupine caribou herd has a positive finding for customary and traditional use of caribou in Units 25A, 25B, 25D, 26B, 26C and an amount reasonably necessary for subsistence uses of 1,250–1,550 caribou.

Intensive Management

C2. Population Objective: 100,000–150,000 caribou.

C3. Harvest Objective: 1,500–2,000 caribou.

MANAGEMENT OBJECTIVES

M1. Maintain a minimum population of 135,000 caribou.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Deployment and maintenance of GPS (global positioning system) and VHF (very high frequency) collars (objectives C1–C3, and M1).

Data Needs

Collars deployed on female and male caribou are required for all management activities associated with monitoring of the PCH. These activities include photocensus and abundance estimates, annual survival rate estimates, parturition rate estimates, calving and seasonal distribution estimates, and composition surveys.

Methods

Collars were deployed annually on caribou via net-gun capture each March during the reporting period in an effort to maintain a sample size of 80–100 adult females (≥ 2 years of age), 15–20 short-yearling females (10-month old), and 15–25 males. Short yearlings and adult females were recollared throughout their life every 3–5 years to maintain a known-age sample that approximates the age structure of the herd. The annual collaring of short-yearling females ensures that all female cohorts are represented in the collared sample.

Results and Discussion

In an effort to maintain desired sample sizes during the report period, 86, 82, and 52 collars were deployed on adult females, short-yearling females, and adult males, respectively. Since 2016, there has been an emphasis to convert all VHF collars to GPS collars. The primary benefits of GPS collars compared to VHF collars are fewer radiotracking flights needed to locate individuals, date and location of mortalities are known, and access to frequent location data via satellites allows for more robust analyses of distribution, movements, and vital rates.

Recommendations for Activity 1.1.

Continue, with an emphasis on replacing all VHF collars with GPS collars to meet the data needs for activities 1.2–1.8 (below).

ACTIVITY 1.2. Photocensus and abundance estimates (objectives C1–C3, and M1).

Data Needs

Estimates of abundance obtained through photocensus are the primary metric for monitoring the status of the PCH. They are important for evaluating intensive management (IM) and amount reasonably necessary for subsistence (ANS) objectives, particularly when population size is near those minimum objectives. Regular measures of population size provide regulatory boards and advisory committees biological information to make informed decisions or recommendations regarding regulatory actions.

Methods

In 2013, a photocensus of the PCH was conducted using the modified aerial photo-direct count extrapolation (APDCE) technique (Davis et al. 1979, Valkenburg et al. 1985). This technique required monitoring postcalving aggregations by radiotracking collared caribou from mid-June through mid-July. Aggregations of sufficient quality to conduct a photocensus typically occurred when temperatures were >55°F and wind speed was <8 mph, presumably in response to insect harassment (Davis et al. 1979, Valkenburg et al. 1985). Groups of caribou were then photographed with a Zeiss RMK-A aerial camera mounted in the belly of a DeHavilland DHC-2 Beaver aircraft. Small groups of caribou were often photographed with handheld cameras or visually estimated. Minimum population size in a given year was the summation of the total number of caribou enumerated from photographs, and caribou that were visually estimated.

In 2017, a photocensus was conducted using the modified aerial photo-direct count technique (Davis et al. 1979; Valkenburg et al. 1985) and digital photography. Groups of caribou were photographed from a DeHavilland DHC-2 Beaver aircraft with a customized digital aerial camera system composed of 3 medium-format, 100-megapixel cameras, with 2 of the cameras oriented obliquely and 1 at nadir. Target altitude for photography was 1,500 feet above ground level (AGL). All cameras were contained within a rigid insert which was attached to a gyrostabilized mount. The system was instrumented with a differential GPS and inertial measurement units (IMU) to record position and altitude (pitch, roll, and yaw). Customized flight management software which ran on a laptop computer controlled the cameras and navigation system and allowed the pilot and camera operator to see footprints of the imagery in real time as well as inspect thumbnails of each image as they were captured.

Flight data from the GPS and IMU were post processed using differential correction or precise point positioning (PPP) depending on the proximity to continually operating reference stations (CORS). Images were individually inspected and adjusted for exposure before being exported from raw format. Exterior orientation information (position, elevation, and altitude) and imagery were then processed through photogrammetry software using automated tie point extraction and bundle adjustment to produce digital terrain models which were then used to orthorectify individual images. Once orthorectification was completed, the oblique and nadir orthophotos were mosaicked separately.

Enumeration of caribou from image mosaics occurs within geographic information system (GIS) software and utilizes a customized tool which allows users to count and classify caribou by placing colored points on top of each animal. Point data are stored in file geodatabases and archived on a local ADF&G server.

In both 2013 and 2017, an estimate of abundance and a measure of uncertainty was conducted using a method described by Rivest et al. (1998). The estimator is based on a 2-phase sampling design. Phase 1 uses the distribution of collared caribou among groups of known size to estimate the number of caribou in groups without collared caribou. Phase 2 uses a Horvitz–Thompson estimator and the proportion of active collars detected to expand the herd size from phase 1 to account for caribou represented by collars not located during the survey. Rivest et al. (1998) describes 3 detection models for use in phase 2. Of these models, the homogeneity method has been most frequently applied (Couturier 1996; Patterson et al. 2004) and is best suited for our data. This model assumes that all active collars are identified in observed groups and that unobserved groups with collared caribou are missed because they are outside of the surveyed area. It is important to note that phase 2 calculations are not necessary if all collars are located and associated groups are counted. Also, the consequences of not meeting the assumptions of phase 2 are greatly mitigated when a high proportion of the active collars are detected, and associated groups counted. Finally, this estimator assumes a random distribution of collars among caribou and, therefore, the number of collars in each group is approximately Poisson distributed. A score test to evaluate overdispersion in a Poisson model is provided by Dean and Lawless, 1989, to assess this assumption.

Results and Discussion

On 14 July 2013, the department completed a photocensus of the PCH. The photocensus included 70 of the 89 active radio collars deployed on PCH caribou (bulls and cows) and 1 collared Central Arctic herd cow that had been with the PCH since spring 2013. Radio collar distribution resulted in a total of 23 groups, of which, 14 groups were in Alaska and 9 groups were in Canada. Additionally, 13 groups that did not contain collared caribou were located and photographed (6 in Alaska and 7 in Canada). In total, 36 groups were identified and photographed. Enumeration of all caribou on photographs resulted in 141,978 caribou (Table 1).

Table 1. Abundance estimate statistics from the 2013 photocensus survey.

Statistic	Value
Located and photographed collars[a]	71
Non-photographed collars	19
Caribou enumerated from located collars	133,295
Abundance estimate	197,228
95% confidence interval	168,667–225,789
Standard error	13,772
t-value	2.07
Test of randomness (p-value >0.05 fails to reject randomness)	0.865

[a] Includes 1 caribou collared as a CAH cow.

Using Rivest et al.'s (1998) method, including the homogeneity model in phase 2 calculations to expand the estimate for missing radio collars, the 2013 PCH photocensus data set consisted of 23 groups with collars, totaled 133,295 caribou, and accounted for 71 of the 90 PCH radio collars (includes 1 caribou originally collared as Central Arctic herd). Abundance was estimated at 197,228 caribou (SE = 13,772; 95% CI = 168,667–225,789; Table 1). Our assumption of a random distribution of radio collars in the survey was supported (P = 0.865, Table 1). A more comprehensive description of the 2013 photocensus and results is in the unpublished memorandum, 2013 Surveys of the Porcupine Caribou Herd – parturition, postcalving, and photocensus, 5 February 2014, J. Caikoski, Wildlife Biologist, ADF&G, Fairbanks.

On 1 July 2017, the department completed a photocensus of the PCH. The photocensus included 105 of the 108 active collars deployed on PCH caribou. Collar distribution resulted in a total of 18 groups, of which, 12 groups were in Alaska and six groups were in Canada. Additionally, 1 group that did not contain collared caribou were located and photographed in Alaska. In total, 19 groups were identified and photographed. Although the locations of all 108 collars were known at the time of the photocensus, 3 collars were not included in the survey. Of those, 1 collar was located but was mixed with the Central Arctic Caribou Herd (CAH) and 2 collars failed to transmit VHF signals, however, their general location was known based on successful GPS location transmissions. Enumeration of all caribou on photographs resulted in 198,104 caribou (Table 2).

Table 2. Abundance estimate statistics from the 2017 photocensus survey.

Statistic	Value
Located and photographed collars	105
Non-photographed collars	3
Caribou enumerated from located collars	197,894
Abundance estimate	218,457
95% confidence interval	202,106–234,808
Standard error	7,750
t-value	2.11
Test of randomness (p-value >0.05 fails to reject randomness)	0.51

Using Rivest et al.'s (1998) method, including the homogeneity model in phase 2 calculations to expand the estimate for nonphotographed collars, the 2017 PCH photocensus data set consisted of 18 groups (with collars present) that totaled 197,894 caribou and accounted for 105 of the 108 PCH collars. Abundance was estimated to be 218,457 caribou (SE = 7,750; 95% CI=202,106–234,808). Our assumption of a random distribution of collars in the survey was supported (p=0.51, Table 2). A more comprehensive description of the 2017 photocensus and results is available in the unpublished memorandum 2017 Photocensus of the Porcupine Caribou Herd, J. Caikoski, Wildlife Biologist, ADF&G, 20 December 2017, Fairbanks.

Recommendations for Activity 1.2.

Continue, with the use of digital photography, and archive details of future surveys in memorandums.

ACTIVITY 1.3. Estimate growth rate, lambda (λ; objectives C1–C4, and M1).

Data Needs

Estimates of trends in abundance are important for evaluating IM and ANS objectives, particularly when population size is near minimum objectives. Rate of population increase or decrease provides regulatory boards and advisory committees additional biological information to make informed decisions or recommendations regarding regulatory actions.

Methods

In 2017, a simple exponential growth model was fit to the 2010–2017 abundance estimates, including their associated intra-survey uncertainty, using Bayesian methods to estimate annual growth rate, lambda (λ).

Results and Discussion

From 2010 to 2017 lambda averaged 1.037 (SE = 0.0082) and was significantly different from 1 at the 95% confidence interval (95% CI = 1.021–1.053). The current estimated growth rate is almost identical to those observed during the last growth phase of the herd during 1972–1989 (λ = 1.035), and between the minimum count observed in 2001 and the abundance estimate in 2010 (λ = 1.036; Table 3; Figs. 3 and 4).

Recommendations for Activity 1.3.

Continue. Archive the details of future surveys in unpublished memorandums.

Table 3. Porcupine Caribou Herd photocensus survey minimum counts, abundance estimates, and growth rates, 1972–2017.

Year	Minimum count	Abundance estimate	95% Confidence interval	Time period	Average annual growth rate (λ)
1972	99,959	–	–	–	–
1977	105,000	–	–	1972–1977	1.01
1979	105,683	–	–	1977–1979	1.00
1982	125,174	–	–	1979–1982	1.06
1983	135,284	–	–	1982–1983	1.08
1987	165,000	–	–	1983–1987	1.05
1989	178,000	–	–	1987–1989	1.04
1992	160,000	–	–	1989–1992	0.97
1994	152,000	–	–	1992–1994	0.98
1998	129,000	–	–	1994–1998	0.96
2001	123,000	–	–	1998–2001	0.99
2010	147,268	168,948	153,493–184,403	2001–2010	1.04
2013	141,978	197,228	168,667–225,789	2010–2013	1.05
2017	198,104	218,457	202,106–234,808	2013–2017	1.03

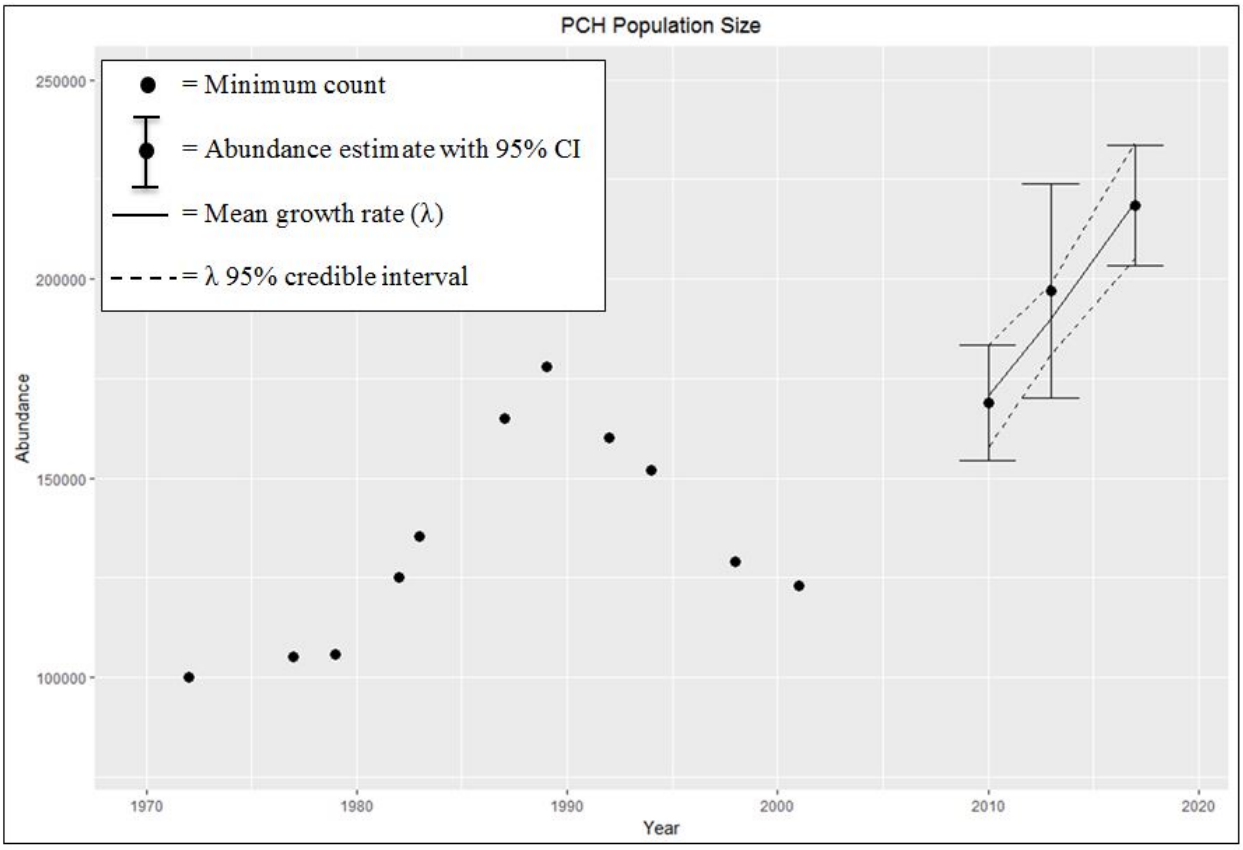

Figure 3. Population size of the Porcupine caribou herd from 1972 to 2017. Data from 1972 to 2001 are photocensus minimum counts. Estimated abundance and associated 95% confidence intervals in 2010, 2013, and 2017 were derived from photocensus minimum counts and modeling (Rivest et al. 1998).

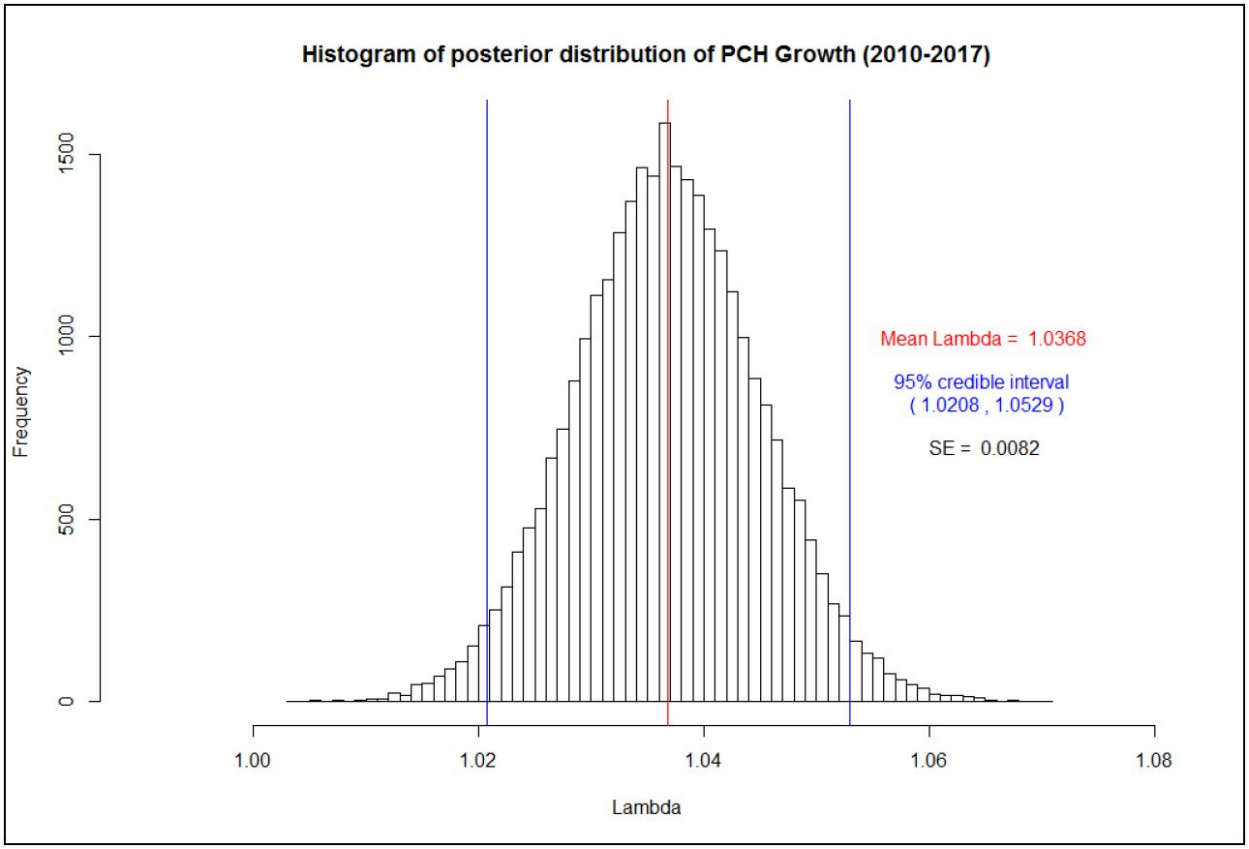

Figure 4. Histogram of the posterior distribution of Porcupine caribou herd growth from 2010–2017. This graph was created using a simple exponential growth model fit to the 2010–2017 estimates, including their intra-survey uncertainty, using Bayesian methods to estimate annual growth rate, lambda (λ).

ACTIVITY 1.4. Estimate annual survival rates of adult females, adult males, and yearling female caribou from collar data (objectives C1–C4, and M1).

Data Needs

Annual survival is a sensitive biological parameter, particularly for adult females, to population growth or decline. Population models based on PCH demographics suggest that relatively small but persistent reductions in adult female survival would result in population decline (Arthur et al. 2003; Griffith et al. 2002; Walsh et al. 1995). However, a suite of demographic parameters likely confounds the effect of adult survival on abundance and either masks the effects of high adult survival or may mitigate against poor adult survival. Estimates of annual survival provide an important demographic parameter to evaluate population trajectory in years when abundance is not estimated and also corroborates estimates of trends in abundance.

Methods

Annual survival was estimated from GPS collared caribou using known-fate models (logistic regression). Annual survival for adult females (years 2012–2017), adult males (years 2015–2017), and yearling females (year 2017) were conducted separately and were reported with 95%

confidence intervals. A year was defined as 1 June through 31 May, which represents the time period from birth to consecutive birth dates.

For adult females only, a series of models were constructed to evaluate constant, trend, and year effects in survival from 2012–2017. Model fit was evaluated using Akaike's Information Criterion values (Akaike 1973) adjusted for sample size (AIC_c; Burnham and Anderson 2002) and estimates were reported with 95% confidence intervals.

Results and Discussion

From 2012–2017, annual survival of adult females ranged from 79.6% (95% CI = 64.5%–88.8%) to 94.5% (95% CI = 83.9%–98.2%) and averaged 87.9% (95% CI = 82.8%–91.6%) across all years (Table 4; Fig. 5). The top model, as ranked by AIC_c, supported constant survival of adult females from 2012–2017 as opposed to a trend or variation by year (Table 5). During 2015–2017, annual survival of adult males ranged from 69.8% (95% CI = 45.1%–85.1%) to 78.5% (95% CI = 56.0%–90.4%) and averaged 74.8% (95% CI = 61.8%–84.0%; Table 4; Fig. 6). Models to evaluate constant, trend, and year effects in male survival were not performed because only 3 years of survival data were collected. Yearling female survival in 2017 was 93.7% (95% CI = 63.2%–99.1%), which was the only year data was available for this age and sex class.

Table 4. Year specific and grand mean annual survival estimates for Porcupine caribou adult females from 2002–2017, adult males from 2015–2017, and yearling females in 2017.

Age/Sex	Year	Annual survival	95% LCL	95% UCL
Adult Females	2012	0.874	0.586	0.967
	2013	0.868	0.645	0.955
	2014	0.881	0.715	0.954
	2015	0.796	0.645	0.888
	2016	0.888	0.752	0.952
	2017	0.945	0.839	0.982
	Grand Mean	0.879	0.828	0.916
Adult Males	2015	0.717	0.415	0.883
	2016	0.698	0.451	0.851
	2017	0.785	0.56	0.904
	Grand Mean	0.748	0.618	0.84
Yearling Females	2017	0.937	0.632	0.991

Note: A year is defined as 1 June–31 May (e.g., year 2012 = 1 June 2012–31 May 2013). LCL and UCL are abbreviations for lower confidence limit and upper confidence limit, respectfully.

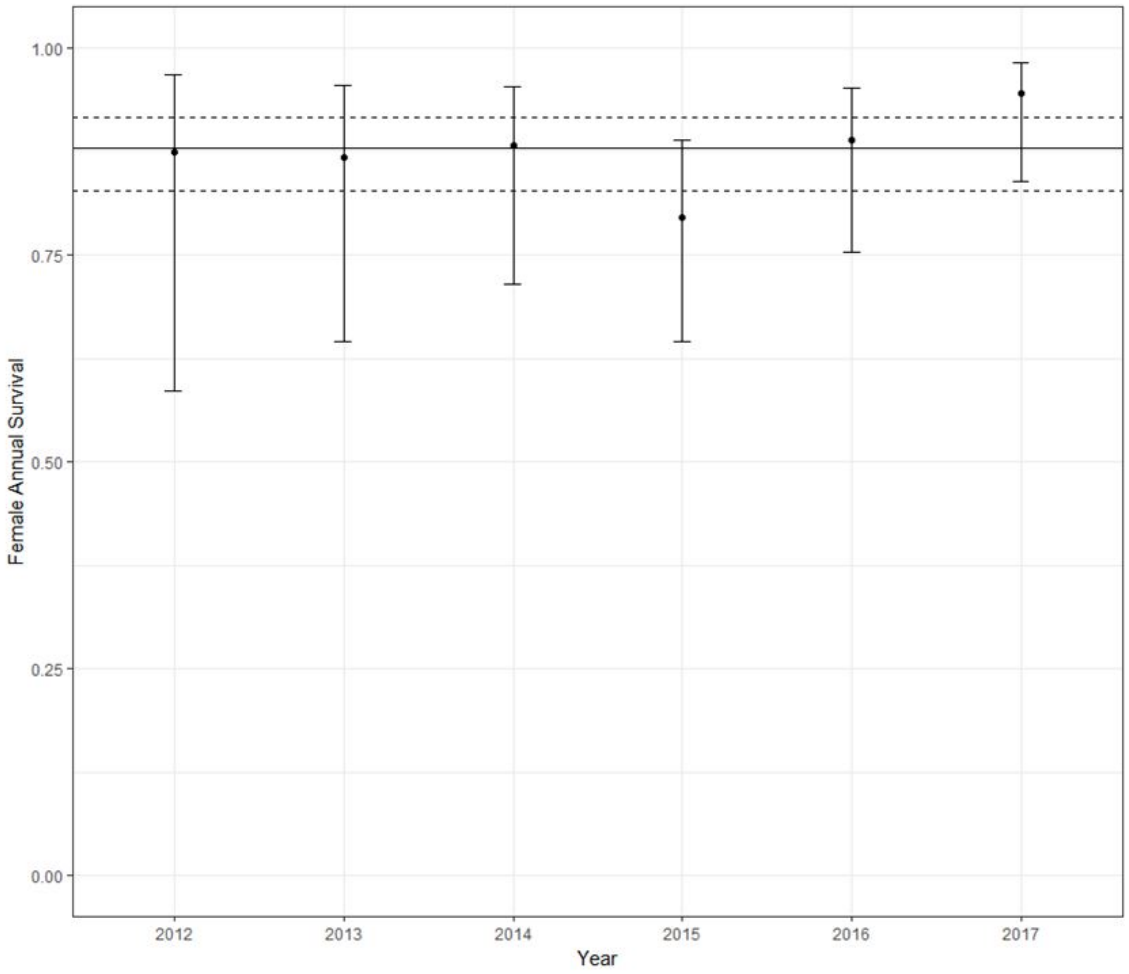

Figure 5. Year specific survival estimates for GPS collared adult female Porcupine caribou (black circles) compared to the grand mean (solid horizontal bar), 2012–2017. All confidence intervals are 95%. A year is defined as the period from caribou birth (June 1) to one year later (May 31). For example, year 2012 occurs from June 1, 2012–May 31, 2013.

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

Population models based on PCH demographics suggest that relatively small but persistent reductions in adult female survival would result in population decline (Arthur et al. 2003; Griffith et al. 2002; Walsh et al. 1995). However, a suite of demographic parameters likely confounds the effect of adult survival on abundance and can either mask the effects of high adult

survival or may mitigate against poor adult survival. Furthermore, precision associated with estimates of survival to date are insufficient to detect statistical differences when small changes in vital rates occur. However, empirical evidence from vital rates reported here, and in 3 other studies (Arthur et al. 2003; Griffith et al. 2002; Walsh et al. 1995), compared to population abundance over the same time periods suggests a minimum long-term average of 84% annual survival for adult females is necessary to prevent population decline.

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

Recommendations for Activity 1.4.

Continue. Archive the details of future surveys in unpublished memorandums.

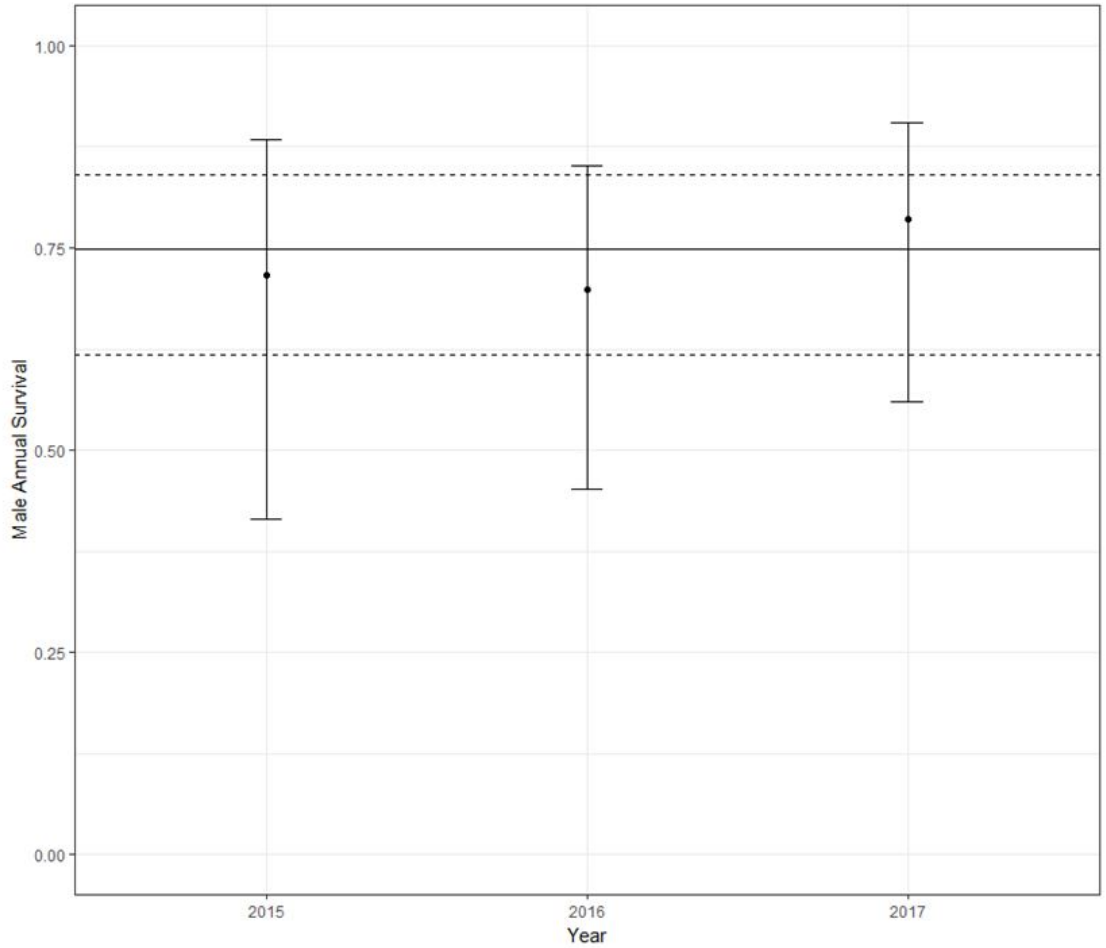

Figure 6. Year specific survival estimates for GPS collared adult male Porcupine caribou (black circled) compared to the grand mean (horizontal solid bar), 2015–2017. All confidence intervals are 95%.

ACTIVITY 1.5. Estimate annual parturition rate from collared caribou (objectives C1–C4, and M1).

Data Needs

Estimates of parturition rate provide a direct measure of productivity and may serve as an index to adult female body condition, particularly for 3-year-old caribou (Boertje et al. 2012).

Methods

Parturition rate was estimated by observing collared females ≥3 years of age from fixed-wing aircraft during the last week of May through the first week of June. Repeated observations of the same individuals were attempted until a newborn calf was observed. However, weather and caribou distribution did not always allow multiple observations. Caribou observed with either calves, or hard antlers, or distended udders were classified as parturient (Whitten 1995a). Parturition rate was calculated as the number of adult females classified as parturient divided by the total number of adult females observed.

Results and Discussion

In 2013, the parturition rate was estimated at 86% for females ≥ 4 years of age (n=42) and 67% for 3-year-olds (n=3; Table 5). Surveys to estimate parturition in 2014 and 2015 were not conducted due to adverse weather conditions that prevented aerial observations. In 2016, the parturition rate was estimated at 75% for females ≥ 4 years of age (n=28) and 78% for 3-year-old females (n=9; Table 5). In 2017, parturition rate was estimated at 90% for females ≥ 4 years of age (n=54) and 100% for 3-year-old females (n=12; Table 6).

Although parturition rate was not estimated in 2014 or 2015, productivity in 2013, 2016, and 2017 was near or above the long-term mean, indicating body condition of adult females was likely good in those years.

Recommendations for Activity 1.5.

Continue. Archive the details of future surveys in unpublished memorandums.

Table 5. Candidate models (known-fate) evaluating annual survival of adult female Porcupine caribou, 2012–2017.

Model	AIC_c	ΔAIC_c	ωi	Deviance	K
Survival ~ 1	289.80	0.00	0.57	287.80	1
Survival ~ trend (year)	290.64	0.84	0.38	286.63	2
Survival ~ year	294.61	4.81	0.05	282.58	6

Note: Models shown with: AIC_c, Akaike's Information Criterion (Akaike 1973) adjusted for sample size; ΔAIC_c, difference in AIC_c values between each model and the best model; ωi, AIC_c weight; K, number of parameters.

Table 6. Porcupine caribou herd parturition rates, June calf survival, and June calf:cow ratios, 1987–2018.

Year	Parturition rate ≥ 4 yrs	Sample size ≥ 4 yrs	Parturition rate 3-yr olds	Sample size 3-year olds	June calf survival[a]	Post-calving survival[b]	Late June calf:cow[c]
1987	0.78	51	–	–	0.71	–	0.55
1988	0.84	91	–	–	0.65	–	0.55
1989	0.78	74	–	–	0.74	–	0.58
1990	0.82	74	–	–	0.90	–	0.74
1991	0.74	77	–	–	0.82	–	0.61
1992	0.86	78	–	–	0.57	–	0.49
1993	0.81	63	–	–	0.56	0.83	0.45
1994	0.91	98	–	–	0.77	0.93	0.70
1995	0.69	95	–	–	0.85	0.92	0.59
1996	0.89	74	–	–	0.81	0.91	0.72
1997	0.75	48	–	–	0.77	0.90	0.58
1998	0.83	58	–	–	0.82	0.94	0.68
1999	0.84	39	–	–	0.83	0.86	0.70
2000	0.73	44	–	–	0.61	0.82	0.44
2001	0.84	70	–	–	0.61	0.79	0.51
2002	0.87	68	–	–	0.65	0.85	0.56
2003	0.87	70	–	–	0.79	0.85	0.69
2004	0.82	74	–	–	[d]	[d]	[d]
2005	0.64	55	0.60	10	0.77	0.88	0.49
2006	0.79	66	1.00	1	0.73	0.86	0.58
2007	0.88	67	1.00	4	0.83	0.90	0.73
2008	0.79	63	0.83	6	0.73	0.92	0.59
2009	0.77	65	1.00	7	0.57	0.75	0.44
2010	0.85	41	0.14	7	0.76	0.87	0.65
2011	0.86	59	–	–	0.48	0.59	0.41
2012	[d]	[d]	[d]	[d]	[d]	[d]	[d]
2013	0.86	42	0.67	3	[d]	[d]	[d]
2014	[d]	[d]	[d]	[d]	[d]	[d]	0.49
2015	[d]	[d]	[d]	[d]	[d]	[d]	[d]
2016	0.75	28	0.78	9	0.61	1.00	0.46
2017	0.90	54	1.00	12	0.80	0.90	0.72
2018	0.88	41	0.33	9	0.73	0.88	0.64
Mean	0.82		0.74		0.72	0.86	0.58

Note: Data are from Fancy et al. (1994, Can. J. Zool. 72:840–846) and the Alaska Department of Fish and Game.

[a] Estimated as (late June calf:cow ratio)/(parturition rate).

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

[c] Only includes cow caribou at least 3 years of age.

[d] No data due to dense caribou groups making identification of cow:calf pairs not possible or weather preventing a survey.

ACTIVITY 1.6. Estimate the spatial extent of the annual calving grounds, concentrated calving areas, and aggregate extent across all years (Objective M1).

Data Needs

Estimates of annual calving distributions document habitat use that may be important for understanding nutritional requirements of lactating females and newborn calves as energy and protein requirements are highest of the year during peak lactation (Parker et al. 1990; White and Luick 1984).

Methods

Locations of calving female caribou were obtained by conducting radio tracking flights during the calving period. The department recorded locations of cows with newborn calves at heel. The annual calving grounds were estimated from fixed-kernel analyses using Least Squares Cross Validation (Silverman 1986; Seaman et al. 1996, 1998, 1999). The extent of calving is defined by the estimated isopleth encompassing 99% of the fixed kernel utilization distribution of cows observed with a calf. Concentrated calving areas are defined as the kernel contour that included calving sites with greater than average density (Seaman et al. 1998).

Results and Discussion

Estimates of the calving grounds or concentrated calving areas were not estimated in 2013–2016 due to adverse weather conditions that prevented a survey or limited a survey to inadequate sample sizes. In 2017, the PCH calving grounds was extensive and ranged from the Babbage River in Yukon, Canada to the Canning River in Alaska (Fig. 7). Concentrated calving occurred on the coastal plain between the Katakturuk River and Jago Rivers in Alaska (Fig. 7).

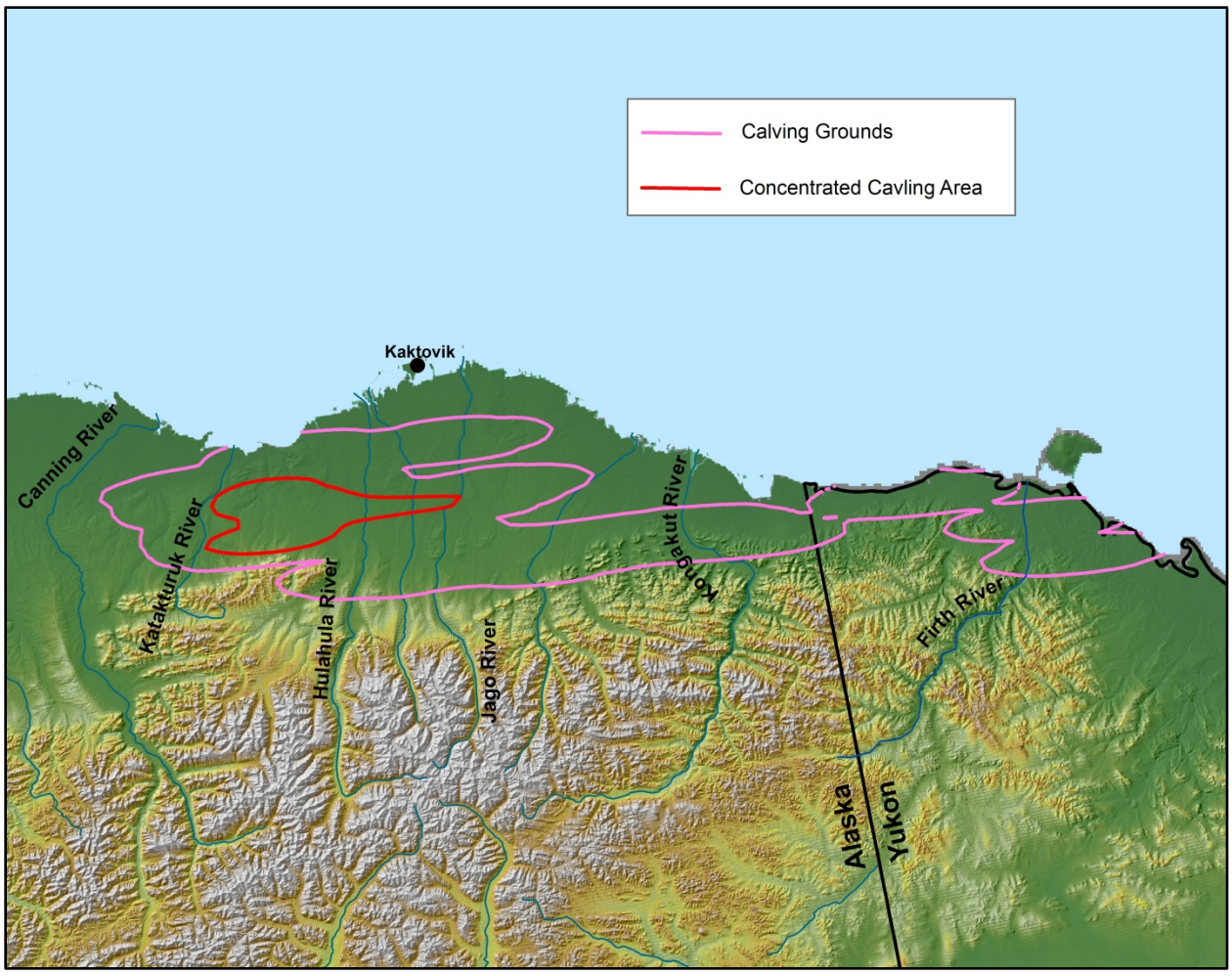

Figure 7. Estimated extent of the Porcupine caribou herd calving grounds estimated by the isopleth encompassing 99% of the fixed kernel utilization distribution of locations with cows observed with a calf (pink polygon), 2017. The concentrated calving area is the area with greater than average density of caribou cows with calves (red polygon), 2017.

Recommendations for Activity 1.6.

Continue. Archive the details of future surveys in unpublished memorandums.

ACTIVITY 1.7. Estimate early summer calf survival and calf:cow ratios (objectives C1–C3, and M1).

Data Needs

Estimates of early summer calf survival and calf:cow ratios provide an index to recruitment potential in a given year. Poor early summer survival may be a result of poor range conditions, poor adult female body condition, adverse weather conditions, elevated predation, or a combination thereof (Griffith et al. 2002; Whitten et al. 1992).

Methods

Early summer calf survival and calf:cow ratios were obtained by observing collared females ≥3 years of age from fixed-wing aircraft during the third or fourth week of June. June calf survival was estimated using two methods: 1) the proportion of collared cows observed with a calf in late June compared to those observed with a calf in early June (excludes most perinatal mortality), and 2) the late-June calf:cow ratio divided by parturition rate (survival from birth to late June). The proportion of calves:100 cows is calculated as the number of adult female caribou observed with a calf at heel divided by the total number of adult females observed.

Results and Discussion

Due to adverse weather conditions that prevented aerial observations, early summer calf survival was not estimated during 2012–2015. Estimates of calf survival using method 1 (excludes most perinatal mortality) were 100% in 2016 and 90% in 2017, compared to the long term mean of 86% (Table 5). Estimates of calf survival using method 2 were 61% in 2016 and 80% in 2017, compared to the long term mean of 72% (Table 6).

The late June calf:cow ratio was not estimated in 2012, 2013, or 2015 due to adverse weather conditions that prevented aerial observations. The estimated calf:cow ratio in 2014, 2016, and 2017 was 49 calves:100 cows, 46 calves:100 cows, and 72 calves:100 cows, respectively, compared to the long term mean of 58 calves:100 cows (Table 6).

Recommendations for Activity 1.7.

Continue. Archive the details of future surveys in unpublished memorandums.

ACTIVITY 1.8. Periodically estimate fall calf:cow and bull:cow ratios (objectives C1–C4, and M1).

Data Needs

Estimates of fall calf:cow ratios are an index of early calf survival. This ratio may serve as an index for the quality of summer conditions when compared to calf:cow ratios of the same period. Estimates of fall bull:cow ratios provide a measure to evaluate if there are adequate numbers of bulls for breeding, satisfactory numbers for hunter preferences, and enough bulls surviving annually. Furthermore, bull:cow ratios may inform appropriate harvest rates when abundance is low and harvestable surplus is near management or codified objectives. These metrics are less important when abundance estimates are regularly obtained but may help evaluate herd status and trends in periods when a photocensus could not be conducted. For example, a decline in the bull:cow ratio has been documented in other Alaska caribou herds such as the Mulchatna and Western Arctic herds, during periods of population decline (Barten 2015; Dau 2015).

Methods

Surveys occur near peak of rut to take advantage of increased mixing of bulls, cows, and calf caribou. Peak of rut was estimated as the date 228 days (gestation period) prior to the median calving date of the PCH, 2002–2010. Caribou groups were located by radiotracking collared caribou (both bulls and cows) from fixed-wing aircraft. Group location and the number of collars in each group was determined by fixed-wing aircraft and relayed to a helicopter immediately prior to the arrival of the helicopter to each caribou group. The department defined a group as either caribou that were lumped together and spatially separated, or distinguishable from neighboring caribou, or caribou groups. The department attempted to locate most collared caribou and sample across the full spatial expanse of the herd.

The number of caribou classified per caribou group was weighted based on the number of collars present in each group. Approximately 200 random caribou were classified by helicopter per collar per caribou group (e.g., if 3 collars were present in a group, 600 caribou were classified). If caribou groups contained less than 200 caribou per collar, all or most of the caribou in those groups were classified. Caribou were classified as small bull, medium bull, large bull, cow, or calf. Group samples were recorded independently. The department did not count or estimate the total number of caribou in each group.

Results and Discussion

In October 2012, the department located 59 collared caribou in Alaska and Yukon, Canada and sampled 40 caribou groups for age and sex composition. A total of 11,614 caribou were classified of which 6,488 were cows, 2,096 were calves, and 3,030 were bulls. The calf:cow ratio was 32 calves per 100 cows and the bull:cow ratio was 47 bulls per 100 cows (Table 7).

Historically, few fall composition surveys have been conducted on this herd. Therefore, long term averages, ranges, and trends in the fall ratios of calves per 100 cows and bulls per 100 cows are unknown. However, the calf:cow and bull:cow ratios estimated in 2012 were within a similar range of values as what was observed in 2009 and 2010 (Table 7).

Table 7. Porcupine Caribou Herd fall composition survey results, 2009, 2010, and 2012.

Year	Number of cows	Number of calves	Number of bulls	Total	calf:cow ratio	bull:cow ratio
2009	4,271	897	1,729	6,897	21:100	40:100
2010	5,864	1,986	3,357	11,207	34:100	57:100
2012	6,488	2,096	3,030	11,614	32:100	47:100

Recommendations for Activity 1.8.

Continue. Archive the details of future surveys in unpublished memorandums. This will reduce the level of detail in the methods and results sections of future species management reports and plans.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor reported and estimated harvest in Alaska and Canada (objectives C1 and C3).

Data Needs

Estimates of annual caribou harvest are important for evaluating IM objectives, and ensuring that the harvest is within sustainable limits compared to the overall population size and trends.

Methods

Reported harvest (primarily nonlocal residents and nonresidents) was obtained from ADF&G's Wildlife Information Network database (WinfoNet).

Harvest reporting was poor for residents of communities within the range of the Porcupine caribou herd in Alaska. Therefore, to estimate annual harvest for those communities, the department use, in part, a model developed by Sutherland (2005) to estimate harvest of Western Arctic caribou for villages within that herd's range. The model uses household surveys, community size, proximity to the herd, and the ability of villagers to access caribou to estimate harvest for a given year. Although the department do not have the data necessary to run the model for Arctic Village, Sutherland (2005) provided estimates of harvest for various villages on a per capita basis. Among similarly sized communities, Anaktuvuk Pass consistently had the highest per capita harvest, 2 caribou per person. Because both communities show a high reliance on caribou, the department use estimated per capita harvest for Anaktuvuk residents to estimate harvest of PCH caribou by Arctic Village residents (200–350 caribou/year). The department estimated harvest by Kaktovik residents (200–250 caribou/year) from household surveys conducted in 1987–1988 (Pedersen 1990) and adjusted per capita harvest rates for current Kaktovik population size. In some years, caribou were opportunistically harvested by residents of Venetie, Beaver, Fort Yukon, and Chalkyitsik (0–100 caribou/year combined) which are on the periphery of the PCH's range.

Estimates of harvest in Canada are obtained from reports by the Porcupine Caribou Management Board (PCMB). Harvest for communities in Canada are collected through annual subsistence surveys for the communities within the range of the PCH in Yukon and Northwest Territories (NWT).

Results and Discussion

Reported harvest in Alaska ranged from 82–149 caribou during RY12–RY16 which was consistent with previous years (Table 8). Unreported annual harvest by rural residents in Alaska was estimated at 400–700 caribou, and estimated harvest in Canada ranged from 860–3,570 annually (Table 8). Based on the abundance estimates of 197,228 (SE = 13,772) caribou in 2013 and 218,457 (SE = 7,750) caribou in 2017, total harvest rate was at or below 2% during RY12–RY16 (Table 9).

Recommendations for Activity 2.1.

Continue, estimates of annual harvest are important to evaluate IM objectives and ensure that harvest is within sustainable limits compared to population size and trend.

Table 8. Porcupine caribou herd harvest, regulatory years 1985 through 2017, Alaska and Yukon Canada.

Regulatory year	Reported				Estimated		
	Male	Female	Unknown	Total	Alaska	Canada	Total
1985	52	12	1	65	500–700	4,000	4,500–4,700
1986	70	14	0	84	1,000–2000	500–1,000	1,500–3,000
1987	106	22	1	129	500	2,000–4,000	2,500–4,500
1988	82	7	0	89	500	2,000–4,000	2,500–4,500
1989	104	8	0	112	500–700	2,000	2,500–2,700
1990	19	1	0	20	100–150	1,680	1,780–1,830
1991	101	3	0	104	100–150	2,774	2,874–2,904
1992	78	1	0	79	658	1,657	2,315
1993	77	5	0	82	250	2,934	3,184
1994	72	3	0	75	200	2,040	2,240
1995	61	7	0	68	200	2,069	2,269
1996	76	2	0	78	200	2,159	2,359
1997	58	4	1	63	300	1,308	1,608
1998	83	11	1	95	300	a	
1999	84	4	0	88	400	a	
2000	62	10	0	72	300	a	
2001	105	9	0	114	400	a	
2002	72	3	1	76	300	a	
2003	120	8	0	128	500	a	
2004	60	7	0	67	200	a	
2005	32	10	0	42	500	a	
2006	57	1	1	59	400–700	a	
2007	113	13	0	126	400–700	a	
2008	78	15	0	93	400–700	a	
2009	108	18	2	128	400–700	a	
2010	89	15	3	107	400–700	1,720	2,227–2,527
2011	127	27	1	155	400–700	1,850	2,405–2,705
2012	115	18	0	133	400–700	1,153–1,283	1,686–2,116
2013	116	15	0	131	400–700	2,920	3,451–3,751
2014	103	20	0	123	400–700	869	1,392–1,692
2015	70	12	0	82	400–700	2,976–3,570	3,458–4,352
2016	115	18	0	133	400–700	860–2,450	1,393–3,283
2017	138	11	0	149	400–700	N/A	N/A

a Data not collected to estimate harvest in Canada.

Table 9. Estimated harvest rates of the Porcupine caribou herd, regulatory years 2010 through 2016, Alaska and Yukon, Canada.

Regulatory year	Estimated harvest[a]	Estimated population size	Estimated harvest rate
2010	2,227–2,527	169,000	1.3–1.5%
2011	2,405–2,705	178,000[b]	1.4–1.5%
2012	1,949–2,249	187,000[b]	0.9–1.1%
2013	3,582–3,882	197,000	1.8–1.9%
2014	1,395–1,695	202,000[b]	0.7–0.8%
2015	3,931–4,231	208,000[b]	1.7–2.1%
2016	1,393–3,283	213,000[b]	0.7–1.5%
2017	N/A	218,000	N/A

[a] Estimated harvest includes both reported and estimated harvest in Alaska and Canada.
b Estimated population size for RY11–RY12 and RY14–RY16 are modeled and based on average annual growth rates between photocensus survey abundance estimates.

3. Habitat Assessment-Enhancement

None.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

Harvest data was stored on an internal database housed on a server (http:/winfonet.alaska.gov/index.cfm). Electronic copies of data, reports, and memorandums will be stored in WinfoNet, Data Archive, Porcupine Caribou Management Program, Project ID: Porcupine Caribou, Primary Region: Region III.

Agreements

The agreement between Alaska and Yukon, Canada is entitled the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine Caribou Herd, 1987 (Appendix A).

Permitting

None.

Conclusions and Management Recommendations

Amounts Reasonably Necessary for Subsistence Uses

C1. The ANS objective for Units 25A, 25B, 25D, 26B, 26C is 1,250–1,550 caribou and was met during this reporting period. The ANS of 1,250–1,550 caribou represents less than 1% of the 2013 and 2017 abundance estimates and is therefore sustainable.

Intensive Management

C2. Population Objective: 100,000–150,000 caribou. This objective was met based on the most recent abundance estimate of 218,457 (SE = 7,750) caribou in 2017.

C3. Harvest Objective: 1,500–2,000 caribou. This objective was not met because less than 1,000 caribou were harvested in Alaska in all years during RY12–RY16.

Management Objectives

M1. Maintain a minimum population of 135,000 caribou. This objective was met based on the most recent abundance estimate of 218,457 (SE = 7,750) caribou in 2017.

II. Project Review and RY17–RY21 Plan

Review of Management Direction

MANAGEMENT DIRECTION

There are no changes in the management direction for the Porcupine caribou herd in Units 25A, 25B, 25D, and 26C.

GOALS

The following goals will remain unchanged from the previous report period and are based on objectives listed in the International Agreement between the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine caribou herd, 1987 (Appendix A).

G1. Conserve PCH and its habitat through international cooperation and coordination so the risk of irreversible damage or long-term adverse effects as a result of the use of caribou or their habitat is minimized.

G2. Ensure opportunities for customary and traditional uses of PCH.

G3. Enable users of PCH to participate in international efforts to conserve PCH and its habitat.

G4. Encourage cooperation and communication among governments, users of PCH, and others to achieve objectives.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

C1. Units 25(A), 25(B), 25(D), 26(B), 26(C): 1,250–1,550 caribou. This objective will be considered to be met if 5% (harvest rate) of the most recent abundance estimate results in at least 1,250 caribou.

Intensive Management

C2. Population Objective: 100,000–150,000 caribou. This objective will be considered to be met if the most recent abundance estimate is at least 100,000 caribou. If a recent abundance estimate is not available, modeled abundance based on the best available demographic data may be used to evaluate this objective.

C3. Harvest Objective: 1,500–2,000 caribou. This objective will be considered to be met if the total Alaska estimated and reported harvest exceeds 1,500 caribou.

MANAGEMENT OBJECTIVES

M1. Maintain a minimum population of 135,000 caribou. This objective will be considered to be met if the most recent abundance estimate results in at least 135,000 caribou. If a recent abundance estimate is not available, modeled abundance based on the best available demographic data may be used to evaluate this objective.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Deploy and maintain GPS (global positioning system) collars (objectives C1–C3, and M1).

Data Needs

Collars on female and male caribou are required for all management activities associated with monitoring of the PCH. Those activities include photocensus and abundance estimates, estimates of annual survival rates, estimates of parturition, estimates of calving and seasonal distribution, and composition surveys.

Methods

Collars will be deployed annually on PCH via net-gun capture in March to maintain 80–100 adult females (≥ 2 years of age), 15–20 short yearling females (10-month-olds), and 15–25 males. Short yearlings and adult females are re-collared throughout their life every 3–5 years to maintain a known age sample that approximates the age structure of the herd. The annual collaring of short yearling females ensures that all female cohorts are represented in the collared sample.

ACTIVITY 1.2. Photocensus and abundance estimate (objectives C1–C4, and M1).

Data Needs

Estimates of abundance (photocensus) are the primary metric for monitoring herd status and are important for evaluating IM and ANS objectives, particularly when population size is near minimum objectives. Regular measures of population size provide regulatory boards and advisory committees biological information to make informed decisions or recommendations regarding regulatory actions.

Methods

A photocensus will be conducted using the modified aerial photo-direct count technique (Davis et al. 1979; Valkenburg et al. 1985) and digital photography. Groups of caribou will be photographed from a DeHavilland DHC-2 Beaver aircraft with a customized digital aerial camera system composed of 3 medium format 100-megapixel cameras with 2 of the cameras oriented obliquely and 1 at nadir. Target altitude for photography will be 1,500 feet above ground level (AGL). All cameras will be contained within a rigid insert which will be attached to a gyrostabilized mount. The system will be instrumented with a differential GPS and inertial measurement unit (IMU) to record position and altitude (pitch, roll, and yaw). Customized flight management software running on a laptop computer will control the cameras and navigation system and will allow the pilot and camera operator to see footprints of the imagery in real time as well as inspect thumbnails of each image as they are captured.

Flight data from the GPS and IMU will be post processed using differential correction or precise point positioning (PPP) depending on the proximity to continually operating reference stations (CORS). Images will be individually inspected and adjusted for exposure before being exported from raw format. Exterior orientation information (position, elevation, and altitude) and imagery will then be processed through photogrammetry software using automated tie point extraction and bundle adjustment to produce digital terrain models which will then be used to orthorectify individual images. Once orthorectification is completed, the oblique and nadir orthophotos will be mosaicked separately.

Enumeration of caribou from image mosaics will occur within geographic information system (GIS) software and will use a customized tool which will allow users to count and classify caribou by placing colored points on top of each animal. Point data will be stored in file geodatabases and archived on department servers.

An estimate of abundance and a measure of uncertainty will be conducted using a method described by Rivest et al. (1998). The estimator is based on a 2-phase sampling design. Phase 1 will use the distribution of collared caribou among groups of known size to estimate the number of caribou in groups without collared caribou. Phase 2 will use a Horvitz-Thompson estimator and the proportion of active collars detected to expand the herd size from Phase 1 to account for caribou represented by collars not located during the survey. Rivest et al. (1998) describes 3 detection models for use in Phase 2. Of these models, the homogeneity method has been most frequently applied (Couturier 1996; Patterson et al. 2004) and is best suited for our data. This model assumes that all active collars are identified in observed groups and that unobserved groups with collared caribou are missed because they are outside of the surveyed area. It is important to note that Phase 2 calculations are not necessary if all collars are located and associated groups are counted. Also, the consequences of not meeting the assumptions of Phase 2 will be greatly mitigated when a high proportion of the active collars are detected, and associated groups counted. Finally, this estimator assumes a random distribution of collars among caribou and, therefore, the number of collars in each group will be approximately Poisson distributed. A score test to evaluate overdispersion in a Poisson model will be provided to assess this assumption (Dean and Lawless 1989).

ACTIVITY 1.3. Estimate growth rate, lambda (λ; Objectives C1–C4, and M1).

Data Needs

Estimates of trends (trajectory) in abundance are important for evaluating IM and ANS objectives, particularly when population size is near minimum objectives. Rate of population increase or decrease provides regulatory boards and advisory committees additional biological information to make informed decisions or recommendations regarding regulatory actions.

Methods

Annual growth rate, lambda (λ), will be estimated using a simple exponential growth model fit to abundance estimates, including their associated intra-survey uncertainty, using Bayesian methods. A year will be defined as 1 June through 31 May, which represents birth to age 1, age 1 to age two, etc.

ACTIVITY 1.4. Estimate annual survival rates of adult females, adult males, and yearling female caribou (objectives C1–C4, and M1).

Data Needs

Annual survival is a sensitive biological parameter, particularly for adult females, to population growth or decline. Population models based on PCH demographics suggest that relatively small but persistent reductions in adult female survival would result in population decline (Walsh et al. 1995; Griffith et al. 2002; and Arthur et al. 2003). However, a suite of demographic parameters likely confounds the effect of adult survival on abundance and either masks the effects of high adult survival or may mitigate against poor adult survival. Estimates of annual survival provide an important demographic parameter to evaluate population trajectory in years when abundance is not estimated and corroborates estimates in trends in abundance.

Methods

Annual survival will be estimated from GPS collared caribou using known-fate models (logistic regression) that include year, sex, and age class parameters. Model fit will be evaluated using Akaike's Information Criterion values (Akaike 1973), adjusted for sample size if appropriate (AIC_c; Burnham and Anderson 2002). Survival estimates will be reported with 95% confidence intervals.

ACTIVITY 1.5. Estimate annual parturition rate (objectives C1–C4, and M1).

Data Needs

Estimates of parturition rate provide a direct measure of productivity and an index to adult female body condition.

Methods

Parturition rate will be estimated by observing collared females ≥ 3-years of age from fixed-wing aircraft during the last week of May through the first week of June. Caribou observed with calves, or hard antlers, or distended udders will be classified as parturient (Whitten 1995a). Parturition rate will be estimated using the following calculation: the number of adult females classified as parturient, divided by the total number of adult females observed.

ACTIVITY 1.6. Estimate annual calving grounds, concentrated calving areas, and aggregate extent (objectives C1–C4, and M1).

Data Needs

Estimates of annual calving grounds, and areas of concentrated use, will provide documentation of habitat use that may be important for understanding the nutritional requirements of lactating females and newborn calves.

Methods

Locations of calving female caribou will be obtained by conducting radiotracking flights during the calving period and recording locations of cows with newborn calves at heel. The annual calving grounds will be estimated from fixed-kernel analyses using Least Squares Cross Validation (Seaman and Powell 1996; Seaman et al. 1998, 1999; Silverman 1986). The extent of calving will be defined by the estimated isopleth encompassing 99% of the fixed kernel utilization distribution of cows observed with a calf. Concentrated calving areas will be defined as the kernel contour that included calving sites with greater than average density (Seaman et al. 1998).

ACTIVITY 1.7. Estimate early summer calf survival and calf:cow ratios (objectives C1– C4, and M1).

Data Needs

Estimates of early summer calf survival and calf:cow ratios will provide an index of recruitment potential in a given year. Poor early summer survival may be the result of poor range conditions, poor adult female body condition, adverse weather conditions, elevated predation, or a combination thereof.

Methods

Early summer calf survival and the calf:cow ratio will be obtained by observing collared females ≥ 3-years of age from fixed-wing aircraft during the third or fourth week of June. June calf survival will be estimated using 2 methods: 1) the proportion of collared cows observed with a calf in late June compared to those observed with a calf in early June (excludes most perinatal mortality), and 2) the late June calf:cow ratio divided by parturition rate (survival from birth to late June). The proportion of calves:100 cows will be calculated as the number of adult female caribou observed with a calf at heal divided by the total number of adult females observed.

ACTIVITY 1.8. Periodically estimate fall bull:cow and calf:cow ratios (objectives C1–C4 and M1).

Data Needs

Estimates of fall calf:cow ratios are an index to early calf survival and recruitment. This ratio may serve as an index to summer conditions when compared to summer calf:cow ratios of the same year. Estimates of fall bull:cow ratios provide a measure to ensure there are adequate numbers of bulls for breeding, satisfactory numbers for hunter preferences, an indication of bull survival, and may inform appropriate harvest rates when abundance is low and harvestable

surplus is near management objectives. These metrics are less informative when abundance estimates are regularly obtained, but may help evaluate herd status and trend in periods when a photocensus could not be obtained. For example, a decline in the bull:cow ratio has been documented in other Alaska caribou herds such as the Mulchatna and Western Arctic herds during periods of population decline (Dau 2015; Barten 2015).

Methods

Fall sex and age composition will be estimated by classifying caribou from a helicopter near peak of rut to take advantage of presumed mixing of bulls, cows, and calf caribou. Peak rut will be estimated as the date 228 days (gestation period) prior to the median calving date of the PCH, estimated from parturition surveys conducted annually in early June. Caribou groups are located by radiotracking collared caribou (bulls and cows) from fixed-wing aircraft. Using a cluster sampling scheme (Cochran 1977), approximately 200 caribou per radio collar per group will be classified. If <200 caribou are present in a group, either all or most of the caribou in that group will be classified. The presence or absence of a vulva will be used to differentiate the sexes for adult caribou, and animal size will be used to differentiate calves from adults. Bulls are further classified as small, medium, or large based on antler characteristics (Eagan 1993). Bull:cow and calf:cow ratios will be generated using pooled data, and variance will be estimated using the variance in those ratios between independent clusters, weighted by cluster size.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Monitor reported and estimated harvest in Alaska and Canada (objectives C1 and C3).

Data Needs

Estimates of annual harvest are important to evaluate IM objectives and ensure that harvest is within sustainable limits.

Methods

Reported harvest (primarily nonlocal residents and nonresidents) will be obtained from ADF&G's Wildlife Information Network database (WinfoNet) harvest database.

Harvest reporting is poor for residents of communities within the range of the Porcupine caribou herd in Alaska. Therefore, in addition to harvest reporting, the department will also use a model developed by Sutherland (2005) to estimate annual harvest of Western Arctic caribou for villages within that herd's range. The model will use household surveys, community size, proximity to the herd, and the ability of villagers to access caribou to estimate harvest for a given year. Although ADF&G does not have the data necessary to run the model for Arctic Village, Sutherland (2005) provided estimates of harvest for various villages on a per capita basis. Among similarly sized communities, Anaktuvuk Pass consistently had the highest per capita harvest, 2 caribou per person. Because both communities show a high reliance on caribou, the department will use estimated per capita harvest for Anaktuvuk residents to estimate harvest of PCH caribou by Arctic Village residents. Harvest by Kaktovik residents will be estimated from household surveys conducted in 1987–1988 (Pedersen 1990) and adjusted for per capita harvest rates to reflect current Kaktovik population size. In some years, caribou are opportunistically-

harvested by residents of Venetie, Beaver, Fort Yukon, and Chalkyitsik (0–100 caribou/year combined) which are on the periphery of the PCH's range.

Estimates of harvest in Canada will be obtained from reports by the Porcupine Caribou Management Board (PCMB). Harvest for communities in Canada are collected through annual subsistence surveys for the communities within the range of the PCH in Yukon and NWT.

3. Habitat Assessment-Enhancement

None at this time.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

None.

Data Recording and Archiving

Harvest data will be stored in ADF&Gs internal WinfoNet database. Electronic copies of data, reports, and memorandums will be stored in the WinfoNet data archive at the following location: Porcupine Caribou Management Program, Project ID: Porcupine Caribou, Primary Region: Region III. Paper data sheets will be stored at ADF&G's Region III headquarters office in Fairbanks.

Agreements

There is an agreement between the government of Canada and the government of the United States of America entitled "Conservation of the Porcupine Caribou Herd, 1987" (Appendix A).

Permitting

None.

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Appendix A. Agreement between the government of Canada and the government of the United States of America on the conservation of the Porcupine caribou herd.

Agreement Between the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine Caribou Herd

Ottawa, July 17, 1987

In force, July 17, 1987

The Government of Canada and the Government of the United States of America, hereinafter called the "Parties":

Recognizing that the Porcupine Caribou Herd regularly migrates across the international boundary between Canada and the United States of America and that caribou in their large free-roaming herds comprise a unique and irreplaceable natural resource of great value which each generation should maintain and make use of so as to conserve them for future generations;

Acknowledging that there are various human uses of caribou and that for generations certain people of Yukon Territory and the Northwest Territories in Canada have customarily and traditionally harvested Porcupine Caribou to meet their nutritional, cultural and other essential needs and will continue to do so in the future, and that certain rural residents of the State of Alaska in the United States of America have harvested Porcupine Caribou for customary and traditional uses and will continue to do so in the future, and that these people should participate in the conservation of the Porcupine Caribou Herd and its habitat;

Recognizing the importance of conserving the habitat of the Porcupine Caribou herd, including such areas as calving, post-calving, migration, wintering and insect relief habitat;

Understanding that the conservation of the Porcupine Caribou Herd and its habitat requires goodwill among landowners, wildlife managers, users of the caribou and other users of the area;

Recognizing that the Porcupine Caribou Herd should be conserved according to ecological principles and that actions for the conservation of the Porcupine Caribou Herd that result in the long-term detriment of other indigenous species of wild fauna and flora should be avoided;

Recognizing that co-operation and co-ordination under the Agreement should not alter domestic authorities regarding management of the Porcupine Caribou Herd and its habitat and should be implemented by existing rather than new management structures;

Have agreed as follows:

1. Definitions

For the purpose of this Agreement only:

a. “Porcupine Caribou Herd” means those migratory barren ground caribou found north of 64 degrees, 30’ north latitude and north of the Yukon River which usually share common and traditional calving and post-calving aggregation grounds between the Canning River in the State of Alaska and the Babbage River in Yukon Territory and which historically migrate within the State of Alaska, Yukon Territory, and the Northwest Territories.

b “Conservation” means the management and use of the Porcupine Caribou Herd and its habitat utilizing methods and procedures which ensure the long term productivity and usefulness of the Porcupine Caribou Herd. Such methods and procedures include, but are not limited to, activities associated with scientific resources management such as research, law enforcement, census taking, habitat maintenance, monitoring and public information and education.

c. “Habitat” means the whole or any part of the ecosystem, including summer, winter and migration range, used by the Porcupine Caribou Herd during the course of its long-term movement patterns, as generally outlined on the map attached as an Annex.

2. Objectives

The objectives of the Parties are:

a. To conserve the Porcupine Caribou Herd and its habitat through international co-operation 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;

b. To ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd by:

(l) in Alaska, rural Alaska residents in accordance with 16 U.S.C. 3113 and 3114, AS 16.05.940(23), (28) and (32), and AS 16.05.258(c); and

(2) in Yukon and the Northwest Territories, Native users as defined by sections A8 and A9 of the Porcupine Caribou Management Agreement (signed on October 26, 1985) and those other users identified pursuant to the process described in section E2(e) of the said Agreement;

c. To enable users of Porcupine Caribou to participate in the international co-ordination of the conservation of the Porcupine Caribou Herd and its habitat;

d. To encourage co-operation and communication among governments, users of Porcupine Caribou and others to achieve these objectives.

3. Conservation

a. The Parties will take appropriate action to conserve the Porcupine Caribou Herd and its habitat.

b. The Parties will ensure that the Porcupine Caribou Herd, its habitat and the interests of users of Porcupine Caribou are given effective consideration in evaluating proposed activities within the range of the Herd.

c. Activities requiring a Party's approval having a potential impact on the conservation of the Porcupine Caribou Herd or its habitat will be subject to impact assessment and review consistent with domestic laws, regulations and processes.

d. Where an activity in one country is determined to be likely to cause significant long-term adverse impact on the Porcupine Caribou Herd or its habitat, the other Party will be notified and given an opportunity to consult prior to final decision.

e. Activities requiring a Party's approval having a potential significant impact on the conservation or use of the Porcupine Caribou Herd or its habitat may require mitigation.

f. The Parties should avoid or minimize activities that would significantly disrupt migration or other important behavior patterns of the Porcupine Caribou Herd or that would otherwise lessen the ability of users of Porcupine Caribou to use the Herd.

g. When evaluating the environmental consequences of a proposed activity, the Parties will consider and analyze potential impacts, including cumulative impacts, to the Porcupine Caribou Herd, its habitat and affected users of Porcupine Caribou.

h. The Parties will prohibit the commercial sale of meat from the Porcupine Caribou Herd.

4. International Porcupine Caribou Board

a. The Parties will establish an advisory Board to be known as the International Porcupine Caribou Board, hereinafter called the Board.

b. The Parties will each appoint four members of the Board within a reasonable period following the entry into force of the present Agreement.

c. The Board will:

(l) adopt rules and procedures for its operation, including those related to the chairmanship of the Board; and

(2) give advice or make recommendations to the Parties, subject to concurrence by a majority of each party's appointees.

d. The Board, seeking, where appropriate, information available from management agencies, local communities, users of Porcupine Caribou, scientific and other interests, will make recommendations and provide advice on those aspects of the conservation of the Porcupine Caribou Herd and its habitat that require international co-ordination, including but not limited to the following:

(1) the sharing of information and consideration of actions to further the objectives of this Agreement at the international level;

(2) the actions that are necessary or advisable to conserve the Porcupine Caribou Herd and its habitat;

(3) co-operative conservation planning for the Porcupine Caribou Herd throughout its range;

(4) when advisable to conserve the Porcupine Caribou Herd, recommendations on overall harvest and appropriate harvest limits for each of Canada and the United States of America taking into account the Board's review of available data, patterns of customary and traditional users and other factors the Board deems appropriate;

(5) the identification of sensitive habitat deserving special consideration; and

(6) recommendations, where necessary, through the Parties as required, to other boards and agencies in Canada and the United States of America on matters affecting the Porcupine Caribou Herd or its habitat.

e. It is understood that the advice and recommendations of the Board are not binding on the Parties; however, by virtue of this Agreement, it has been accepted that the parties will support and participate in the operation of the Board. In particular they will:

(1) provide the Board with the information regarding the conservation and use of the Porcupine Caribou Herd and its habitat;

(2) promptly notify the Board of proposed activities that could significantly affect the conservation of the Porcupine Caribou Herd or its habitat and provide an opportunity to the Board to make recommendations;

(3) consider the advice and respond to the recommendations of the Board; and

(4) provide written reasons for the rejection in whole or in part of conservation recommendations made by the Board.

5. International Responsibility

The Parties will consult promptly to consider appropriate action in the event of:

a. significant damage to the Porcupine Caribou Herd or its habitat for which there is responsibility, if any, under international law; or

b. significant disruption of migration or other important behavior patterns of the Porcupine Caribou Herd that would significantly lessen the ability of users of Porcupine Caribou to use the Herd.

6. Implementation

Co-operation and co-ordination under and other implementation of this Agreement shall be consistent with the laws, regulations and other national policies of the Parties and is subject to the availability of funding.

7. Interpretation and Application

All questions related to the interpretation or application of the Agreement will be settled by consultation between the Parties.

8. Entry into force; Amendments

a. This agreement which is authentic in English and French shall enter into force on signature and shall remain in force until terminated by either Party upon twelve months' written notice to the other.

b. At the request of either Party, consultations will be held with a view to convening a meeting of the representatives of the Parties to amend this Agreement.


ALASKA
DEPARTMENT OF FISH AND GAME