Species Management Report and Plan ADF&G/DWC/SMR&P–2024–11

Western Arctic Caribou Management Report and Plan, Game Management Units 21D, 22, 23, 24, and 26A:

Report Period 1 July 2012–30 June 2017, and

Plan Period 1 July 2017–30 June 2022

Alex Hansen, Christie Osburn, and Nicole Edmison

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Alaska Department of Fish and Game Division of Wildlife Conservation

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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 Phillip Perry, Management Coordinator for Region V for the Division of Wildlife Conservation.

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Purpose of this Report

This report provides a record of survey and inventory management activities for the Western Arctic caribou herd (WAH, the herd; *Rangifer tarandus*) in Units 21D, 22, 23, 24, and 26A for the 5 regulatory years 2012–2016 and plans for survey and inventory management activities in the next 5 regulatory years, 2017–2021. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY15 = 1 July 2015–30 June 2016). This report is produced primarily to provide agency staff with data and analysis to help guide and record agency efforts but is also provided to the public to inform it 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 report more efficiently on trends and to describe potential changes in data collection activities over the next 5 years. It replaces the WAH management report of survey and inventory activities that was previously produced every 2 years.

I. RY12–RY16 Management Report

Management Area

WAH occupies an area of northwestern Alaska totaling approximately 157,000 mi^2. This herd's range includes all of Unit 23, as well as a portion of Units 22, 24, and 26. The range is bordered by the Chukchi Sea to the west and the Trans-Alaska Pipeline System to the east, and it extends as far south as the Nulato Hills and as far north as Utqiaġvik. This vast area contains various habitat types, including open tundra, coastal plains, steep barren mountains, and timbered hills and valleys.

Summary of Status, Trend, Management Activities, and History of the Western Arctic Caribou Herd in Units 21D, 22, 23, 24, and 26A

The 2016 census indicated that WAH continued to be one of the largest caribou herds in Alaska, at an estimated size of 201,000 animals; however, it also demonstrated the declining trend that has continued since the peak estimate of nearly 500,000 animals in 2003.

Management Direction

Existing Wildlife Management Plans

Previous management direction has been documented in the WAH management reports of survey and inventory activities (Harper and McCarthy 2015).

GOALS

1. Protect and maintain the herd and its habitat.

2. Provide for subsistence and general season hunting on a sustained yield basis.

3. Provide for viewing and other uses of caribou.

4. Perpetuate associated wildlife populations, including carnivores.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

WAH has a positive customary and traditional (C&T) use finding. The amount reasonably necessary for subsistence (ANS; AAC 99.025) in this herd is unusual because it is combined with the adjacent Teshekpuk caribou herd (TCH). The combined WAH-TCH ANS range is 8,000–12,000 caribou.

Intensive Management

WAH is recognized as an intensive management (IM) population. The Board of Game (BOG, the board) established the IM population objective for the herd as at least 200,000 caribou and the harvest objective as 12,000–20,000 caribou (5 AAC 92.108). Unlike the ANS, the IM objectives are independent of TCH.

MANAGEMENT OBJECTIVES

1. Encourage cooperative management of the herd and its habitats among state, federal, and local entities and all users of the herd, and integrate scientific information and traditional ecological knowledge (Goals 1, 2, 3, and 4).

2. Manage for a healthy population using strategies adapted to population levels and trends while recognizing that caribou numbers fluctuate naturally (Goals 1 and 2).

3. Assess and protect important habitats of the herd (Goal 1).

4. Promote consistent, understandable, and effective state and federal regulations for the conservation of the herd (Goals 1, 2, and 3).

5. Seek to minimize conflict between reindeer herders and WAH (Goals 1 and 3).

6. Increase understanding and appreciation of the herd through use of scientific information, traditional ecological knowledge of Alaska Native users, and knowledge of all other users (Goals 1, 2, 3, and 4).

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Determine population size and trend of the herd at least every 3 years.

Data Needs

WAH has a positive C&T use status, and the board has determined the ANS (5 AAC 99.025) as 8,000–12,000 caribou for WAH and TCH combined. The herd has also been identified as a potential candidate for IM and it has a population objective of at least 200,000 caribou. Population estimates and trends are necessary components for determining allowable harvest as prescribed in Table 1 of the *Western Arctic Caribou Herd Cooperative Management Plan* (Western Arctic Caribou Herd Working Group 2019).

Methods

ADF&G staff used the aerial photo direct count estimate (APDCE; Davis et al. 1979:23) to produce a minimum count, with a concomitant abundance estimate derived using the distribution of radiocollared caribou among groups (Rivest et al. 1998). Survey scheduling for the herd was determined by the objectives described in the *Western Arctic Caribou Herd Cooperative Management Plan*, which outlines a schedule for estimating abundance every 3 years in the Liberal Management strategy, every 2 years under the Conservative Management strategy, and every year when the herd falls below 200,000 caribou (Western Arctic Caribou Herd Working Group 2011).

The objective for precision of the estimate is a 95% confidence interval half-width of <10% of the point estimate. Based on simulated data and experience, the number of active collars should be >100 to achieve this level of precision.

Results and Discussion

Photocensus population estimates were produced in 2013 (234,757 animals) and 2016 (201,000 animals). A photocensus was attempted in 2015; however, inadequate photocensus conditions prevented an estimate from being generated. At the end of the report period (late June 2017), staff mobilized for a photocensus, which was completed during the second week of July 2017. This census generated a new point estimate of 259,000 caribou, indicating an increase of 58,000 animals from the 2016 estimate of 201,000 (Fig. 1). A portion of this increase may be due to a higher proportion of caribou being counted in photos, stemming from upgrades to photography equipment and GIS (geographic information system)-based counting techniques. Demographic metrics, including decreased adult cow mortality in 2013–2016 (Table 1) and increased short-yearling recruitment in 2016–2017 (Fig. 2), provide strong supporting evidence that herd growth occurred between 2016 and 2017.

The RY12–RY16 population trend can be inferred from the mean annual rate of change (Fig. 1). Dau (2015) depicted historical photocensus data between 1970 and 2013, including that mean annual rates of change were estimated to be as high as 26% (1980–1982) and as low as −18% (1970–1976). The most recent decline (2003–2016) indicates that the lowest rates of change averaged −15% per year (2011–2013). More recently (2016–2017), the rate of change was 29%,

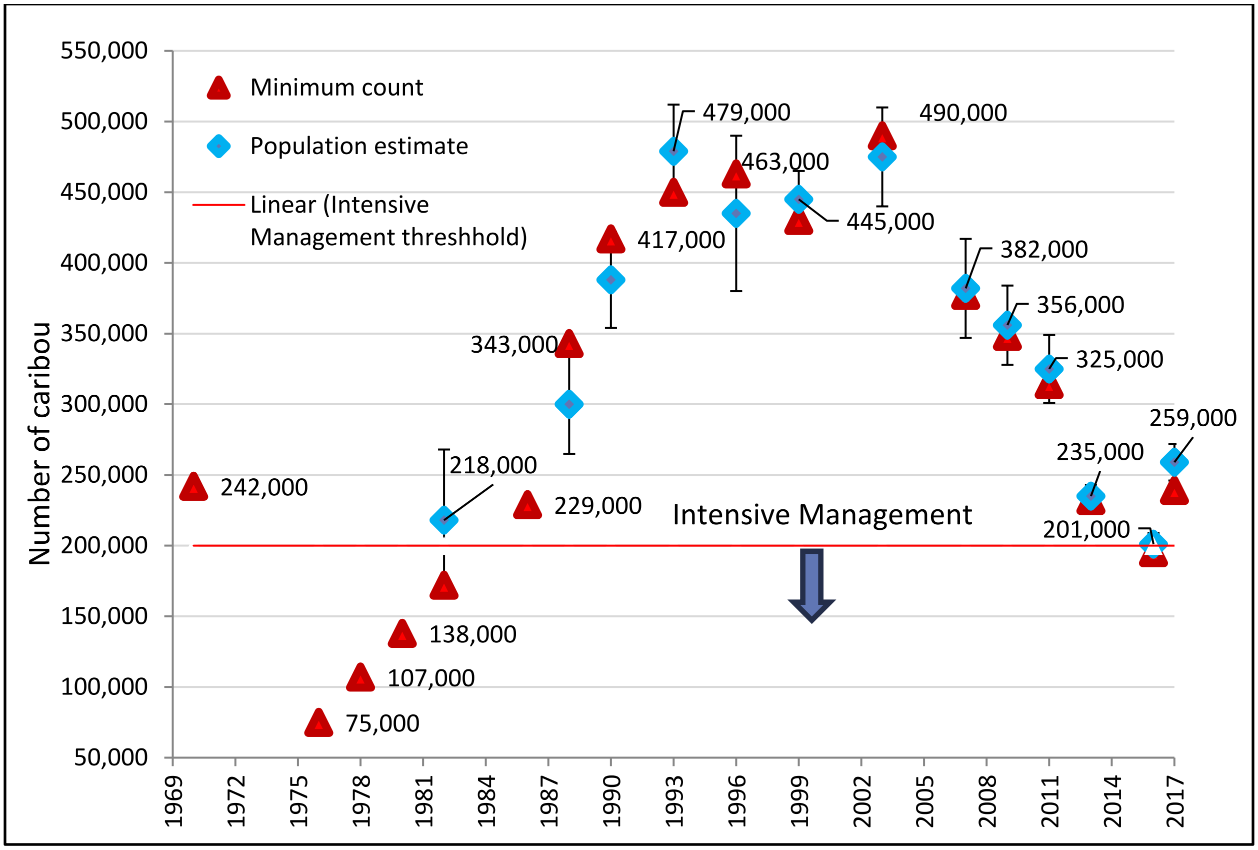

Figure 1. Western Arctic caribou herd population estimate, 1969–2017, Alaska. Estimated abundance is indicated with a blue diamond, along with associated 95% confidence limits. Estimates are produced using an estimator described by Rivest et al. (1998). Minimum count is indicated by red diamonds. The red line is the intensive management threshold for the herd (200,000 animals).

which is near the higher end of the possible population growth for the herd. This may serve as additional evidence that the detected increase may be partially attributable to differences in photography and counting methods.

Recommendations for Activity 1.1.

Modify. The authors recommend that abundance estimates continue to use the APDCE method, Rivest estimator, and new technologies and techniques used during the 2017 census. The new cameras and counting tools have proven to be more efficient and likely more accurate than the previous system, which used printed black-and-white photographs.

ACTIVITY 1.2. Estimate harvestable surplus based on abundance, trend in abundance, and other demographic contexts.

Data Needs

Estimating harvestable surplus provides critical information for hunt management strategies under the principle of sustained yield. The board has set the IM harvest objective for the herd at 12,000–20,000 caribou.

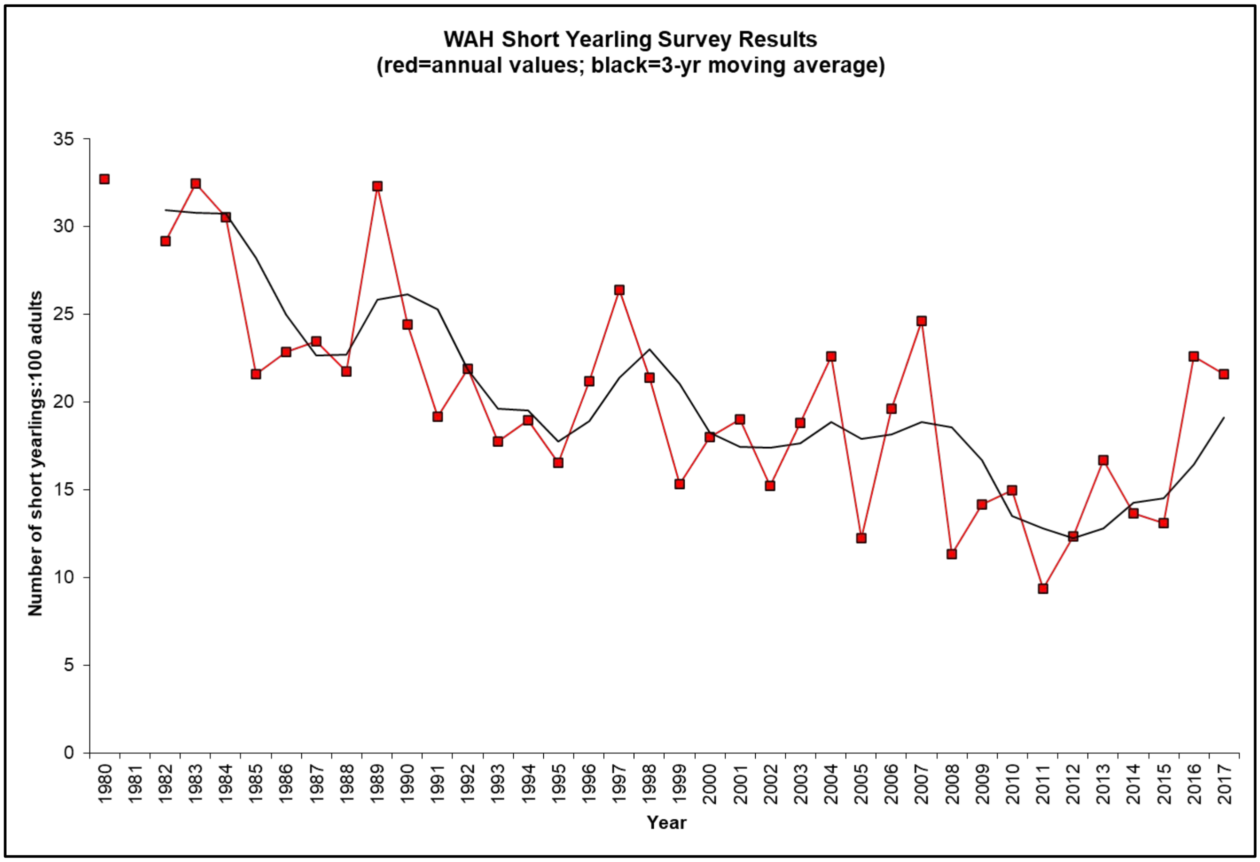

Figure 2. Spring short-yearling ratios for the Western Arctic caribou herd, 1980–2017, Alaska. Fixed-wing estimates of herd composition are indicated by the red line and red squares. The black line indicates a 3-year moving average.

Methods

The most recent abundance estimate would be used as the basis for determining harvestable surplus unless the estimate occurred more than 2 years in the past. During RY12–RY16, harvest level was primarily prescribed by the *Western Arctic Caribou Herd Cooperative Management Plan* (Western Arctic Caribou Herd Working Group 2011). Harvest recommendations were inclusive of bulls and cows and ranged from a low of 6% in a declining trend to a high of 8% during an increasing trend. Management levels defined by the plan included Liberal, Conservative, Preservative, and Critical, with harvest objectives ranging from 6,000 to 24,850 caribou depending on population trend and management level (Table 1).

Results and Discussion

The minimum IM harvest objective (12,000 caribou) for the herd was likely met each year during RY12–RY16 despite uncertainties in annual harvest (Activity 1.2). The harvestable surplus, calculated as 6% of the most recent abundance estimate or modeled population for each year of the report period, ranged from 12,000 to 16,500 caribou, with a high in RY12 and a low in RY16. While harvest may have exceeded 6% in some years, there is substantial uncertainty due to a lack of precision in harvest estimates.

Table 1. Western Arctic Herd Working Group caribou management levels, 2011, Alaska.

Management level and harvest level	Population trend Declining low: 6%	 Stable medium: 7%	 Increasing high: 8%
Liberal	Population: 265,000+ Harvest: 16,000–22,000	Population: 230,000+ Harvest: 16,000–22,000	Population: 200,000+ Harvest: 16,000–22,000
Conservative	Population: 200,000–265,000 Harvest: 12,000–16,000	Population: 170,000–230,000 Harvest: 12,000–16,000	Population: 150,000–200,000 Harvest: 12,000–16,000
Preservative	Population: 130,000–200,000 Harvest: 8,000–12,000	Population: 115,000–170,000 Harvest: 8,000–12,000	Population: 100,000–150,000 Harvest: 8,000–12,000
Critical[a]	Population: <130,000 Harvest: 6,000–8,000	Population: <115,000 Harvest: 6,000–8,000	Population: <100,000 Harvest: 6,000–8,000

[a] Keep the bull-to-cow ratio at >40:100.

Following a decade of decline with limited signs of recovery, regulatory actions were implemented to reduce and more accurately track annual harvest. The declining trend in abundance appeared to reach its lowest point in 2016 at 201,000 caribou; however, an increase was detected at the beginning of 2017, when the herd was estimated at 259,000 caribou. Further regulatory restrictions, primarily aimed at reducing cow harvest, were considered and would likely have been necessary if the population estimate had dropped below the IM objective.

Since the last major decline during the mid-1970s, subsistence harvest of the herd has been loosely regulated with liberal seasons and no annual bag limits. Creative solutions would have been necessary to allocate harvest opportunity for all users of the herd. Some proposed ideas included discussions with the public and representatives of the Western Arctic Caribou Herd Working Group, the introduction of annual bag limits, restricted seasons for cows, and community or regional harvest quotas.

Recommendations for Activity 1.2.

Modify. Efforts should be made to establish socially acceptable and biologically meaningful harvest levels for bulls and cows separately under different population levels. For instance, the harvest prescription could call for the harvest of up to 15% of the bulls and 1–2% of the cows in the herd. This will likely become necessary if the population ever falls below the IM objective and the minimum recommended harvest rate of 6% is not sustainable.

ACTIVITY 1.3. Capture and collar adult caribou annually to maintain a sample of 100 active collars by the end of the regulatory year.

Data Needs

The deployment of collars on adult caribou is fundamental to nearly all management activities for WAH. Radiotelemetry and satellite collars can monitor herd movement and distribution and produce estimates on population, calving, adult survival, recruitment, and herd composition.

Methods

Each September during fall migration, an attempt was made to deploy collars on adult caribou as they swam across the Kobuk River near Onion Portage. In recent decades, capture of WAH caribou has not involved chemical immobilization; instead, caribou are captured by hand as they swim across from the north side of the Kobuk River (Institutional Care and Use Committee [IACUC] permit #2016-36). Public concerns about the use of helicopters for captures, the use of immobilizing drugs, and the ability to include school-age children in capture efforts are some of the prominent reasons for the current approach.

Ideally, each collar year (CY; 1 October–30 September) would begin with 115–140 potentially active collars (Dau 2007), with the goal of having ≥100 active collars remaining by the photocensus season in July. Additionally, ADF&G staff aimed to have ≥15 collared bulls at the start of each CY, primarily to conduct a census.

Due to the challenges of assessing the age of partially submerged animals, specific age classes were not targeted in this herd. Instead, collars were randomly deployed on cows >1 year of age and bulls ≥3 years old. Beginning in 2008, calves were weighed annually, and since then, most newly collared cows have had a calf. This focus on reproductively mature cows may have implications for the age structure of the collared sample, resulting in an older sample overall. For instance, cows typically do not reach maturity until 3 years of age, meaning cows that are 1–2 years of age are unrepresented. Younger bulls were not collared to avoid the possibility of choking due to skeletal growth and seasonal enlargement of their necks during rut.

During 2015 and 2016, in addition to being captured to collect weights (Activity 1.7), 4-month-old calves were collared (Activity 1.9) to better understand overwinter calf mortality.

From 1992 to 2014, blood was taken from each captured adult for analysis of haptoglobin levels, disease, and viral antibodies. Blood draws were suspended in 2015 and replaced with nasal swabs (Activity 1.10). Each caribou that was handled was also classified into a subjective body condition category ranging from 1 to 5 (very skinny, skinny, average, fat, and very fat). Any caribou classified as very skinny was released without a collar.

While this capture activity was generally supported by local residents, the capture window was typically limited to 1–2 weeks to minimize impact on local hunters.

Results and Discussion

In 2012, 32 adults were collared (22 cows and 10 bulls) with 20 collars from the department and 12 collars from the National Park Service (NPS). All NPS collars were programmed with a 5-year breakaway release. With the new collars deployed, CY12 began with 102 active collars (88 cows and 14 bulls).

In 2013, 29 adults were collared (26 cows and 3 bulls) with 19 collars from the department and 10 collars from NPS. Following collar deployment, CY13 began with 103 active collars (93 cows and 10 bulls).

In 2014, 40 adults were collared (35 cows and 5 bulls) with 35 collars from the department and 5 collars from NPS. There were 113 active collars for the start of CY14 (104 cows and 9 bulls).

2015 was an excellent year for caribou capture with good weather and steady caribou passage. Over 3 days, 48 adults were collared (38 cows and 10 bulls). The department provided 25 collars (10 bulls and 15 cows), while NPS provided collars for the remaining 23 cows. CY15 started with 117 active collars (105 cows and 12 bulls).

In 2016, 33 adults were collared (25 cows and 8 bulls). NPS provided 7 collars, and the remainder were provided by the department. CY16 started with 133 active collars (115 cows and 18 bulls).

Efforts were made to keep a current list of radiocollared caribou; however, the reported number of active collars varied between years. This inconsistency can arise from retroactively removing collars that were determined to be offline due to battery exhaustion or other malfunctions, as well as from cases where mortalities were later deemed to have occurred before the start of a CY.

In all 5 years of RY12–RY16, ADF&G staff met their objective of completing a CY with ≥100 collars; however, we only managed to maintain ≥15 bulls for CY16.

Recommendations for Activity 1.3.

Modify. Overall, collaring adults at Onion Portage has been a successful strategy for deploying collars to monitor the herd. The practice receives general support from local communities and should continue with modification.

Moving forward, ADF&G staff would like to deploy only GPS satellite collars due to their ease of tracking and near real-time movement data. This data can inform decisions for other management activities such as photocensus, short-yearling surveys, calving surveys, and future adult captures. While a complete transition to GPS collars is ideal, budgetary constraints may impede this goal. In this case, we should continue to strive for a minimum of 40 GPS collars and an overall minimum of 70 collars in July.

In addition, we would also like to see a more uniform set of collar frequencies. Currently, collars purchased by the department operate within a VHF range of 148.000–154.000 megahertz, whereas collars provided by NPS use a range of 165.000–169.000 megahertz. This means that 2 sets of antennas must be used for radiotracking collared caribou. The current equipment cannot simultaneously monitor both sets of frequencies, creating a logistical challenge that requires either using multiple aircraft or landing the aircraft to change antennas and receivers.

ACTIVITY 1.4. Determine parturition rates and sites through annual calving survey.

Data Needs

Body condition and herd-level productivity are important facets of herd ecology to monitor. Parturition rates can provide broad insight into herd-level body condition (Cameron and Ver Hoef 1994) and specific information about summer nutrition (Barboza and Parker 2008) and can signal issues with disease (e.g., brucellosis). Parturition rates are incorporated into abundance models for years when photocensuses are not conducted. The spatial component of calving is particularly important for understanding habitat use and informing future land management decisions.

Methods

Calving surveys of the herd have been conducted consistently since 1987. The direct observation of radiocollared cows on the calving ground provides both parturition rates and spatial distribution of calving sites.

Calving surveys were conducted during the first 2 weeks of June. GPS locations of collared cows were mapped to produce a general idea of survey areas and routes. Once locations were identified, field crew and aircraft were mobilized to Eagle Creek Camp. Surveys were based out of Eagle Creek Camp and conducted with a pilot-observer pair in a fixed-wing aircraft (PA-18 or similar). Radiocollared cows were located and identified through VHF radiotelemetry. After visually locating and identifying a collared cow, the observation team assessed the maternal status of the animal by recording the presence or absence of a neonate calf, the presence or absence of hard or velvet antlers, and the location of the caribou.

The parturition site for each cow was either the first location where a neonate was observed or, if no neonate was observed, the last location where the cow was observed with >1 hard antler. These parturition locations were then used to calculate annual kernel density estimates, following methods described by Seaman et al. (1998) and Griffith et al. (2002). Locations of collared cows without a calf at heel, south of the DeLong Mountain crest (lat 68.65), were excluded from the kernel density estimates. Harper and McCarthy (2015) attribute the exclusion to the rapid movement of maternal cows to the calving grounds before giving birth.

Results and Discussion

Estimated parturition rates for RY12–RY16 have varied from 63% to 83%, with an average rate of 76% (Fig. 3). Parturition in 2016 was estimated at 85%, just shy of the herd's highest recorded estimate of 86% in 1992. Core calving areas vary from year to year; however, the herd continues to show a strong fidelity to the Utukok River Uplands, a pattern demonstrated repeatedly for decades (Fig. 4; Cameron et al. 2020, Harper and McCarthy 2015, Kelleyhouse 2001, Lent 1966).

Starting June 2017, an effort was made to detect udder distension (Whitten 1995). Dau (2015) acknowledged this method; however, it was not used during past surveys. Observations of udder distension have the potential to account for additional parturition by classifying cows that have lost their antlers and their calves prior to observation. A total of 3 cows with visible udders were observed without hard antlers and without calves in 2017. This information was not used for the purposes of estimating parturition rate primarily because it represents a departure from the standard methods used prior to 2017. If these data had been included, the totals would have shifted from 71 maternal cows to 74 maternal cows and 15 nonmaternal cows to 12 nonmaternal cows, generating a parturition rate of 86%.

The median observation date for all observations between 1992 and 2017 is shown in Table 2. It should be noted that observation dates do not perfectly align with actual calving dates. The inability to make daily observations of each collared cow throughout the survey period is one inherent weakness of the survey as it fails to capture the exact timing of each calving event, and survey timing in most years occurs after peak calving.

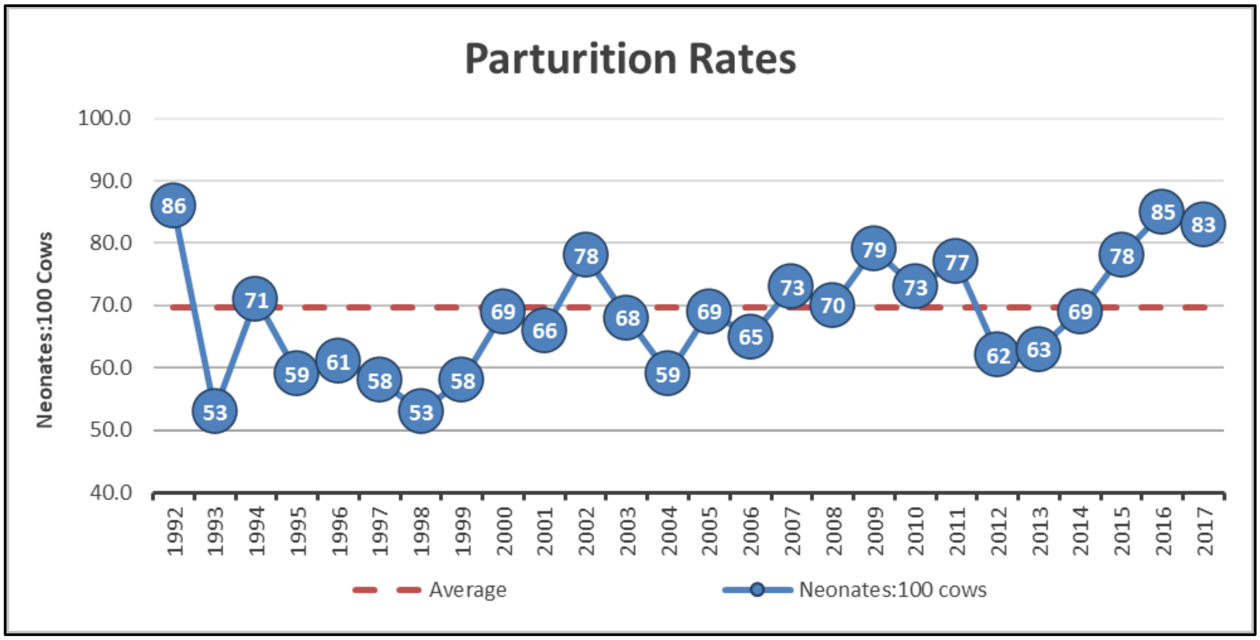

Figure 3. Parturition rates of caribou calves per 100 cows, 1992–2017, Alaska.

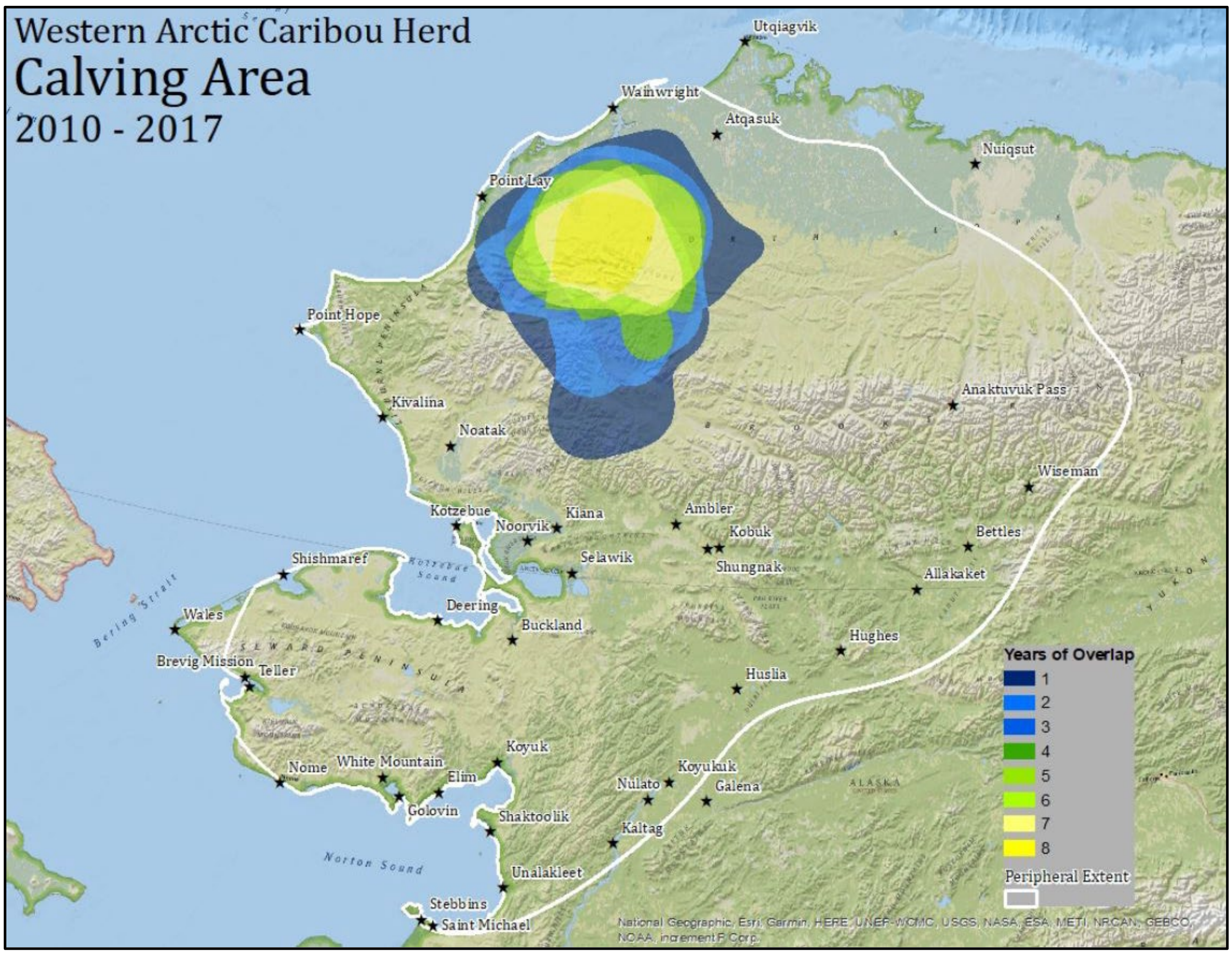

Figure 4. Western Arctic caribou herd calving area, 2010–2017, Alaska.

Table 2. Aerial calving survey results from observations of radiocollared cows in the Western Arctic caribou herd, 1992–2017, Alaska.

Year	Median survey date[a]	With calf	No calf & >1 hard antler	No calf & soft (velvet) antlers	No calf & no antlers	Total	Maternal[b]	Nonmaternal[c]	Neonates per 100 cows
1992	12	55	6	0	10	71	61	10	86
1993	14	39	3	17	21	80	42	39	53
1994	11	42	15	2	21	80	57	23	71
1995	11	47	2	13	21	83	49	34	59
1996	6	38	16	13	21	88	54	34	61
1997	5	39	13	16	22	90	52	38	58
1998	13	36	5	16	21	78	41	37	53
1999	12	47	0	11	23	81	47	34	58
2000	13	39	11	5	17	72	50	22	69
2001	16	8	34	9	13	64	42	22	66
2002	2	13	38	8	6	65	51	14	78
2003	6	16	38	7	19	80	54	26	68
2004	6	38	13	17	18	86	51	35	59
2005	10	45	13	8	18	84	58	26	69
2006	10	37	11	8	18	74	48	26	65
2007	6	36	25	7	16	84	61	23	73
2008	12	48	5	7	16	76	53	23	70
2009	6	35	20	6	9	70	55	15	79
2010	7	49	9	17	5	80	58	22	73
2011	9	47	10	13	4	74	57	17	77
2012	7	41	3	21	6	71	44	27	62
2013	12	37	8	13	13	71	45	26	63
2014	11	45	2	19	2	68	47	21	69
2015	7	46	7	13	2	68	53	15	78
2016	9	67	4	10	3	84	71	13	85
2017	7	58	13	6	9	86	71	15	83

[a] The median date of all observations includes replicated observations of radiocollared cows and observations of both maternal and nonmaternal cows.
[b] Maternal is defined as cows having a calf at heel or >1 hard antler, regardless of location or the presence of a calf.
[c] Nonmaternal is defined as cows having no calf and no hard antlers or having no calf and soft (i.e., velvet) antlers.

Recommendations for Activity 1.4.

Continue.

Activity 1.5. Determine population composition through fall survey every 2–3 years.

Data Needs

While no objectives of this plan currently specify desired bull-to-cow ratios for WAH, the Western Arctic Caribou Herd Working Group (2011) recommends maintaining a population-to-sex ratio of 40 bulls per 100 cows. The importance of monitoring bull-to-cow ratios increases as the population nears the IM population objective of 200,000 caribou. Based on historical annual harvest levels, the harvestable surplus may be exceeded at or near the IM population objective.

At or below the IM objective level, sex-specific harvestable surplus may need to be estimated and incorporated into regulatory approaches.

Methods

Surveys were conducted in October, coinciding with the rut, when the herd was presumed to be well mixed. Surveys were based out of Kotzebue and utilized a fixed-wing aircraft (PA-18 or similar) and a helicopter (R-44). Satellite locations of collared animals were reviewed prior to initiating the surveys, and an effort was made to start the survey at the head of the migration and work back along the migration trail to minimize the possibility of resurveying animals. The fixed-wing aircraft deployed to locate collared animals, and the locations were relayed to the classification team. Surveys followed a focal-animal cluster design (Cochran 1977), where approximately 200 caribou were classified as a bull, calf, or cow within a 5-mile radius of each collared animal. If there were fewer than 200 caribou within 5 miles of a collared animal, then the search was terminated for that group, and the location and number of caribou classified were documented. The survey objective was to locate 50 collared caribou and classify 10,000 caribou every 2–3 years. Proportions for the classifications were calculated using a cluster-sampling scheme (Cochran 1977) and were expressed as proportions as well as a ratio relative to 100 cows.

Results and Discussion

Fall composition surveys were conducted in 2012, 2014, and 2016 (Table 3). Surveys were not conducted in 2013 and 2015 due to conflicts with other projects as well as to offset costs associated with photocensus attempts in those years. In 2012 and 2016, the Western Arctic Caribou Herd Working Group's 2019 management objective was met or exceeded with a bull-to-cow ratio of 42:100 (42%) and 41:100 (41%), respectively. The bull-to-cow ratio in 2014 was just below the objective at 39:100.

The survey objective of 10,000 caribou was exceeded in 2014 with 11,019 caribou but was not met in 2012 or 2016 with 9,120 and 9,385 caribou, respectively. Since 1995, bull-to-cow ratios have been in a very slight decline; however, the variation has been relatively small, with the highest recorded bull-to-cow ratio of 54:100 in 1998 and the lowest bull-to-cow ratio of 38:100 in 2001. The 2001 survey occurred on 14 November, and sexual segregation was apparent.

Calf-to-cow ratios increased over RY12–RY16, with 38:100 in 2012, 42:100 in 2014, and 54:100 in 2016. Since 1995, calf-to-cow ratios have remained relatively stable, with the lowest ratio of 35:100 observed in both 2004 and 2010 and the highest ratio of 54:100 in 2016. Currently, there are no management objectives for calf-to-cow ratios.

These surveys attempted to target a timeframe with minimal sexual segregation; however, this condition deteriorates as October progresses. ADF&G staff have not attempted to quantitatively evaluate sexual segregation during these surveys. Additionally, the surveys were conducted during fall migration, which can cover a vast area and vary spatially between years. Due to logistical challenges and associated expenses, the entire range has never been fully surveyed for fall composition. The large sample size, when paired with broad spatial representation, is presumed to produce reasonably accurate trends in ratios (Harper and McCarthy 2015). Caution

Table 3. Western Arctic caribou herd fall composition ratios, 2001–2016, Alaska.

Year	Calves:100 cows	Calves:100 adults	Bulls:100 cows
2001	37	27	38
2002	–	–	–
2003	–	–	–
2004	35	24	48
2005	–	–	–
2006	40	28	42
2007	–	–	–
2008	48	33	45
2009	–	–	–
2010	35	23	49
2011	–	–	–
2012	38	27	42
2013	–	–	–
2014	42	30	39
2015	–	–	–
2016	54	38	41

Note: Years with en dashes represent years when no survey was conducted.

is advised when comparing actual values between years, as annual variability may reflect survey conditions more than actual population composition changes.

Recommendations for Activity 1.5.

Modify. Consider tradeoffs between an arbitrarily large sample size and a spatially representative sample of WAH. Compare calf survival estimates to spring recruitment rates.

Move to a 5-year schedule for composition surveys unless the population falls below 230,000 caribou. Surveys may be conducted at 1–2-year intervals when needed to calculate sex-specific harvestable surplus and to establish a relationship between harvest, regulations, and herd composition.

ACTIVITY 1.6. Estimate annual recruitment with short-yearling surveys.

Data Needs

Short-yearling surveys provide an annual index of calf recruitment for the herd. This index of recruitment has been consistently collected every year since 1982 (Harper and McCarthy 2015) and is used to approximate calf survival as well as prospective population trends when paired with adult cow mortality. As an added benefit, short-yearling surveys also provide an updated radiotracking list to bring into the calving and photocensus season (Activities 1.3 and 1.6).

Methods

Short-yearling surveys (also referred to as spring composition surveys) were conducted in April and May, which is when most of the herd occupies lower elevation flatlands favorable for survey flights. Surveys were typically flown with a telemetry-equipped PA-18 aircraft and a pilot-observer pair. Satellite-collared cow locations were used to inform radiotracking efforts. Cows collared the preceding fall were excluded to minimize sampling bias from nonrandom distribution of marked animals. Collared bulls were also excluded as they are typically segregated from adult cows and calves in the spring. For each collar identified, 200 animals were classified within a 3–5-mile radius (Harper and McCarthy 2015). Each caribou was classified as either a calf (<12 months old) or adult and recorded using a mechanical tally counter. If 200 caribou were not found within 5 miles of a collared cow, then the location and total number of classified caribou were noted, and the survey proceeded to the next collared group. A sample objective of 10,000 WAH caribou has been in place since 1988. The sample size was arbitrarily set on the premise that it would require a large area of sample coverage to locate the minimum of 50 collars the sampling protocol requires and thereby minimize the effects of any regional variation in calf-to-adult ratios (Harper and McCarthy 2015). Similar to fall composition, a focal-animal cluster sample was used to calculate sample variance (Cochran 1977).

Results and Discussion

Short-yearling surveys have taken place in the herd since the early 1980s (Jim Dau, Caribou Biologist, ADF&G, Kotzebue, 2016 short yearling survey memorandum, 26 April 2016) and have provided a long-term index of calf recruitment (Table 4). During RY12–RY16, there was an overall increase in short-yearling-to-adult ratios from 17:100 (14%) in 2013 to 22:100 (18%) in 2017. The increase in short-yearling-to-adult ratios is far more pronounced when comparing the all-time low ratio of 9:100 in 2011 to the recent high of 23:100 in 2016, the highest ratio since 2007. The recent increase in short-yearling recruitment rates along with the increase in adult cow survival (Activity 1.3) strongly supports a turnaround in the declining population trend as demonstrated by the recent uptick in the population detected between the 2016 and 2017 photocensus surveys (Fig. 1). Comparing calf recruitment ratios during the recent decline (2003–2016) to the population change rates provides some evidence of this (Table 5). Very low recruitment rates may corroborate declines sufficiently predicted through adult female mortality rates or may indicate rates of decline of greater magnitude.

Table 4. Western Arctic caribou herd spring short-yearling counts, short-yearling herd percentages, and short-yearling-to-adult ratios, 2013–2017, Alaska.

Year	Adults	Short yearlings	Total caribou	% Short yearlings	Total SY:100 adults[a]
2013	9,584	1,601	11,185	14	17
2014	10,423	1,425	11,848	12	14
2015	12,659	1,661	14,320	12	13
2016	10,766	2,431	13,197	18	23
2017	8,370	1,808	10,178	18	22

[a] SY refers to short yearlings.

There are a few limitations of spring short-yearling surveys. First, the composition of the denominator is unknown. Along the spectrum of representing calves per 100 adult females and calves per 100 adults, it is unknown where this index lies and if it varies among years or across space. The approach of using collared adult females as focal while avoiding collared males may

Table 5. Mean annual rate of population change and recruitment ratios for the Western Arctic caribou herd, 2013–2017, Alaska.

Census year	Population size[a]	Mean annual rate of change[b]	Short yearlings:100 adults
2013	234,757	−15	17
2014	–	−5	14
2015	–	−5	13
2016	201,000	−5	23
2017	259,000	−29	22

[a] Maximum value of minimum count or Rivest estimate.
[b] Mean annual rate of change = e^r where e = 2.7183; $r = [\ln(N_{t2}) - \ln(N_{t1})]/t$; t = number of years between censuses; N_{t1} = population estimate at time$_1$; N_{t2} = population estimate at time$_2$.

push the denominator more toward adult females, particularly since it appears that males and adult females are segregated at multiple spatial scales in the spring. Second, surveys are spatially restricted due to travel time from Kotzebue and subject to the logistical challenges of surveying all collared cows within the range of the herd. During a typical spring within the report period, most of the collared cows were located on the Seward Peninsula, while a lesser number were in other areas, including the Delong Mountains, Gates of the Arctic National Park, and on the North Slope. Given the associated logistics and expense of surveying groups in those outlying areas, they have not been consistently surveyed, and the effect, if any, of this spatial sampling bias is currently unknown. Third, since the late 1980s, the sample size of 10,000 caribou has generally been reached; however, in years when the population or collar count is low, this target may prove to be unattainable.

Recommendations for Activity 1.6.

Continue. Short-yearling surveys provide consistent information at relatively little cost compared to other surveys. Consideration should be given to expanding the survey area to include collared cows located outside the high concentration wintering areas, including those caribou wintering on the North Slope.

ACTIVITY 1.7. Evaluate trends in body condition through calf weights.

Data Needs

Monitoring body condition of the herd is an important component of understanding large-scale drivers of abundance and herd trajectory. Fall calf weights provide an indicator of herd-level body condition, overall herd health, and range condition. Absent lingering effects of difficult winters, which are expressed through birth weights and lactation, oversummer weight gain is thought to primarily reflect summer foraging conditions (Valkenburg et al. 2016, Barboza and Parker 2008).

Methods

Calves are weighed annually in conjunction with adult collaring efforts at Onion Portage (Activity 1.3).

The calf capture boat required a minimum of 3 people. Once the boat was alongside the calf, the person in the bow grabbed the calf and held the calf's neck along the boat while another person held the calf's tail. Immediately upon securing the calf, the boat driver dropped anchor. Two nylon slings were placed under the calf, one immediately behind the forelegs and the other in front of the hindlegs. A carabiner secured the ends of the sling together, and the looped ends slipped onto the scale's hook. The digital scale (440 lb/200 kg Pesola PHS200, China) was suspended from the center of an 8 ft, 2 in diameter aluminum pole, which was supported on the shoulders of the 2 people holding the calf. Simultaneously, the 2 people holding the calf would release the aluminum pole and stand, lifting the calf out of the water and into the boat via the slings. The third person would assist in guiding the calf into the boat and take the weight reading while the calf was suspended. The process was then reversed to return the calf to the water. If the capture included collaring, an expandable collar (ATS model M2230B) was fit, and the relevant calf and collar data was recorded. With the calf still held alongside the boat, the anchor was pulled, and the boat maneuvered slowly toward the adult capture boat. Cow and calf were released together, and if necessary, the pair was herded to the south shore of the river.

All calf weights were corrected for water retained in the animal's fur. This correction factor was determined by weighing calves at the University of Alaska Large Animal Research Center before and after soaking with a hose and was approximately 2 lb (1 kg) per calf, regardless of calf size (VanSomeren et al. 2011).

In addition to calf weights, a subjective body condition rating on a scale of 1–5 (very skinny, skinny, average, fat, and very fat) was assigned to captured caribou.

Results and Discussion

Body weight of 4-month-old calves serves as an indicator of nutrition and range conditions. Valkenburg (1997) indicated that cohorts of WAH calves were the smallest calves compared to other herds in the state, averaging approximately 44 lb (20 kg) less than calves from interior herds. Valkenburg et al. (2016) indicated that fall calf weights strongly affected individual overwinter survival, with smaller calves significantly less likely to be represented upon recapture during the spring.

Between 2012 and 2016, a total of 130 calves were weighed, comprising 76 females and 54 males (Fig. 5). Overall average calf weight for RY12–RY16 was 42 kg ± 2.7 (standard error [SE]), corrected for water weight. Female calf weight over this period averaged 41 kg ± 1.1 (SE), while male calf weight averaged slightly heavier at 46 kg ± 1.1 (SE). Previous analyses have shown that male calves typically weigh more than females (Harper 2013); therefore, differentiating between sexes when comparing long-term weights is warranted.

Body condition was assessed in collared adults during the report period. From 2012 to 2016, 224 adult caribou were captured and assessed for body condition while crossing the Kobuk River. Of these adults, 171 were cows and 53 were bulls. As a combined group, 5% were classified as skinny or very skinny (n = 12), 34% as average (n = 77), and 60% as fat or very fat (n = 135).

From 1995 to 2011, body conditions averaged 14% skinny or very skinny, 43% average, and 43% fat or very fat. Although body condition has varied over time, comparing these subjective evaluations and previous assessments is difficult because of changes in evaluators; however, it is

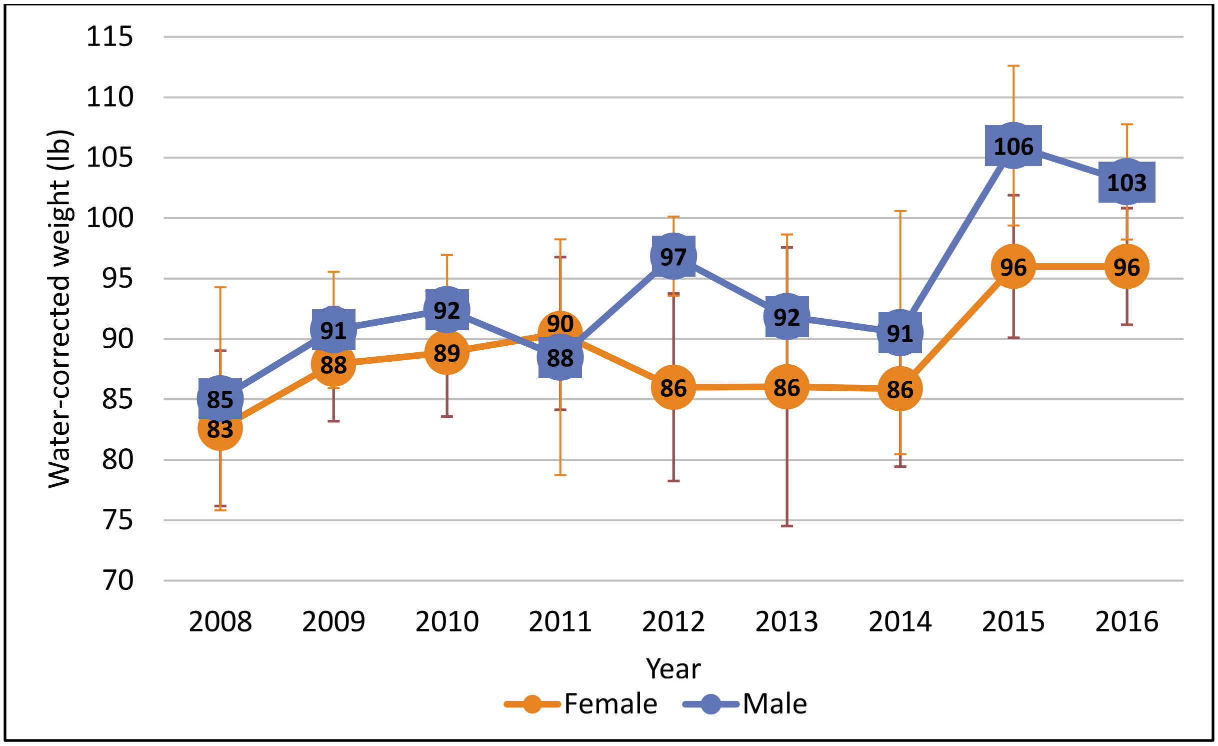

Figure 5. Western Arctic caribou herd sex-specific average calf weights (lb) from calves captured at Onion Portage, 2008–2016, Alaska. Calves are approximately 4-months old at capture. Weights are corrected for water saturation of fur.

believed that body condition improved over 1995–2011, potentially because of a large decrease in abundance or favorable environmental conditions. This improvement is corroborated by heavier calf weights (Activity 1.7) and increases in parturition rates (Activity 1.4).

Recommendations for Activity 1.7

Continue. We recommend comparing calf weights and short-yearling recruitment to see if a correlation exists.

ACTIVITY 1.8. Determine seasonal range of the herd by use of radiotelemetry and satellite collar location data.

Data Needs

An understanding of temporal and spatial range use for the herd provides valuable context for management decisions and mitigation measures within the range. Map products are routinely shared and distributed to various user groups, including state and federal committees and commissions, resource development entities, other government agencies, nongovernmental organizations, and private user groups.

Methods

The primary data source for seasonal distribution consisted of point locations from satellite collars (GPS and PTT) affixed to female caribou. Analysis of seasonal ranges generally used 2 separate methods: fixed kernel analysis to define calving grounds and wintering areas, and cumulative estimates from Brownian Bridge models to define movement corridors, including spring and fall migratory routes (Sawyer et al. 2009). In addition to ADF&G staff, ABR Inc. (Fairbanks, AK) provided data analysis and mapping services for RY12–RY16.

Calving period distribution. Calving period (9–13 June) distribution provided an approximation of habitat and land use by female caribou. This contrasts with depictions that rely explicitly on parturient cows (Harper and McCarthy 2015, Cameron et al. 2020).

Spring and fall migration. Spring migration intensity was determined by using location data from 6 May through 8 June, while fall migration used data from 18 September through 7 November. The 95% utilization distribution of dynamic Brownian Bridge movement models for each individual was used to calculate the migration percentages by migratory season. Dau (2015) established migratory dates based on herd-level movement rates.

Post-calving, summer, late summer, and winter distribution. Seasonal distribution kernels were an average of daily utilization distributions during a given season (post-calving, 14 June through 5 July; summer, 6–30 July; late summer, 31 July through 17 September; and winter, 8 November through 5 May). Areas of high, medium, and low density utilization were represented by the 50%, 75%, and 95% distribution contours, respectively, with the bandwidth being calculated using the plugin method.

Results and Discussion

Calving period distribution. The herd has shown strong fidelity to calving grounds in the Utukok Hills since at least the late 1950s (Fig. 6; Kelleyhouse 2001, Harper and McCarthy 2015, Cameron et al. 2020). For all years within RY12–RY16, excluding 2013, the herd exhibited predictable patterns in calving distribution. 2013 was the first year on record in which the core calving area extended south of the Delong Mountains. In 2015, ADF&G caribou biologist Jim Dau attributed this to a late spring breakup, which hampered northward movement (Harper and McCarthy 2015).

Summer distribution. During the summer period, the herd utilizes the western portion of the North Slope and the central to western Brooks Range (Fig. 6; Harper and McCarthy 2015).

Although general summer patterns were consistent with previous years, annual variation in range use was evident across RY12–RY16. One notable difference occurred in 2013, when a greater proportion of the herd remained on the Lisburne Peninsula during the summer. General movement patterns during the report period include an eastward movement from the Lisburne Peninsula through the western Brooks Range. While moving east, a portion of the herd generally leaves the mountains for the North Slope while the remainder continue to the central Brooks Range.

Spring migration. Spring migratory routes for the herd vary individually based on wintering locations but generally follow a pattern of northward movement toward the calving grounds (Fig. 7). Maternal cows lead the spring migration, which usually commences during the first week of May (Harper and McCarthy 2015), and arrive on the calving grounds near the end of the month.

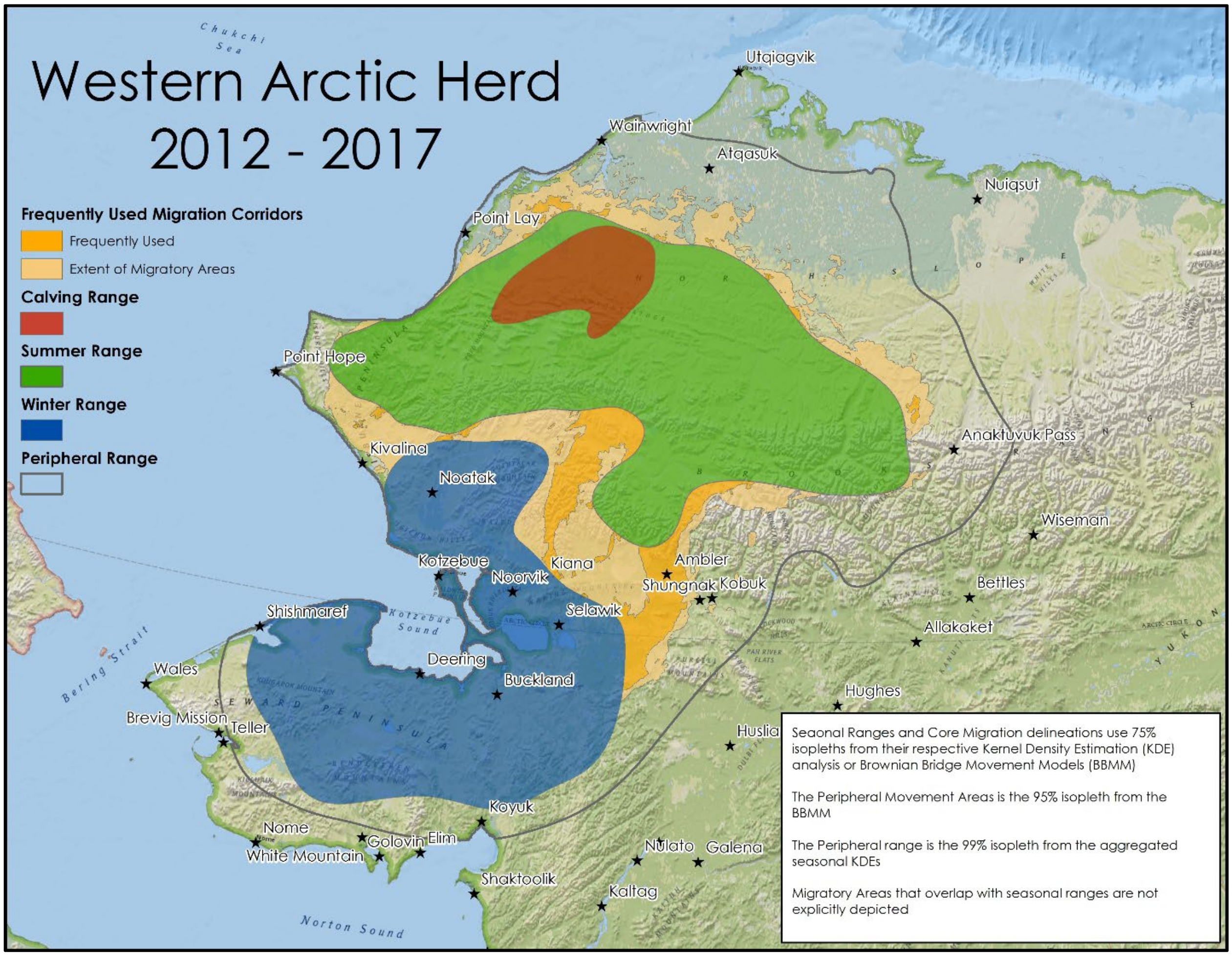

Figure 6. Seasonal distribution of the Western Arctic caribou herd, 2012–2017, Alaska.

In most cases, bulls and nonmaternal cows stay south of the calving grounds, then turn west toward the Lisburne Peninsula, arriving ahead of the maternal cows and neonates.

Fall migration. Fall movements are arguably the least predictable of all movements exhibited by the herd. Dau (2015; Fig. 8) indicates that fall movements have taken place later and have been less predictable since at least 2000. Additionally, individuals of this herd have been more widely distributed during the fall than any other time of year. Figure 8 illustrates the routes of highest use during RY12–RY16. The most prominent fall migration route during this period has been through the Baird Mountains, crossing the Kobuk River between the Hunt River and the village of Ambler. Other high-use routes include a western route along the coast near the village of Kivalina, crossing the DeLong Mountain Transportation System, then following the coast either along the north shore of Kobuk Lake or down the Baldwin Peninsula. A middle route through the Baird Mountains crossing the Kobuk River near the village of Kiana also received moderate use during the report period.

Winter distribution. For all years within RY12–RY16, most of the herd wintered on the Seward Peninsula. In each year, small portions of the herd occupied other areas, including the central Brooks Range, North Slope, and the Selawik, Kobuk, and Buckland river drainages (Fig. 6). Dau

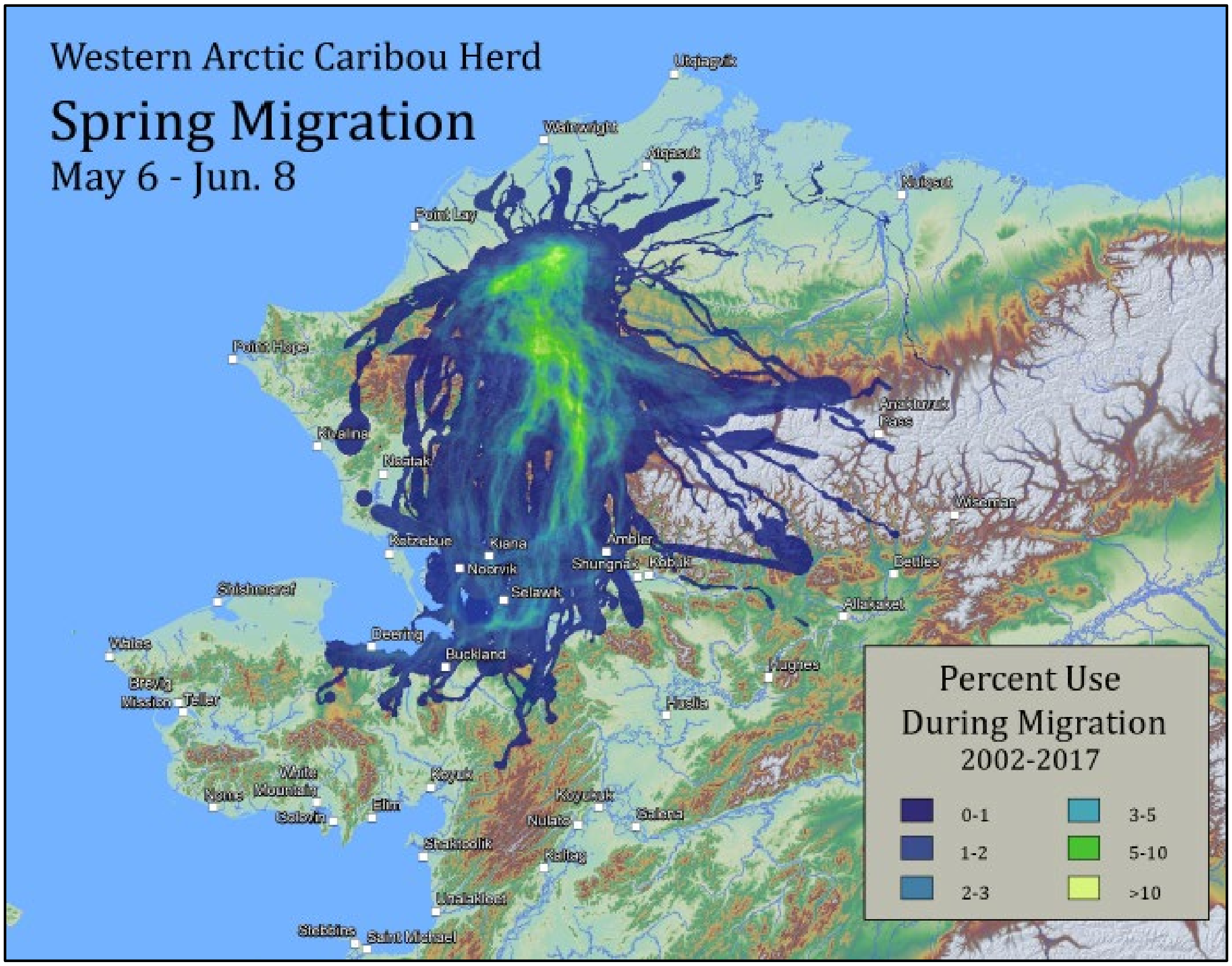

Figure 7. Western Arctic caribou herd spring migration, 2002–2017, Alaska.

(2015) noted that prior to the winter of 1996–1997, few caribou wintered on the Seward Peninsula west of the Kugruk River drainage; however, since that time, a large proportion of the herd has wintered there during most years.

<u>Combined seasonal distribution.</u> To summarize seasonal distributions in a single figure, we displayed 75% contours for calving, combined summer seasons, and winter, with migratory routes connecting the seasonal ranges (Fig. 6).

Recommendations for Activity 1.8.

Continue. A better understanding of factors influencing fall movements would provide valuable information that could inform the public process and potentially reduce tensions between user groups. We recommend continuing to support efforts aimed at understanding and mitigating the issues surrounding fall user conflicts.

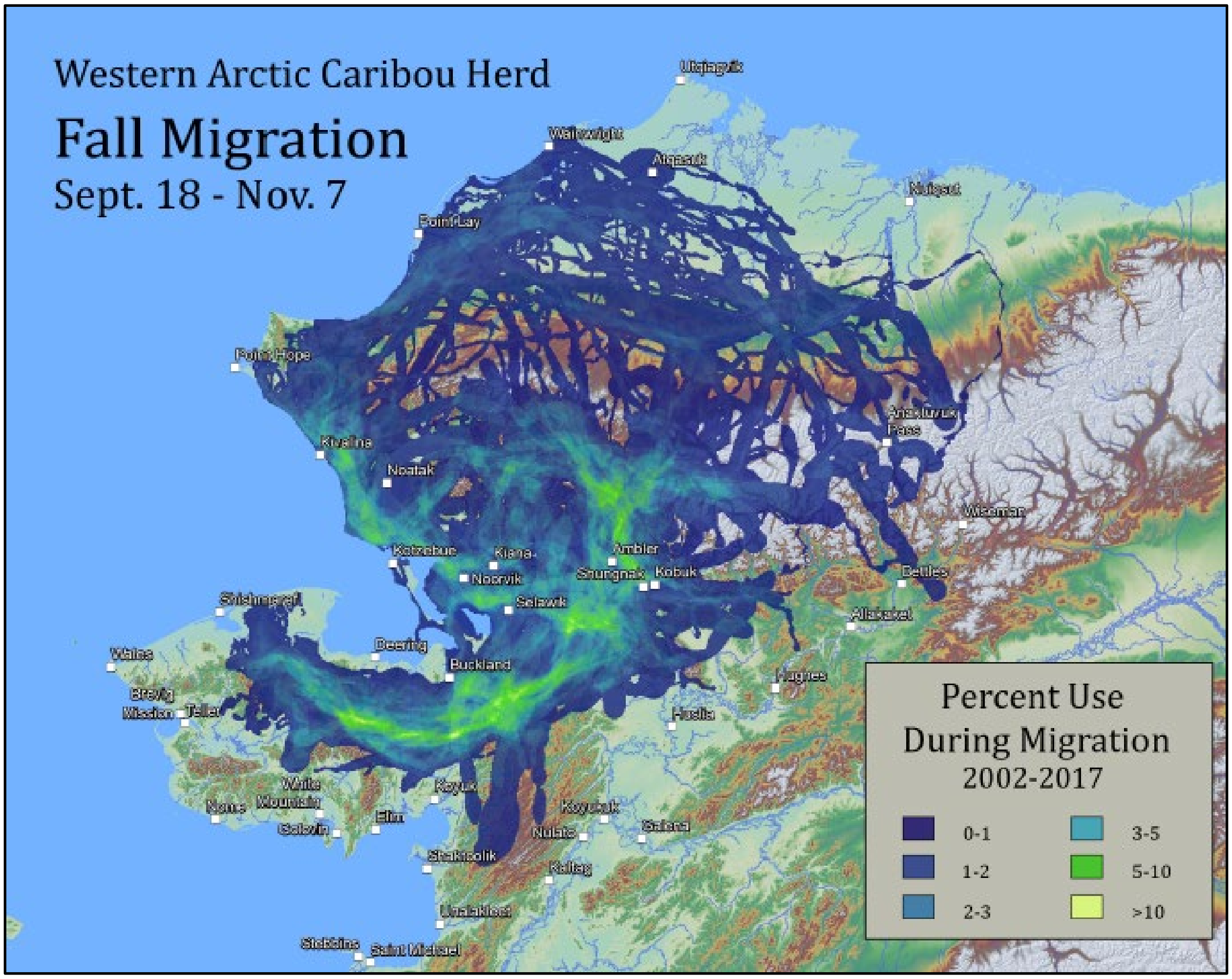

Figure 8. Western Arctic caribou herd fall migration, 2002–2017, Alaska.

ACTIVITY 1.9. Estimate rates and causes of mortality to WAH caribou.

Data Needs

Assessing adult mortality rates, causes, and seasonality provides information on factors affecting herd demographics and population trends. The spatial, temporal, and causal aspects of adult mortality can help inform management and regulation decisions, including hunting seasons and bag limits, as well as the efficacy and feasibility of IM actions.

Methods

Collars were deployed on WAH animals in late September through early October of each year. As such, a CY for the herd is defined as 1 October through 30 September. Adult mortality rate was determined by dividing the number of collared adult mortalities detected in a CY by the number of known, active adult collars during that CY, represented as a percentage. Cow and bull mortality rates and seasons were determined separately to limit confounding influences of sex and collar sample size on mortality rates.

During RY12–RY16, 30 calves were collared as they crossed the Kobuk River in 2015 and 2016 as a supplement to the adult mortality monitoring program. This method was deemed to be the most economically acceptable way to begin to investigate overwinter calf survival. Radiotracking flights with fixed-wing aircraft were attempted monthly as well as opportunistically through concurrent projects in the region. Calf survival estimates from 4-months to 1-year of age were produced using a Kaplan-Meier curve (Fig. 9).

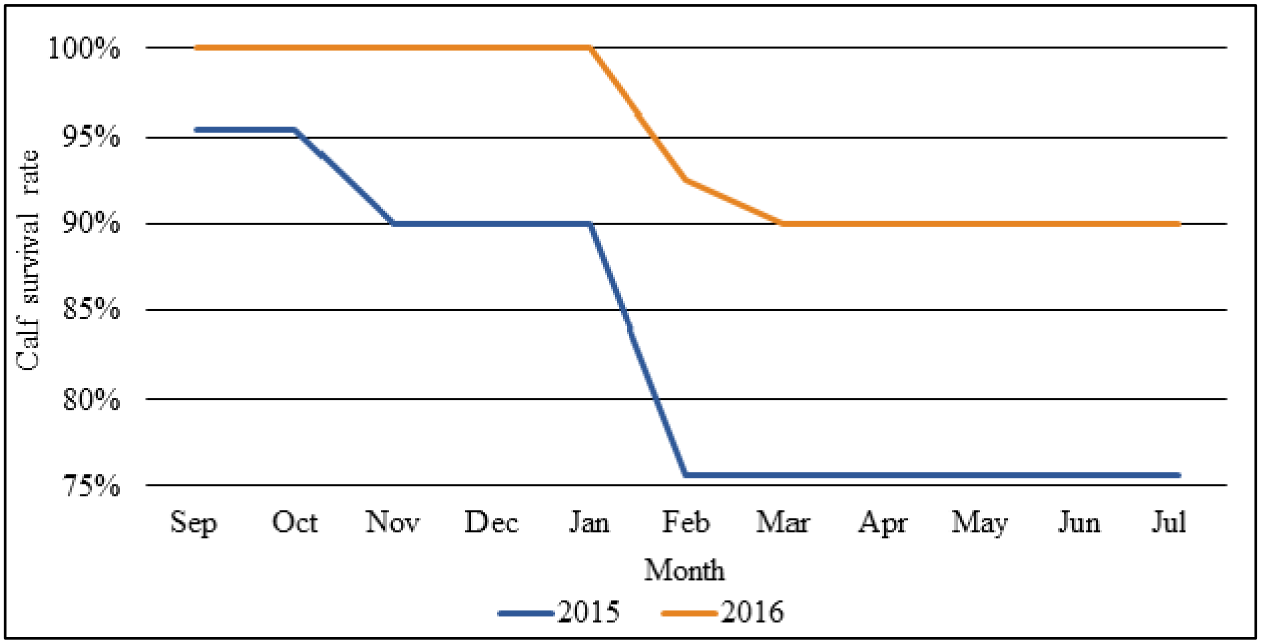

Figure 9. Western Arctic caribou herd calf survival rate, 2015–2016, Alaska. A Kaplan-Meier curve was fit to these data to render 6 survival estimates from the 7 survey flights conducted during the 2015–2016 caribou calf year.

Efforts were made to determine the mortality cause for all collared individuals through visits to mortality sites. Access to a mortality site was typically achieved with a helicopter but was also accomplished with small, fixed-wing aircraft and snowmachines. Mortality site and carcass disposition were assessed for evidence of mortality cause and classified under four general categories of hunter harvest, predation, unknown natural, and unknown. Assessment of the site and carcass followed recommendations described by Valkenburg et al. (2016). When possible, collars were recovered from the field and checked for blood using a latent bloodstain reagent (Bluestar Forensics, Monte Carlo, Monaco). Quantity and pattern of bloodstaining were used to further differentiate between predatory and nonpredatory (starvation, drowning, fall, etc.) mortalities. If evidence from the site and collar was sufficient, the predator species was identified. An unknown cause of death was assigned when evidence was inconclusive.

The timing of mortality was determined based on the type of collar fitted to the caribou. For caribou with GPS-enabled collars, location and movement data were reviewed to determine the timing of mortality. For those with VHF-only radio collars, mortality site and overall condition of any remains were used to determine the season of death as accurately as possible.

Results and Discussion

Adult cow mortality rates during RY12–RY16 ranged from 10% to 20% annually and averaged 16% (95% confidence interval [CI] = 9–22%). This report period included some of the lower mortality rates observed in the last 20 years (Fig. 10; CY96–CY15 range 8–33%). The report period's average is a notable decrease in cow mortality rate relative to those observed during the herd's recent drastic population decline, where cow mortality averaged 24% (CY04–CY11 range 16–33%; 95% CI = 19–29%). Also, it appears very similar to the mortality rates observed prior to the decline during periods of herd growth (CY87–CY03 range 8–22%; average 16%; 95% CI = 14–17%).

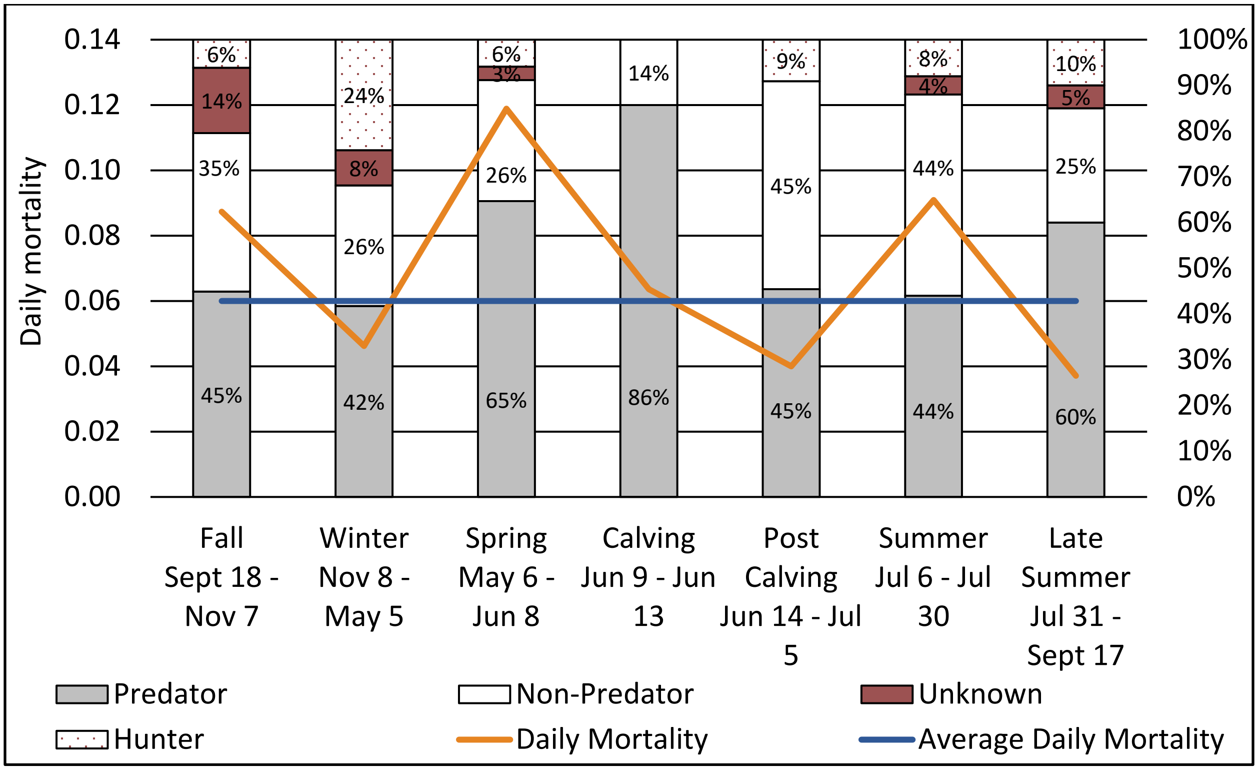

Figure 10. Average seasonal collared Western Arctic caribou herd cow mortality and cause, collar years 2006–2016, Alaska.

These lower mortality rates may represent a slowing of the herd's current decline and a transition toward a more stable population; however, it should be noted that mortality rate estimates based on collared cows are biased low because collaring efforts often target prime-aged animals and exclude those in poorer condition. This focus on prime-aged females has been exacerbated by a desire to weigh 4-month-old calves, resulting in the capture and collaring of their dams, often at the exclusion of unaccompanied cows, which may be younger. By excluding this demographic, we intrinsically miss some degree of additional mortality (Prichard et al. 2012). Furthermore, due to the timing and method of collaring within the herd, a collared subset of known-aged animals has not been maintained. Consequently, the mortality rates in this herd must be viewed as an index to overall rates, lacking information on younger age classes and some older animals that outlive the battery life of their collars.

Adult bull mortality rates ranged from 17% to 56% during the report period (Fig. 11). While mortality rates are generally observed to be different between the sexes (Harper 2013), bull mortality rates estimated in this herd are based on small annual samples (*n* ≤ 18). Also, collars are typically deployed on older males, likely biasing bull mortality higher. As a result, bull mortality rates are not heavily utilized in management decisions.

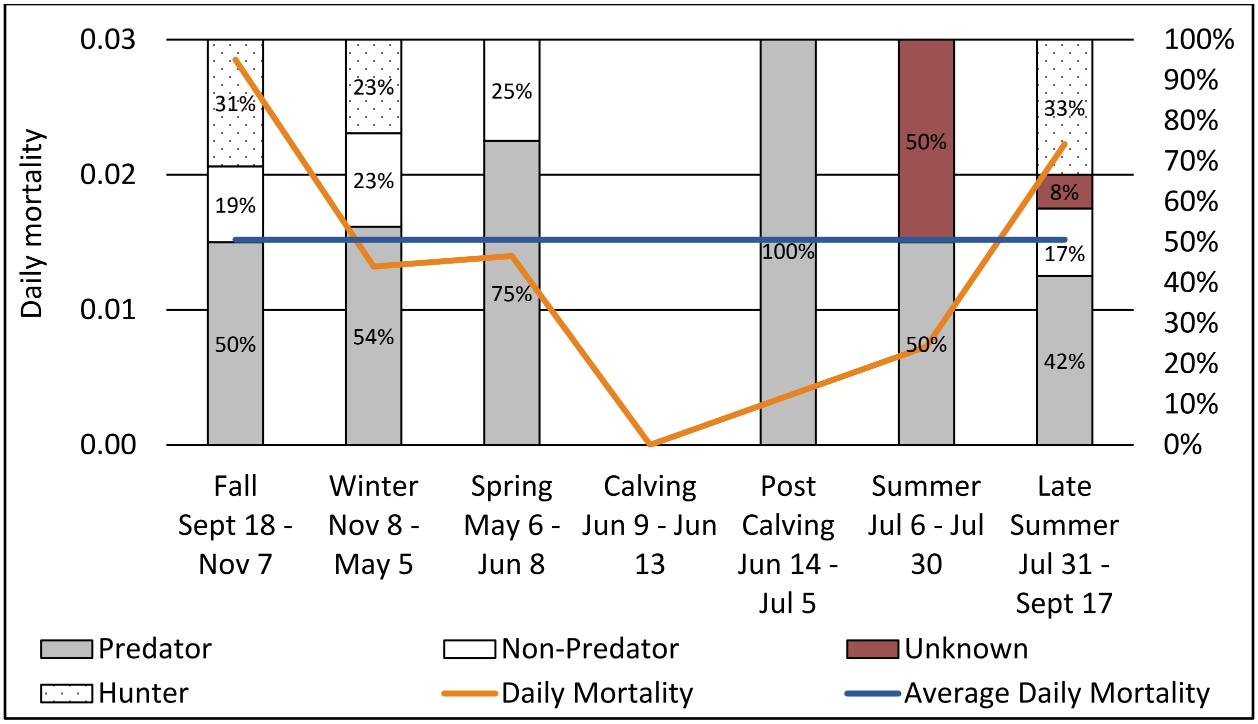

Figure 11. Average seasonal collared Western Arctic caribou herd bull mortality and cause, collar years 2006–2016, Alaska. No collared bull mortality was detected during the calving season in regulatory years 2012–2016.

In total, 102 collared caribou mortality sites were investigated during RY12–RY16, and general mortality cause was determined for 89% of those. Hunter harvest accounted for 27% (*n* = 28), and unknown natural and nonpredatory mortality accounted for 13% (*n* = 13). Predation was determined as the cause in 49% of mortality (*n* = 50) and was comprised of 14% wolf predation (*n* = 14), 10% bear predation (*n* = 10), and 25% unknown predation (*n* = 26; Table 6).

Unknown predation was assigned when evidence indicated predation but was insufficient to identify specific species. Other predators, such as wolverine, lynx, and golden eagle, have been known to kill WAH caribou (Harper and McCarthy 2015), but none were clearly identified at the mortalities investigated during the report period.

Hunter harvest of collared caribou increased substantially over the report period. Hunter-caused mortality prior to the report period averaged 14% of all collared caribou mortalities across sexes (CY89–CY11, 95% CI = 11–17%). In CY13, CY14, and CY15, hunter harvest accounted for 37%, 26%, and 28% of collared caribou mortalities, respectively (Table 6), representing some of the highest percentages of hunter harvest since CY89. These changes likely reflect the decrease in herd size; in 2016, the population estimate was the lowest recorded since the mid-1970s.

Table 6. Number of radiocollared caribou mortalities by source and year, Western Arctic caribou herd, collar years 1996–2016, Alaska.

Collar year	Initial n_i collared caribou	Total mortality	Known-cause mortality	Harvested by hunter	Wolf	Bear	Unknown predator	Nonpredator natural mortality	Unknown natural mortality
1996	118	18	16	3	1	0	0	0	12
1997	114	20	17	6	1	1	1	0	8
1998	107	19	17	4	0	0	0	0	13
1999	100	27	21	2	2	0	4	3	10
2000	86	20	14	4	0	0	0	1	9
2001	98	21	17	2	0	0	3	1	11
2002	115	26	21	4	0	0	0	2	15
2003	113	27	21	5	0	0	1	0	15
2004	115	25	22	6	3	1	1	3	8
2005	129	47	38	8	0	0	6	3	21
2006	115	17	16	1	0	0	6	3	6
2007	139	46	46	4	7	2	22	3	8
2008	114	28	27	2	1	0	9	3	12
2009	130	38	36	5	5	1	7	4	14
2010	128	29	26	2	9	2	0	4	10
2011	122	47	43	5	12	5	11	4	2
2012	100	23	23	4	4	3	7	1	4
2013	103	19	18	7	6	2	1	0	2
2014	113	23	22	6	2	3	5	1	5
2015	117	13	9	5	0	2	1	0	1
2016	134	24	19	6	2	0	11	0	0

Note: All categories are mutually exclusive; collar year = 1 October through 30 September.

Because we attempt to maintain a consistent sample size of collars, a decrease in the population creates an increase in the exposure opportunity of collared caribou to harvest.

As with sex-specific rates, the seasonality of mortality also tends to differ between cows and bulls. These daily rates provide a relative metric for comparison between seasons. Cow mortality rates were observed to be highest in spring, summer, and fall and lowest in winter and post-calving (Fig. 10). Bull mortality rates were highest in late summer and fall and lowest during calving and post-calving (Fig. 11). The seasonality of bull mortality should be evaluated with caution because collared bulls account for a very small sample size relative to the overall herd.

A total of 63 calves were collared during the report period, including 30 calves each in 2015 and 2016. Of the 30 calves collared in 2015, 5 died within the first year of life. A Kaplan-Meier curve was fitted to the data from 7 aerial surveys conducted during the 2015 calf year (Fig. 9), producing survival estimates between September and October (97%), through January (90%), through March (83%), and overall to 1 year (83%). Of the 5 mortalities detected, 3 were attributed to predation while the remaining 2 were of unknown cause. The predation events were likely by wolf ($n = 2$) and brown bear ($n = 1$). The 2016 cohort produced a slightly higher survival estimate of 90%, with an intermediary survival from September to February of 93%. The 3 collared calf mortalities were all investigated during the summer of 2017. Mortality sites had minimal remains, and all collars showed signs of latent blood, indicating predation was likely; however, additional evidence was inconclusive, and actual cause remained unknown.

While only 2 years of data are available, it appears that overwinter survival was relatively high for the sampling period and area. It is worth noting that collars deployed at Onion Portage are inherently biased toward caribou wintering south of the Kobuk River and do not necessarily represent rangewide winter survival.

Recommendations for Activity 1.9.

Modify. Estimate female harvest rate as a function of the overall mortality rate of collared cows and the proportion attributed to hunting. Establish a baseline for neonate survival for the herd from birth to year 1 and evaluate cause-specific mortality to better understand calf survival and recruitment. Evaluate the role of body condition and dam condition in overwinter survival.

ACTIVITY 1.10. Conduct disease and parasite surveillance.

Data Needs

Nutrition, disease, and parasitism are potential factors that influence herd health. Understanding their relative roles is important to a holistic understanding of population dynamics. The department can also play a role in publicizing the presence of zoonotic diseases in heavily utilized subsistence species.

Methods

Disease surveillance was conducted annually on adult caribou during fall collaring efforts at Onion Portage. All captures were by hand, as previously described in Activity 1.3. Once the adult was secured along the boat, the animal's body condition was assessed, and 20 cubic centimeters of blood were drawn from the jugular prior to fitting the radio collar. The presence of a calf or physical abnormalities were also documented. Prior to RY12–RY16, blood samples were left to stand overnight at room temperature, and the serum was separated for transport from the field. From 2012 through 2014, samples were centrifuged prior to serum draw and were frozen. No blood samples were collected from 2015 through 2016. Starting in 2016, in lieu of blood samples, swabs from the eyes and nares were taken. Eye swab samples were analyzed for cervid herpesvirus 2. No samples were found during the study. Nare samples were tested for *Mycoplasma ovipneumoniae* (*M. ovi*). A total of 80 samples were analyzed, and 2 samples tested positive for *M. ovi*. Blood serum samples have historically been analyzed to assess haptoglobin levels as an indicator of inflammation along with a suite of other serum antibody tests, including tests for exposure to *Brucella suis* bacteria through the presence and prevalence of antibodies. The potential role of cross-reaction to some antibody tests and a lack of clarity in what inference could be made from those tests led to abandoning certain tests. During the report period, all serum samples were sent to the ADF&G wildlife health veterinarian in Fairbanks for processing and storage. ADF&G veterinary staff conducted brucellosis tests, and haptoglobin assays were done at the Acute Phase Protein Laboratory housed at the University of Miami.

Results and Discussion

During RY12–RY16, disease surveillance varied annually both in extent and number. Blood was only sampled from 2012 through 2014, and only analyzed in 2012 and 2013. As fall migration became less predictable, longer field deployments were required to meet collaring needs and the logistics of proper sample storage for these longer field durations became problematic. Additionally, ADF&G veterinary services in Fairbanks were becoming short on staff and storage; therefore, despite having collected samples, no blood was analyzed in 2014. Due to these challenges, blood samples were no longer collected after 2014.

Over RY12–RY16, blood samples were collected from 88 adult caribou, including 60 cows and 28 bulls. Of these, 61 samples were analyzed from 2012 to 2013. Results indicated the presence of elevated haptoglobin levels in 18% of samples in 2012 and 31% in 2013. For comparison, the average between 1992 and 2013 was 11%. Brucellosis was detected in 2% (n = 45) and 6% (n = 16) of samples in 2012 and 2013, respectively. Caribou sampled for disease analyses are selected opportunistically rather than randomly. Because ADF&G staff collect blood from most caribou that we radiocollar and because we do not collar subadults or sickly animals, our samples are biased toward healthy-looking adults. Also, the availability of bulls sometimes affects the relative numbers of bulls and cows sampled. These factors, along with small sample sizes relative to the size of WAH, may compromise our understanding of disease. As such, we interpret serology results as a coarse indicator of prevalence, with no direct implications for the role of a given disease influencing population dynamics of the herd.

Recommendations for Activity 1.10.

Modify. While there were several reasons to suspend aspects of disease surveillance during RY12–RY16, we feel that some of these challenges, such as sample storage in the field and opportunity for sample analysis, could be overcome. Moving forward, a more structured health assessment could have merit for continued long-term monitoring of herd health, especially as it may relate to population trend.

Through a more structured health assessment program, we aim to revitalize the monitoring of haptoglobin levels as a broad approach for detecting disease. This includes a more comprehensive comparison of continuous haptoglobin levels (as opposed to a binary designation of *elevated*); active infections; exposure to other infectious diseases, parasite loads, body condition; and subsequent fitness (i.e., survival and parturition). Additionally, we aim to continue monitoring brucellosis and its relationship to fitness while evaluating other genetic markers for inflammation and disease.

ACTIVITY 1.11. Mandible collection for determining age.

Data Needs

Age structure is thought to be a major driver of ungulate population dynamics. Establishing clear links between age structure and population growth or decline may help to predict when populations are demographically primed for a given trajectory.

The primary questions intended to be addressed through the collection of jaws are: What is the sex-specific age distribution of random and harvested caribou, and does age-specific structural size vary under different densities and environmental conditions?

Methods

Caribou jaws can be used to monitor the age structure of WAH and assess herd health through morphometric indices of jaw growth.

Mandible collection in the herd has been episodic and opportunistic since its initiation in the late 1950s. Jaws collected prior to 1997 were measured, and an age estimation was assigned based on tooth eruption pattern and wear. Following 1997, most jaws were aged by counting cementum annuli from the first incisor tooth (I-1) or, if unavailable, a canine or first molar (M-1). All teeth processed by Matson's Laboratory Inc. (Milltown, MT) were aged by sectioning and staining of tooth cementum annuli. When possible, data such as the sex of the caribou and approximate time of death were provided along with the sample. All mandibles were measured following the CARMA protocol.

Results and Discussion

During RY12–RY16, between 140 and 270 mandibles were collected each year to be measured and catalogued for the purposes of determining density dependence and age structure of the herd. Measurements and tooth extraction were suspended in 2016 due to changes in staff and competing research needs.

Most of the jaws collected came from bulls harvested on the Kobuk River, though some effort was made to collect jaws of both sexes elsewhere. Harvested individuals are most often selected based on individual characteristics, including sex, body size, condition, and trophy value, and therefore do not represent the overall herd structure.

Dau (2015) compared the median age of mandibles collected from natural mortalities to those from hunter harvest between 2005 and 2014. Samples were comprised of jaws retrieved from the mortality sites of collared caribou as well as random samples opportunistically collected during normal work duties. Most of the mandibles collected from natural mortalities came from collared individuals, also subject to selection bias. Only adult bulls are collared to prevent slippage or ill-fitting collars during continued skeletal growth. The collection of calf weights (Activity 1.7) also leads to the selection of adults since cow-calf pairs are targeted, which essentially eliminates cows <3 years of age. In either case, harvested and collared animals are subject to bias and fail to represent the age of the whole population.

To investigate body size related to age, Dau (2015) found that skeletal growth largely ceased for cows by 4 years of age and bulls at 5 years of age. This result was confirmed in other studies (Finstad and Prichard 2000, Harper 2013). Thus, period-specific size estimates excluded samples for cows <4 years of age and bulls <5 years of age. Given adequate sample sizes between years, Dau (2015) was able to demonstrate size differences between years. Ramus lengths for both sexes were significantly shorter between the years 1959 and 1961 than those sampled from 2009 to 2015, likely indicating an increased body size in the second sampling period. This may imply superior range conditions, weather, density dependence, or other factors influencing growth were more favorable during those years.

Age estimates were primarily derived from cementum annuli and correlated with tooth eruption and wear. While this method is generally accepted as the most accurate for aging caribou, Dau (2015) found that 31% of the time the age estimate was off by >1 year using blind samples of known-age caribou and reindeer (n = 13). Evaluation of sampling bias based on characteristics not specifically tied to age (i.e., body condition) is more difficult to obtain.

Recommendations for Activity 1.11

Discontinue. Given the biases inherent in the sample, whether derived from collared individuals or harvested individuals, the intended hypotheses cannot be addressed adequately. Currently, budgetary cost and time investment of the activity cannot be justified given the inability to accurately monitor the age structure of the herd.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Estimate annual caribou harvest.

Data Needs

The herd has a positive C&T use status, and the board has determined the ANS (5 AAC 99.025) as 8,000–12,000 caribou for WAH and TCH combined. Harvest estimates provide important information in the determination of ANS and can influence determinations of allowable harvest as prescribed in Table 1 of the *Western Arctic Caribou Herd Cooperative Management Plan* (Western Arctic Caribou Herd Working Group 2019).

Methods

Several years into the most recent population decline (2003–2016), WAH users and managers realized that the current level of harvest reporting did not provide enough detail to inform timely management decisions. Acting on the need for more detailed information, the board instituted mandatory reporting requirements for caribou in Unit 22 (RY16) with registration permit RC800, followed by RC907 for Units 23 and 26A (RY17). RC800 and RC907 were preceded by other registration hunts for all hunters living north of the Yukon River, RC900 and RC901 (2014 for Units 23 and 26A); however, they did not have mandatory reporting requirements. Outreach efforts are currently underway to encourage local residents to use the caribou registration permits. Prior to the institution of the current registration permits, harvest by local hunters was estimated using a harvest by availability model. This model estimated harvest based on inputs including caribou proximity and availability, household harvest surveys, and community demographics. As the herd continued to decline and movements became less predictable, it became obvious that large annual swings in harvest were occurring within communities. Given these changes, ADF&G staff decided to abandon the use of the model as it was incapable of detecting short-term, year-to-year changes in harvest. The final references to this method of estimating harvest are found within Figure 12.

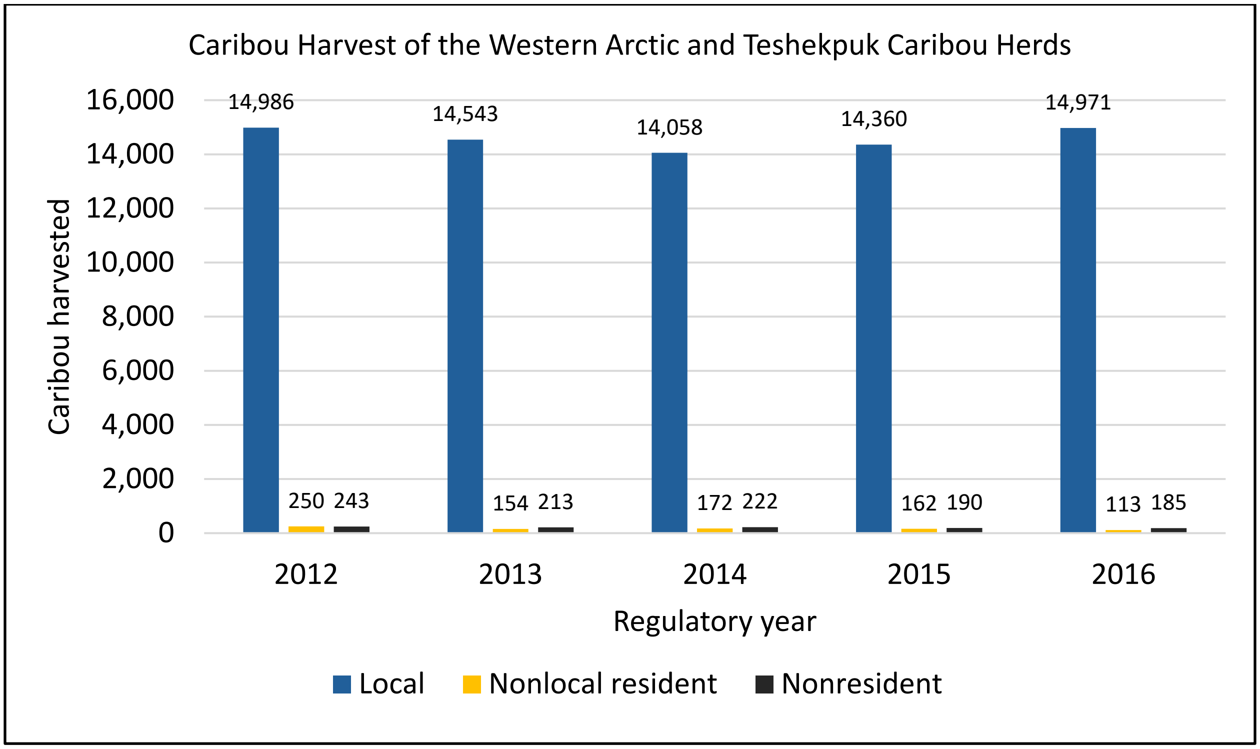

Figure 12. Hunter harvest of the Western Arctic and Teshekpuk caribou herds by residency, regulatory years 2012–2016, Alaska. Local hunters live within range of the herds; nonlocal residents are Alaska residents that live outside the range of the herds; and nonresidents are not residents of Alaska.

Season and Bag Limit

RY15–RY16.

	Bag limits		Resident open season (subsistence and general hunts)		
Unit	Resident hunters	Nonresident hunters	Bulls	Cows	Nonresident open season
Unit 21D remainder	5 caribou per day	1 bull	1 Jul–14 Oct; 1 Feb–30 Jun	1 Sep–31 Mar	1 Aug–30 Sep
Unit 22 remainder; Unit 22B west of Golovnin Bay, west of Fish and Niukluk rivers, and excluding Libby River; Unit 22C; Unit 22D remainder; and Unit 22E remainder	20 caribou total, up to 5 per day; however, calves may not be taken, bulls may not be taken Oct 15–Jan 31, and cows may not be taken April 10–Aug 31	1 bull	May be announced	May be announced	May be announced
Unit 22A north of the Golsovia River drainage; Unit 22B remainder; Unit 22D Kuzatrin River drainage, excluding the Pilgrim River drainage, and the Agiapuk River drainages; and Unit 22E east of and including the Sanaguich River drainage	20 caribou total, up to 5 per day; however, calves may not be taken	1 bull	1 Jul–30 Jun	1 Jul–31 Mar	1 Aug–30 Sep

-continued-

Season and Bag Limit continued

RY15–RY16.

	Bag limits		Resident open season (subsistence and general hunts)		
Unit	Resident hunters	Nonresident hunters	Bulls	Cows	Nonresident open season
Unit 22B west of Golovin Bay, west of the west banks of Fish and Niukluk rivers below the Libby River, excluding the Niukluk River drainage above, and including the Libby River drainage; 22D that portion in the Pilgrim River	20 caribou total, up to 5 per day (season may be announced 1 May–30 Sep); however, cows may not be taken 1 Apr–31 Aug	1 bull	1 Oct–30 Apr	1 Oct–31 Mar	May be announced
Unit 23 remainder	5 caribou per day; however, calves may not be taken	1 bull	1 Jul–14 Oct; 1 Feb–30 Jun	1 Sep–31 Mar	1 Aug–30 Sep
Unit 24A remainder, 24B remainder, and Units 24C and Unit 24D	5 caribou per day; however, calves may not be taken	1 bull	1 Jul–14 Oct; 1 Feb–30 Jun	15 Jul–30 Apr	1 Aug–30 Sep
Unit 26A; the Colville River drainage upstream from Anaktuvuk River and drainages of the Chukchi Sea south, west of, and including the Utukok River drainage	5 caribou per day; however, calves may not be taken	1 bull	1 Jul–14 Oct; 1 Feb–30 Jun	15 Jul–30 Apr	15 Jul–30 Sep

-continued-

Season and Bag Limit continued

RY15–RY16.

Unit	Bag limits: Resident hunters	Bag limits: Nonresident hunters	Resident open season (subsistence and general hunts): Bulls	Resident open season (subsistence and general hunts): Cows	Nonresident open season
26A remainder, Anaktuvuk Pass Controlled Use Area. Use of aircraft for caribou hunting is prohibited from 15 Aug–15 Oct	5 bulls per day; however, calves may not be taken	1 bull	1 Jul–15 Jul; Mar 16–30 Jun	1 Jul–15 Jul; Mar 16–30 Jun	15 Jul–30 Sep
	5 caribou per day, 3 of which may be cows; calves may not be taken, and cows with calves may not be taken		16 Jul–15 Oct	16 Jul–15 Oct	
	3 cows per day; however, calves may not be taken		16 Oct–31 Dec	16 Oct–31 Dec	
	5 caribou per day 3 of which may be cows; calves may not be taken		1 Jan–15 Mar	1 Jan–15 Mar	
Unit 23 north of and including the Singoalik River drainage	5 caribou per day; however, calves may not be taken	1 bull	1 Jul–14 Oct; 1 Feb–30 Jun	15 Jul–30 Apr	1 Aug–30 Sep

Results and Discussion

Harvest by Hunters-Trappers

Current caribou hunting regulations affecting WAH include Units 21D, 22, 23, 24C, the remainder of 24B, 24D, and 26A (Fig. 12). Unit 22 is currently the most restrictive, with an annual bag limit of 20 caribou. Aside from Unit 22, all other units within the range of the herd have a resident daily bag limit of up to 5 caribou with separate seasons for cows and bulls. Nonresident harvest is limited to 1 bull per year. Season and bag limits in RY12, as outlined by Dau (2015), represent the most liberal regulations during RY12–RY16. Beginning in RY15, regulation changes were made (5 AAC 85.025) to hunt dates and bag limits for both residents and nonresidents alike. These changes include setting a closure period for bulls, extending the closure for cows, prohibiting the harvest of calves, and reducing the bag limit for nonresidents.

Trapper harvest is not applicable.

Permit Hunts

The RC900 and RC901 permits were implemented after it was recognized in RY12–RY16 that better information on harvest by local hunters was necessary; however, there was limited participation and reporting on these permits. This led to the institution of RC800 in Unit 22 in RY16. In RY17, RC907 was established for Units 23 and 26A. These permits have a mandatory reporting requirement. Outreach and education efforts are underway to encourage residents to participate.

Hunter Residency and Success

Consumptive users of WAH include local area residents, nonlocal Alaska residents, and hunters from outside the state (nonresidents). During RY12–RY16, local residents accounted for approximately 95% of all harvest, with nonlocal Alaska residents and nonresidents rounding out the final 5% on average. Nonlocal hunter harvest was reported through state harvest tickets and registration hunts, while local harvest was largely unreported. Due to this data gap, local harvest is estimated for the herd using a model that attempts to account for availability (Dau 2015).

The majority of hunters are Alaska residents and residents of the herd range. The data on the success of resident hunters is limited by the lack of reporting during RY12–RY16. Delays to migration and the narrowness of migration routes have made it harder for hunters to access animals as they cross the major rivers. Nonresident and nonlocal resident hunter harvest is generally better reported. There was a decrease in their success rates over the report period from a high of 88% in RY12 to a low of 68% in RY13 and RY16 (Table 7).

Harvest Chronology

The movement patterns of the herd are a major driver of harvest chronology. The calving grounds are remote and far from easily accessible areas. During the summer, the herd has traditionally occupied the Lisburne Peninsula, allowing some harvest by hunters based out of Point Hope. As the herd starts their fall migration, they typically cross major rivers, including the Noatak, Kobuk, and Selawik rivers. These areas are traditionally used for harvest. Fall caribou

Table 7. Nonresident and nonlocal resident hunting success, regulatory years 2012–2016, Alaska.

Regulatory year	Hunter success
2012	88%
2013	68%
2014	69%
2015	70%
2016	68%
Average	72%

harvest by residents of the herd range are most often taken by boat as the caribou swim across the rivers. Fall is also when nonresident harvest occurs (the RY15–RY16 season was 1 bull, from 1 August through 30 September). Significant harvest by local hunters also occurs during the snow-covered months in winter and spring with the aid of snowmachines.

Transport Methods

Due to the limited road network and general remoteness of the herd's range, the 3 major transport methods used to harvest WAH caribou are aircraft, boats, and snowmachines. Boats are used as caribou cross rivers during fall migration. Aircraft are used by many of the nonresident hunters and some residents. In the winter, most harvest occurs by snowmachine and is primarily from local residents.

Other Mortality

Mortality investigations on collared individuals are completed to understand causes of mortality for this herd; however, these investigations are subject to biases discussed earlier in the report. For instance, a bias for collaring mature animals in good condition lowers mortality rates and misses causes of mortality that affect animals in poor condition, such as starvation and disease. Additionally, weather events, such as severe winter storms that create ice-on-snow conditions, have caused significant mortality in the past.

Alaska Board of Game Actions and Emergency Orders

In January 2014, the board adopted a positive C&T use finding for TCH and modified the ANS for WAH (8,000–12,000 caribou) to include TCH. During the January 2017 Arctic and Western regions board meeting, the board voted to modify the hunt structure of WAH and TCH by implementing a registration permit.

Recommendations for Activity 2.1

Modify. It is recommended that the transition to the registration permit reporting system be encouraged for all Alaska residents that hunt the herd. Failure to collect more complete harvest data continues to challenge the department's ability to make sound management recommendations. It could be argued that in years of abundance, the collection of harvest data is less important; however, the implementation of a permit of this magnitude takes time and cannot simply be turned on or off depending on the population trajectory of this herd. It is also important to establish and understand harvest trends at all population levels and refer to past management plans.

3. Habitat Assessment-Enhancement

The department did not conduct any habitat assessment or enhancement activities during RY12–RY16.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

WAH has one of the most intact ranges of any large caribou herd in North America. Currently, the Red Dog mine, road, and port site comprise the only large development complex within the range of this herd. These facilities are located wholly within the northwestern portion of the range.

The Ambler Road is a major development project still under consideration. This project was described in previous WAH management reports (Dau 2013, 2015). The objective of this project is to build an access road into the Ambler Mining District to open the upper Kobuk region to mineral development. This road could have profound impacts on subsistence users, movements of the herd, and the distribution and harvest of other wildlife species, especially resident species (e.g., moose, brown bears, black bears, furbearers, and wolves). Under the Parnell Administration, Alaska Industrial Development and Export Authority (AIDEA) intended to minimize these impacts to wildlife and local users by requiring industry to ultimately finance construction of this road, thus making it privately owned. That would allow industry to control, and presumably limit, access to this road. Private ownership of the road would not guarantee in perpetuity that the road would never be open to the public, creating potential impacts for the herd.

Data Recording and Archiving

- State caribou harvest data is stored on an internal server.
- Field data sheets are stored in file folders located in the Kotzebue Area office. Additional field data is electronically stored on the Kotzebue Shared Drive (OTZDWC (W)\Caribou).

Agreements

A data sharing agreement exists between ADF&G and NPS to share collar data, which will expire in 2020.

Permitting

None.

Conclusions and Management Recommendations

WAH is still a large herd despite its decline since 2003. There is no evidence that any single factor (e.g., human harvests, predation, environmental contaminants, range degradation, or disease) is currently limiting the size of this herd. Icing events likely caused high mortality in some years and may have initiated this population decline. Long-term declines in recruitment and the proportion of bulls in the population might suggest that density-dependent factors have subtly affected the population dynamics of this herd; however, this is inconsistent with the consistently good body condition of caribou during recent years. Opportunistic observations by department staff and numerous reports from local residents and long-term commercial operators suggest that brown bears and especially wolves have been abundant and taking many caribou in recent years. Predators are almost certainly affecting the population dynamics of this herd to a greater degree now than in the previous 30 years.

Despite the continued large size of this herd, local and visiting hunters have experienced difficulty harvesting caribou during recent fall hunting seasons due to delays in the onset of the fall migration and caribou moving through relatively narrow migration corridors. Limited availability of caribou appears to intensify conflicts among user groups even when local and nonlocal hunters are spatially separated. User conflicts will likely intensify if this herd continues to decline and hunting becomes more difficult.

The need for accurate and complete caribou harvest data is becoming increasingly important to the management of this herd (Dau 2013) and the adjacent TCH. Without substantial increases in funding and staffing levels or a substantial change in methodology, it is unlikely that ADF&G's Division of Subsistence will be able to conduct an adequate number of community harvest assessments annually to detect short-term changes in harvest levels. Paper-based harvest report systems have a history of limited success in the range of the herd. If the department hopes to change this, it will be necessary to spend substantial staff time visiting communities within the herd's range to convey the importance of collecting this information for herd management. With adequate compliance, a harvest report system could provide accurate caribou harvest information annually throughout the range, and it could do so at relatively little expense. The greatest obstacle to this has been the lack of participation in voluntary harvest reporting systems by local hunters. This likely will not change without a substantial public outreach program describing why managers need harvest data.

Several large-scale resource development projects are being considered for northwest Alaska. Potential impacts of individual projects on caribou and users should not be evaluated individually. Instead, the cumulative effects of all existing and proposed development should be collectively considered over the short and long term to predict impacts on caribou. Additionally, social impacts from expanding roads into historically remote, traditional subsistence areas must be considered. Preliminary analyses strongly suggest that roads significantly alter the herd movements in some years. The mechanisms for this and their biological impacts on caribou are still not understood. Even so, the impact on subsistence users and other hunters from delayed or diverted caribou migrations could be serious. Additionally, it has long been clear that subsistence harvests are significantly lower near road systems than away from them (Wolfe and Walker 1987). The social impacts of establishing new roads into previously remote areas should be a primary consideration when deciding whether to build new roads within the range of the herd.

Despite efforts to keep caribou regulations as simple, consistent, and understandable as possible during the March 2015 BOG meeting, the Federal Subsistence Board subsequently created federal caribou regulations that differ substantially from those of the state. The complexity of inconsistent state and federal regulations will probably confuse many hunters and could lead to citations when they unknowingly break state or federal laws. Ultimately, this will not facilitate a spirit of cooperation between managers and the public, nor will it help conserve caribou. It should be possible to promulgate at least very similar—if not completely consistent—state and federal caribou regulations; both sides are dealing with the same caribou herd on adjoining lands used by the same people. A major challenge now facing managers is to reconcile differences in state and federal regulations to make them fair, effective, and understandable to the hunting public.

During 2014 and early 2015, department staff conducted an extensive and intensive public outreach campaign in Units 22, 23, 26A, and Anaktuvuk Pass to inform people of the population status of WAH and TCH and to initiate discussion on how to begin reducing harvests from these herds. If WAH continues to decline, this level of outreach is going to become a necessity, perhaps on an annual basis, if managers hope to have public support for and compliance with regulatory restrictions and harvest reporting requirements. Throughout these public meetings, a frequently repeated comment was that managers cannot simply reduce harvests to stop or reverse the decline in WAH caribou numbers; they must reduce numbers of wolves and brown bears as well. Given the size and remoteness of the herd range and the presence of large tracts of NPS and U.S. Fish and Wildlife Service lands where predator control is prohibited, a state-administered predator control program could be challenging. Even so, if the state hopes to work cooperatively with the public in addressing the herd's population decline, a meaningful attempt to at least reduce the impact of predators on this herd may be necessary even if the intensive management review process deems it infeasible. There is no terrestrial wildlife population in northwest Alaska more important to subsistence users, nonlocal hunters, or commercial operators than WAH. It will be imperative that managers work with the public in managing this herd through this decline.

II. Project Review and RY17–RY21 Plan

Review of Management Direction

Management Direction

No change from RY12–RY16.

Goals

No change from RY12–RY16.

Codified Objectives

Amounts Reasonably Necessary for Subsistence Uses

The herd has a positive C&T use finding. The ANS (5 AAC 99.025) in this herd is unusual in that it is combined with the adjacent TCH. The combined WAH-TCH ANS range is 8,000–12,000 caribou.

Intensive Management

The herd is recognized as an IM population. The board established the IM population objective for the herd as at least 200,000 caribou and the harvest objective as 12,000–20,000 caribou (5 AAC 92.108). Unlike the ANS, the IM objectives for WAH are independent of TCH.

Management Objectives

No change from RY12–RY16. The herd is managed based on the codified population objectives established by the board.

Review of Management Activities

1. Population Status and Trend

ACTIVITY 1.1. Determine population size and trend of the herd at least every 3 years.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. The authors recommend that abundance estimates continue to use the APDCE method and Rivest estimator along with new technologies and techniques used during the 2017 census. The new cameras and counting tools have proven to be more efficient and likely more accurate than the previous system, which used printed black-and-white photographs.

ACTIVITY 1.2. Estimate harvestable surplus based on abundance, trend in abundance, and other demographic contexts.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. Efforts should be made to establish socially acceptable and biologically meaningful harvest levels for bulls and cows separately under different population levels. For instance, the harvest prescription could call for the harvest of up to 15% of bulls and

1–2% of cows in the herd. This will likely become necessary if the population ever falls below the IM objective and the minimum recommended harvest rate of 6% is not sustainable.

ACTIVITY 1.3. Capture and collar adult caribou annually to maintain a sample of 100 active collars by the end of the regulatory year.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. Overall, the collaring of adults at Onion Portage has been a successful approach for deploying collars used to monitor the herd. The practice receives general support from local communities and should be continued. Deploy collars only within the 148.000–154.000 megahertz range.

ACTIVITY 1.4. Determine parturition rates and sites through an annual calving survey.

Data Needs

No change from RY12–RY16.

Methods

No change from RY12–RY16.

ACTIVITY 1.5. Determine population composition through fall survey.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. Consider tradeoffs between an arbitrarily large sample size and a spatially representative sample of the herd. Compare calf survival estimates to spring recruitment rates. Move to a 5-year schedule for composition surveys unless the population falls below 230,000 caribou. Surveys may be conducted at 1–2-year intervals when needed to calculate sex-specific harvestable surplus to establish a relationship between harvest, regulations, and herd composition.

ACTIVITY 1.6. Estimate annual recruitment with short-yearling surveys.

Data Needs

No change from RY12–RY16.

Methods

No change from RY12–RY16.

ACTIVITY 1.7. Evaluate trends in body condition through calf weights.

Data Needs

No change from RY12–RY16.

Methods

No change from RY12–RY16.

ACTIVITY 1.8. Determine the seasonal range of the herd by use of radiotelemetry and satellite collar location data.

Data Needs

No change from RY12–RY16.

Methods

No change from RY12–RY16.

ACTIVITY 1.9. Estimate rates and causes of mortality.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. Estimate female harvest rate as a function of the overall mortality rate of collared cows and the proportion attributed to hunting. Establish a baseline for neonate survival for the herd from birth to 1 year and evaluate cause-specific mortality to better understand calf survival and recruitment. Evaluate the role of body condition and dam condition in overwinter survival.

ACTIVITY 1.10. Conduct disease and parasite surveillance.

Data Needs

No change from RY12–RY16.

Methods

Modify the RY12–RY16 methods. While there were several reasons to suspend aspects of disease surveillance over the report period, some of these challenges, such as sample storage in the field and opportunity for sample analysis, could be overcome. Moving forward, a more structured health assessment could have merit for continued long-term monitoring of herd health, especially as it may relate to population trend.

Through a more structured health assessment program, we aim to revitalize the monitoring of haptoglobin levels as a broad approach for detecting disease. This includes a more comprehensive comparison of continuous haptoglobin levels (as opposed to a binary designation of *elevated*); active infections; exposure to other infectious diseases, parasite loads, body condition; and subsequent fitness (i.e., survival and parturition). Additionally, we aim to continue monitoring brucellosis and its relationship to fitness while evaluating other genetic markers for inflammation and disease.

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Estimate annual caribou harvest.

Data Needs

No change from RY12–RY16.

Methods

Modify. It is recommended that the transition to the registration permit reporting system be encouraged for all Alaska residents that hunt the herd. Failure to collect more complete harvest data continues to challenge the department's ability to make sound management recommendations. It could be argued that in years of abundance, the collection of harvest data is less important; however, the implementation of a permit of this magnitude takes time and cannot simply be turned on or off depending on the population trajectory of this herd. It is also important to establish and understand harvest trends at all population levels and refer to past management plans.

3. Habitat Assessment-Enhancement

There are no plans for habitat assessment or enhancement activities during RY17–RY21.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

No change from RY12–RY16.

Agreements

No change from RY12–RY16.

Permitting

No change from RY12–RY16.

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