

SPECIES
MANAGEMENT REPORT

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CHAPTER 17: CARIBOU MANAGEMENT REPORT

From: 1 July 2012

To: 30 June 2014¹

LOCATION

GAME MANAGEMENT UNIT: 26A (56,000 mi²)

HERD: Teshekpuk

GEOGRAPHIC DESCRIPTION: Western North Slope

BACKGROUND

Archeological and traditional knowledge suggest that caribou have been abundant near Teshekpuk Lake for at least the last 400 years (Silva et al. 1985). Currently, the Teshekpuk caribou herd (TCH) is an important subsistence resource for hunters from several North Slope villages. In recent years, the average per capita harvest of caribou by North Slope communities within the TCH range was estimated at 0.9 caribou per person; most caribou harvested are from the TCH (Carroll 2007).

Based on a calving distribution that was geographically distinct from the adjacent Western Arctic and Central Arctic herds (WAH and CAH), the TCH was first identified as a distinct herd in 1978 (Davis and Valkenburg 1978). The TCH primarily inhabits the central coastal plain north of the Brooks Range during spring and summer, but has a large historical range, encompassing wintering areas across northwestern Alaska (Fig. 1).

Visual counts between 1978 and 1982 indicated that approximately 4,000 caribou used the area near Teshekpuk Lake during post-calving aggregations (Davis et al. 1979, Reynolds 1981, Silva et al. 1985). In 1984, a minimum population of 11,822 was estimated using post-calving aggregation photography (Davis et al. 1979, Carroll 1992). Growth continued until at least 2008, when the TCH was estimated at more than 68,000 individuals (Parrett 2011). The exponential growth rate was 7.0% between 1984 and 2008, based on minimum count estimates (Table 1). The next abundance estimate in 2011 showed a 19% decline in abundance to approximately 55,000 (Parrett 2013).

Starting in 1990, cooperative efforts between the North Slope Borough (NSB), U.S. Bureau of Land Management (BLM), and Alaska Department of Fish and Game (ADF&G) led to extensive deployments of satellite collars in the TCH. Major findings include the demonstration of high fidelity to calving areas surrounding Teshekpuk Lake, extensive use of coastal habitats between Cape Halkett and Barrow for insect relief, broad use of the coastal plain west of the Colville

¹ This report contains data collected outside the report period at the discretion of the reporting biologist.

drainage in late summer, and highly variable use of winter ranges. Overlap of the TCH with the WAH and CAH can be extensive during fall and winter. These data have been summarized in multiple publications (Philo et al. 1993, Prichard et al. 2001, Person et al. 2007, Yokel et al. 2009, Wilson et al. 2012, Parrett 2013, Prichard et al. 2014).

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Provide for subsistence and other hunting opportunity on a sustained yield basis.
- Ensure adequate habitat exists to maintain the TCH.
- Provide for viewing and other uses of caribou.

MANAGEMENT OBJECTIVES

- Encourage cooperative management of the herd and its habitats among state, federal, and local entities and all users of the herd.
- Develop a better understanding of relationships and interactions among North Slope caribou herds.
- Monitor herd characteristics and population parameters (on an annual or regular basis).
- Attempt to maintain a minimum population of 15,000 caribou, recognizing that caribou numbers naturally fluctuate.
- Maintain a harvest level of 900–2,800 caribou using strategies adapted to population levels and trends.
- Maintain a population composed of at least 30 bulls per 100 cows.
- Seek to minimize conflicts between resource development and TCH.

MANAGEMENT ACTIVITIES

- Determine the population size of the herd every 2–3 years.
- Monitor recruitment and calf production through late winter recruitment and summer calving-ground surveys each year.
- Define seasonal habitat areas, such as calving, insect relief, and wintering areas.
- Identify and map the movements and distribution of the herd throughout the year using aerial survey, radiotelemetry, and satellite telemetry data.
- Encourage local participation in research and management decisions.
- Work with the North Slope Borough and the ADF&G Subsistence Division to collect harvest information.

- Determine the sources and timing of mortality in adult and calf caribou.
- Monitor mortality events through radiotelemetry, field observations, and sample collection.
- Work with management agencies, oil companies, and caribou users to minimize conflicts between the herd and major exploration and development projects.
- Maintain a sample size of at least 70 collared females. Capture caribou without the use of immobilization drugs.
- Monitor disease, parasite, contaminant, and body condition levels.
- Involve students in caribou research operations, work with students to track satellite-collared caribou movements, and lecture to school classes about caribou biology.

METHODS

POPULATION STATUS AND TREND

Population Size

Since 1984, we have used the aerial photo-direct count extrapolation technique (Davis et al. 1979), known more commonly as a “photo census,” to estimate the minimum population size of the TCH. Starting in 2011, and used retroactively where data were available, we used methods outlined by Rivest et al. (1998) for producing estimates of abundance and associated variance that account for caribou in groups that do not contain radio collars, as well as protocols for expanding estimates to account for missing collars. This method can also assess the randomness assumption that is inherent to the overall methodology, but notably it is incapable of dealing with variation in photo quality that sometimes causes a large negative bias in the number of observable caribou. This method may also be a useful tool to quantify the mixing of caribou herds during photocensus photography, as caribou that are associated with a different herd at the time of photography can be treated as missing, and the number of caribou that a collar represents can be estimated separately; this adaptation of the technique now has two-way utility, as the number of added caribou from another herd can be explicitly estimated (Brian Taras, ADF&G biometrician, personal communication).

A photo census was completed on 16 July 2013. A Cessna 182 aircraft with telemetry equipment was used to search for radiocollared caribou while TCH caribou were in insect relief aggregations. A DeHavilland Beaver (DHC-2) aircraft was directed toward groups for photography. Photographs were taken with a floor-mounted Zeiss RMK-A camera. The software program “Photoman” (Rob DeLong, ADF&G analyst/programmer, Fairbanks, Alaska) was used to ensure adequate endlap and sidelap of sequential images during photography and accurate photo layout prior to counting. Immediately following photography, we radiotracked over the area to listen for WAH and CAH collars. There were 181 black and white 9x9-inch photographs developed and printed by HAS Images (Dayton, Ohio) and subsequently used in photo layout. Photo layout and drawing of overlap lines occurred in August 2013 and photographs were counted in October 2013 by a group of 5 staff, with 21% of the photos being recounted by a different individual.

Productivity, Recruitment, and Mortality Estimates

Each year we attempted to fly early June calving surveys every 1 to 3 days over most of the TCH range using telemetry equipment to relocate collared cows. Calving surveys were flown using a Cessna 182, 6–12 June 2013, and 6–10 June 2014. For each observation of a collared cow, we recorded the location using a Garmin Global Positioning System (GPS) receiver, the presence or absence of a calf, antler condition (hard, soft, or none) and presence or absence of a distended udder (Whitten 1995). Cows with soft antlers (covered with velvet) were determined to be nonparturient. We continued to observe collared cows through the end of the survey period, or until they were seen with a calf. We estimated parturition rate as the number of adult cows (≥ 3 years old) seen with a calf or observed with hard antlers or a distended udder (Whitten 1995) divided by the total number of adult cows. A second measure of productivity, termed the calving success rate, was estimated as the number of adult cows which still had a calf at the end of the survey period divided by the total number of adult cows.

Population composition was estimated using 2 methods of aerial survey, both based on focal animal sampling using collared animals. Fixed-wing surveys were completed using a Cessna 182, and helicopter surveys using a Robertson R-44 with a Piper PA-18 spotter plane radiotracking ahead of the helicopter. Autumn helicopter surveys were completed 20–21 October 2012 and 19–20 October 2013, while spring fixed-wing surveys were completed 13–14 April 2013 and 7–9 April 2014. Sampling rates to determine composition were based on the total count of collared animals within a 3–5 mile radius surrounding collared animals, but the rates differed by aerial technique. During fixed-wing composition surveys approximately 100 caribou per radio collar were sampled for composition, and during helicopter composition surveys approximately 200 caribou were sampled per radio collar. Calf:adult, calf:cow, and bull:cow ratios were calculated using cluster sampling methods (Cochran 1977). The long-term trend in short-yearling recruitment rate was analyzed using a weighted regression, weighting annual estimates by 1 over the estimated variance (Zar 1999).

Annual female mortality rate was estimated from the number of detected mortalities divided by the number of active collars on July 1, corresponding to the beginning of a 12-month collar year (CY) aligned with the approximate date when new collars were deployed each year. Very High Frequency (VHF) transmitters were tracked 10–15 times each year, primarily during calving, the insect relief season, rut, and late winter prior to spring migration. When analyzing trends in mortality, we did not use mortality data from collared caribou instrumented with satellite Platform Terminal Transmitters (PTT) from 1990 to 1998 because they appeared to have a much higher mortality rate than those carrying VHF-only collars, an observation supported in recent analyses from other herds (Rasiulis et al. 2014). Beginning in 2000, major reductions in the transmitter weight of PTTs appeared to eliminate the differential mortality rates; since then, we have used data from VHF, GPS, and PTT collars for mortality estimates.

The survival of a sample of 121 caribou with known ages was evaluated with a staggered-entry Kaplan–Meier survival curve. These caribou were captured as yearlings from 1990 through 2014. In addition to estimating annual survival rates, we investigated age-specific survival rates of these animals. This was achieved by comparing the sample proportion of living animals within a given year to another sample proportion of living animals within a different given year.

Capture, Health Assessments, and Body Condition

We captured yearling and adult caribou using a hand-held net gun fired from a Robinson R44 helicopter and restrained them using hobbles, ropes, and blindfolds. We collected blood, fecal, and hair samples and took morphometric measurements, including weight, and made a subjective assessment of body condition (Gerhart et al. 1996). To account for within-year growth while assessing the potential for a long-term trend in capture weight of yearlings, we ran a linear mixed effects model, using Julian date and year as fixed effects, and year as a random effect to account for differences in the pattern of within-year growth by year. In June 2013, we hand-captured neonatal calves as part of a cooperative calf mortality study with BLM. An additional sample of calves was weighed in June 2014. Calves were weighed during capture, and we compared weights from those 2 capture events to weights of caribou captured in previous years, and from other herds.

Distribution and Movements

We received satellite-location data from the Service Argos Data Collection and Location System (ARGOS, www.argos-system.org/) in Landover, Maryland. Current locations from PTT and GPS collars were plotted periodically throughout the year using ArcMap 9.3 (ESRI, Redlands, CA). Further geospatial analyses of satellite-telemetry data were undertaken as part of the cooperative research program by ABR Inc.—Environmental Research & Services, under contract to BLM. In addition to receiving caribou locations from PTT and GPS collars, we completed periodic VHF radiotracking flights to collect information on caribou movements and distribution.

ArcMap was used to map calving period locations based on information collected during calving surveys. For cows seen with a calf, the location the cow was first seen with a calf was assumed to be the approximate calving location (Carroll et al. 2005). For cows that were not observed with a calf, the location nearest in time to the median calving date was used. To document historical use of calving grounds, we used calving locations documented from 1994 to 2012 to produce fixed kernel utilization distributions for each year using Kernel HR (Seaman et al. 1998, Griffith et al. 2002, Parrett 2007). Annual utilization distributions were produced using a 5-km grid, with least-squares cross-validation of bandwidth selection (Seaman et al. 1998). We then summed the observation densities at grid intersections across years and rescaled the densities to sum to one to produce a cumulative calving distribution that is unbiased with respect to annual sample size.

We did not update fall and spring migration using Brownian Bridge Movement Models (Horne et al. 2007, Sawyer et al. 2009). Previous estimates and detailed methods are included in the previous management report (Parrett 2013).

Winter distribution in 2013 and 2014 was estimated using a cumulative kernel based on a 5-km grid, similar to the cumulative calving distribution. Individual locations from satellite telemetry and VHF radiotracking surveys for short yearlings completed in early April were used to generate annual kernel estimates, with sample sizes of 37 and 34 caribou of both sexes, from 2013 and 2014, respectively. We estimated 75% volume contours for the cumulative kernel density utilization distribution. The late winter locations are appropriate to use for estimating generalized winter distribution because movement rates are so low in winter (Prichard et al.

2014), and spring migration does not start until 4 May for most individuals (median date of spring migration initiation, unpublished ADF&G data).

HARVEST

Harvest data are summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY12 = 1 July 2012–30 June 2013). Harvests during RY12 and RY13 were monitored through sealing and permit reporting processes, as well as through community harvest surveys conducted by ADF&G's Division of Subsistence.

Previous analyses have shown that the hunter registration and reporting system was not effective in estimating caribou harvest in communities within the range of the TCH (e.g., Georgette 1994). For at least the past 10 years, few hunters have registered with the department, and as a result no inquiries regarding harvest have been conducted using the registration system. Consequently, community harvest surveys have been used as an alternate method to quantify harvest; however, during this reporting period, no community harvest surveys were completed within the range of the TCH. Lacking recent estimates, we used average per-capita harvests from communities located in the core TCH range. We used the estimated harvest from past survey reports and the human population for the year of the estimate to calculate the per capita harvest, and then applied recent human population estimates from the Alaska Department of Commerce, Community, and Economic Development to the per capita harvest rate for each village to estimate the total caribou harvest for RY12 and RY13. Because some communities have access to caribou from more than one herd on an annual basis, we used previously estimated proportional herd harvest from specific communities based on harvest in relation to caribou distribution where spatially referenced harvest data and satellite telemetry caribou location data were concurrent (Parrett 2013)

Additionally, harvest by nonlocal hunters was determined through harvest ticket reporting, with proportional herd harvest estimated using knowledge of caribou distribution at the time of reported harvest to evaluate the likelihood that harvest came from the TCH or from an adjacent herd.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

From census photographs taken on 16 July 2013, we counted 32,629 caribou, distributed in 10 groups between Barrow and Harrison Bay. Of 77 collared adult caribou that were believed to be active, we located 59 during the 2013 photo census. Of the active caribou not located during the photocensus, 2 were known to be with the CAH at the time of the photo census, 8 were with the WAH, and an additional 8 were missing at the time of the photo census. Only 3 of the missing caribou were later found alive, but 5 others were heard in the month prior to the photocensus. During radiotracking in the hours following photography, we did not hear any WAH frequencies among TCH photocensus groups, however we did hear 2 CAH collars.

For the abundance estimate described by Rivest et al. (1998), random distribution of collars within the population is both necessary and testable. Because of this statistical necessity, we used and tested data sets that excluded recent collar deployments (adults and neonates since 2012) due

to anticipated unequal mixing and nonrandom distribution of collars in the herd. Despite attempts to satisfy this precaution by limiting data to collars deployed prior to 2013, the hypothesis of randomness was rejected ($P = 0.002$).

Rivest et al. (1998) provided 3 different models that varied in the assumptions associated with missing collars. The results of choosing different models vary substantially only if a relatively large proportion of collars are missing. Using the Rivest et al. (1998) homogeneity model, which assumes that all collars have an equal probability of being missing, the population estimate was 39,172 ($\pm 12\%$); however, this number includes an unknown number of CAH caribou, includes a large number of caribou associated with the WAH at the time of the photo census, and importantly, fails the assumption of randomness.

Only estimates used for management purposes have been reported here; however, multiple ways of analyzing the herd mixture and the variety of newly deployed collars were considered independently. The results from these supplemental analyses corroborate the Rivest analysis (above), indicating that the herd likely numbered 32,000–45,000 at the time of the photo census in 2013. The herd experienced an exponential growth rate (Johnson 1994) of 7% from 1984 to 2011, and an exponential rate of decline of 5.0% between 2008 and 2011 and 27% from 2011 to 2013 (Table 1).

Productivity, Recruitment, and Mortality Estimates

Parturition Surveys. In 2013, we monitored 36 adult cows in early June. The parturition rate was 61%, and calving success was 44%. In 2014, we monitored 32 adult cows during the calving period. The parturition rate was 28%, and calving success was 16%. Both parturition and calving success rates were lower in 2013 and 2014 than the long-term averages for parturition (72%, 2002–2012) and calving success (58%, 1999–2012; Table 2), consistent with a long-term trend in declining productivity. The parturition rate of 3-year old females was 71% ($n = 7$) in 2013 and 25% ($n = 4$) in 2014. Boertje et al. (2012) suggested that a prolonged rate (5-year running average) of 3-year-old parturition less than 55% was indicative of low nutritional status.

Fall composition counts. During surveys on 20–21 October 2012 we located 31 collared caribou, and classified 5,010 caribou in the vicinity of the collared animals. The proportion of bulls in the adult sample was 28% (26–31% 95% CI; bull:cow ratio 39:100; Table 3).

During surveys on 19–20 October 2013, we located 30 collared caribou, and classified 2,449 caribou in the vicinity of the collared animals. The proportion of bulls in the adult sample was 28% (22–34% 95% CI; bull:cow ratio 39:100; Table 3).

Short-yearling counts. On 13–14 April 2013, we located 25 collared caribou during spring recruitment surveys. We classified 3,566 caribou in the areas surrounding the collared animals and observed 12% short yearlings (10–13%, 95% CI) or 13 short yearlings:100 adults (Table 2).

On 7–10 April 2014, we located 28 collared caribou during spring recruitment surveys. We classified 2,614 caribou in the areas surrounding the collared animals and observed 13% short yearlings (9–17%, 95% CI) or 15 short yearlings:100 adults. The percentage of short yearlings in the spring composition counts has declined an average of 0.5% per year since 1990 ($p = 0.01$).

Mortality. Collar year 2012 (CY12; the 12-month collar year period beginning 1 July 2012) started with 65 collared females, the mortality rate was 32% (21–35%, 95% CI). CY13 started with 67 collared females and the mortality rate was 28% (18–41%, 95% CI). In both years, most of the mortality occurred in late winter and early spring. These mortality rates compare to a long-term average of 14.5% (1990–2011; Table 4). Although confidence intervals on mortality estimates are wide in any given year due to small sample sizes, they appear to provide a good index to mortality, and the running average for any 3 years is likely to provide a solid comparison for mortality rates exceeding the long-term average by more 10%.

The Kaplan-Meier curve indicated that survival declined steadily from 1 year of age through 10 years of age. The estimated probability of surviving up to 6 years of age was approximately 50% (Fig. 2, initial $n = 121$). Yearlings may survive at a lower rate than 2-year-olds, but the difference was not statistically significant (79% survival for yearlings, 95% CL 71–86%, $n = 121$; 90% survival for 2-year-olds, 95% CL 82–95%, $n = 82$).

Capture, Body Condition, and Calf Weights

Captures. During 26–28 June 2013 we captured 32 female caribou. Twenty-one were new captures, and 11 were recaptures. Eighteen VHF and 13 GPS collars were deployed on females. We captured 6 male caribou which were collared with PTT collars, and recaptured 2 yearling males to remove their calf collars.

During 25–28 June 2014 we captured 27 female caribou and 13 male caribou. Twenty-one were recaptures, and 19 were recaptures. Fifteen VHF, 7 PTT, and 11 GPS collars were deployed.

There was 1 capture mortality in 2013, and 0 in 2014.

Body Condition. A likelihood ratio test comparing models with and without year as a fixed effect indicated no support for the additional parameter ($\chi^2 = 0.15$, $p = 0.7$), indicating no long-term trend in yearling weights, with an average weight of 50.5 kg (SE = 1.3). This result may be in part due to the confounding effects of capture date and year. Early in the summer, daily weight gain appears to be high (0.6 kg/day). Concomitantly, since 1994, the overall trend has been for capture dates to occur earlier in the summer (range 20 June–7 July). Because capture dates have tended to occur earlier in the summer, particularly in recent years, reduced capture weights could be partially or wholly due to earlier capture dates. To best fit this model, a small number of captures ($n = 3$) that occurred in September were removed because they were highly influential in estimating the daily change in weights, and implied a curvilinear growth rate that would have been difficult to fit accurately given a lack of data in midsummer.

Calf Weights. Female calves weighed 5.5 kg ($n = 31$) and 5.8 kg ($n = 25$) in 2013 and 2014, respectively. These weights are lighter than previous average female weights from the TCH from 2006 through 2009 ($\bar{x} = 6.0$ kg, $n = 77$), and from the adjacent CAH from 2001 through 2005 (Arthur and Del Vecchio 2009; $\bar{x} = 6.6$ kg, $n = 266$). The mean weights from 2011 through 2014 are among the lightest ever recorded in North America (e.g., Couturier et al. 2009; Bergerud et al. 2008)

Distribution and Movements

General patterns of seasonal movement and the highly diverse wintering areas used by the TCH have been previously documented (Philo et al. 1993, Prichard et al. 2001, Carroll et al. 2005, Carroll 2007, Person et al. 2007, Parrett 2013). The TCH is unique among arctic coastal plain calving caribou in that a substantial proportion of caribou remain on the coastal plain through the winter in most years. Even with that relative consistency, the only times of the year when caribou are predictably distributed are during the insect season and late summer. Winter distribution can be highly variable, and even calving distribution can be unpredictable in some years. However, the 1994–2012 cumulative calving distribution shows the highest density calving area to be to in the areas north, east, and south of Teshekpuk Lake (Fig. 3). Caribou that winter near or with the CAH or WAH frequently calve with those herds, resulting in a broad cumulative calving distribution.

Summer range is typically bounded by the Colville River to the east and southeast, and extends to the southwest as far as a line from Umiat to Icy Cape. Coastal areas from Barrow to Cape Halkett are heavily used for insect relief from late June through early August, particularly the area north of Teshekpuk Lake. Although a few caribou temporarily diverge from the TCH and adopt the summer movement patterns of an adjacent herd, particularly after calving with them, fidelity by TCH caribou to summer range is very high. Adopting summer movement patterns of an adjacent herd is less common than simply sharing a calving range for the period surrounding parturition. The portions of the summer range used for insect relief are typically the coastal areas within 1–15 km of the Beaufort Sea coast. See Wilson et al. (2012) for examples of summer range and habitats used when insect harassment is high or low.

Fall migration routes are variable, as expected in a herd with highly variable wintering locations. Movements could be characterized into 3 broad categories: coastal plain movements that typify wintering concentrations near Nuiqsut, Wainwright and Atkasuk; southeasterly movements toward wintering areas in the central Brooks Range; and southwesterly movements along the Chukchi coast towards wintering areas in Unit 23. Other fall movements occur, but these 3 movement types are the most common (Parrett 2013). Of 314 total collar years (i.e., some individuals were repeated in multiple collar years), 92 (29%) were not defined as migratory based on the criteria used in Bunnefeld et al. (2011). Most nonmigratory individuals were characterized by nondirectional movements in the fall. Although this pattern was more typical for caribou that remained on the coastal plain, some individuals that moved away from the coastal plain were also characterized as nonmigratory because there was no distinct directional movement, but rather a long period of movement with very gradual increases in net distance away from post-calving habitats. In contrast, the migratory portion of the sample included many individuals that stayed on the coastal plain, but had a distinct movement from one portion of the coastal plain to another. This is a function of migration being primarily defined by directed movements, and less by the overall magnitude of movement in the technique described by Bunnefeld et al. (2011).

In previous years, there had been 4 relatively distinct wintering concentrations: the coastal plain between Atkasuk and Wainwright, the coastal plain west of Nuiqsut, the central Brooks Range, and shared winter range with the WAH in the Noatak, Kobuk, and Selawik drainages. In the

winters of 2012–2013 and 2013–2014, caribou were primarily concentrated near Atqasuk and Wainwright and to the east of Anaktuvuk Pass (Fig. 4).

Spring migration routes are variable, similar to those seen in fall, as would be expected for the return migration to the calving ground (Parrett 2013). A major difference is that the individual routes tend to be more direct and less consistent across individuals in the spring. This increased independence in individual movement along common routes results in population-level patterns that are more diffuse. In particular, caribou that migrated together along the coast in the fall were likely to move independently through the mountains and across the interior of the coastal plain in the spring.

HARVEST

Season and Bag Limit. The hunting seasons and bag limits were the same for both regulatory years of the reporting period.

<i>RY12 and RY13</i>	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit and Bag Limits		
<i>Unit 26A</i>		
Resident Hunters:		
5 caribou per day; cow caribou may not be taken	1 Jul–30 Jun	
16 May–30 Jun		
Nonresident Hunters:		
5 caribou total; cow caribou may not be taken		1 Jul–30 Jun
16 May–30 Jun.		

Board of Game Actions and Emergency Orders. There were no Board of Game actions or emergency orders associated with the TCH during the reporting period.

Human-Induced Mortality. It has been difficult to estimate TCH harvest because of poor to non-existent reporting, annual variation in community harvest survey effort and location, widely varying wintering distribution of the TCH, and overlapping distribution of adjacent herds within village harvest areas. Typically, annual harvests by communities come from more than one herd, although the proportions can be strongly skewed toward one herd or another. Results from previous analyses of proportional harvest from different herds indicate that caribou harvested by Barrow residents have almost exclusively been from the TCH, at least during the period 2002 through 2007 (Parrett 2013). Harvest in Atqasuk had a smaller proportion of unknown-herd harvest (14%), and was similarly dominated by TCH harvest; in contrast, Nuiqsut harvest did include an estimated 11% directly attributable to the CAH (Parrett 2013).

Using per capita harvest rates and recent population levels for villages within the primary range of the TCH, we estimate that approximately 3,387 TCH caribou were harvested in each of RY12

and RY13 (Tables 5 and 6). The harvest rate from the TCH based on these per capita estimates was approximately 6% of the 2011 population estimate, but 10% of the 2013 population estimate.

With respect to harvest that occurs outside of Unit 26A, some low level of harvest likely occurs in Units 23, 24 and 26B. Given the low levels of harvest in winter in the latter units, as well as seasonal overlap with adjacent herds, it is unlikely that the overall TCH harvest is significant when mixed with other herds. Given the high level of overall harvest that occurs in Unit 23, some harvest there is possible, but is likely overwhelmed by the much greater number of WAH caribou in that unit (Parrett 2013).

Permit Hunts. There were no permit hunts for caribou in Unit 26A during the reporting period.

Hunter Residency and Success. Most TCH harvest is from local hunters because the area is remote and largely inaccessible to nonlocal hunters. Nonlocal resident and nonresident hunters took a small proportion of TCH caribou, primarily from the Colville River drainage. Since the vast majority of nonlocal harvest is actually from the WAH (Parrett 2013), we did not report sub-unit specific harvest, success rates, or residency. In the past, the total number of caribou harvested by nonlocal hunters has averaged around 100 caribou per year, with nonlocal hunters typically been split evenly between nonlocal resident and nonresident hunters (Parrett 2013).

Harvest Chronology. Caribou are harvested throughout the year, but most harvest by local residents occurred from July through October in recent years (Braem et al. 2011, Parrett 2011). Nonresidents and nonlocal residents harvested more than 95% of their caribou in August and September in both RY12 and RY13.

Transport Methods. Caribou hunters in Unit 26A used a wide variety of transport methods. Most residents of the unit used boats and all-terrain vehicles (ATVs) during July, August, and September; they used snowmobiles during the remainder of the year. Some use of aircraft occurs throughout the year, primarily by nonlocal residents and nonresidents, of whom the majority use aircraft to hunt caribou. Hunters occasionally used highway vehicles when caribou moved near the limited local road systems, particularly the gas-well road near Barrow. Some additional harvest of TCH caribou occurs in Unit 26B along the Dalton Highway by hunters using dog teams or highway vehicles for access.

HABITAT

Assessment

Results of satellite telemetry studies (Philo et al. 1993; Prichard et al. 2001, Person et al. 2007, Wilson et al. 2012), VHF radiotracking flights (Kelleyhouse 2001, Carroll et al. 2005, Parrett 2007), and composition surveys have indicated that the areas around Teshekpuk Lake, particularly south, east, and north of the lake, have historically been the highest density calving areas used by the TCH. Additionally, the area to the north of the lake is used intensively for insect relief and grazing (Parrett 2007, Wilson et al. 2012), and the narrow corridors of land to the east and northwest of the lake are important migratory pathways to and from the insect relief area (Yokel et al. 2009).

In 1997 BLM began a process of opening the National Petroleum Reserve–Alaska (NPR-A), which encompasses much of the TCH range, to oil exploration and development. The first area to be considered was a 4.8-million-acre planning area in the northeast corner of NPR-A, which includes important TCH calving, insect relief, grazing, and migration areas located near Teshekpuk Lake. After a compilation and review of the available data and many public meetings, it was decided that 87% of the planning area would be available for oil and gas leasing. In recognition of the importance of the land around Teshekpuk Lake as crucial habitat for caribou and geese, much of it was protected. No leasing was allowed in the area north and east of the lake, and no surface structures were allowed in a strip of land to the west and south of Teshekpuk Lake and around the Kogru River (BLM 1998). BLM revised this plan in 2005, and again in 2008 and in 2013 (BLM 2005, BLM 2008a, BLM 2013). In 2008, the plan made 90% of the 4.4-million-acre planning area available to leasing, with a 10-year deferral on the remaining 430,000 acres, which included a large proportion of the concentrated calving area, caribou insect relief areas, and important waterfowl and shorebird habitat (BLM 2008b). In the 2013 record of decision, much of the additional area opened to leasing and exploration in 2008 was closed to leasing, including the areas surrounding Teshekpuk Lake used for calving and insect relief by the TCH, as well as some areas in southwestern NPR-A intended to preserve habitats used by the WAH (BLM 2013). Some areas deferred from leasing in previous plans retained those deferrals.

Enhancement

There were no habitat enhancement activities during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

The fate of important caribou habitats and the future of resource development in northeast NPR-A continue to be very important management issues in Unit 26A. They will be determined through an ongoing process involving public input, agency recommendations, and executive decisions. ADF&G will play an important role in providing information relative to this process.

CONCLUSIONS AND RECOMMENDATIONS

The 2013 population estimate of 32,000 caribou continues the decline first documented in 2011. Based on recruitment indices, adult mortality rates, and calf production, continued decline seems likely, particularly if vital rates are similar to the past 5 years. Much like the adjacent WAH in previous years, adult female mortality in the TCH over the past 2 years was a strong contributor to the recent decline, which increased from a 5% annual decline to a 27% annual decline.

While the lack of trend in yearling capture weights does not currently imply a density dependent nutritional problem in the herd, the tendency of caribou to move long distances and encounter a wide variety of habitats and habitat conditions makes timely detection of density dependent effects particularly problematic. Both parturition rate and calving success during the reporting period were two of the lowest observed in the history of TCH studies, continuing a downward trend in these indices of productivity. These metrics have been very variable over the long-term, making it difficult to detect changes in long-term trends.

There is a statistically significant, slowly declining trend in the short-yearling to adult ratio, perhaps an indication of density dependent recruitment. Preliminary information from the calf mortality study started in 2011 corroborates the highly elevated late winter-spring mortality and

suggests predation as the dominant proximal cause, although some calves do die from apparent starvation each spring.

It would be extremely helpful to document and confirm this long-term trend in declining recruitment through assessments of age structure via analysis of caribou jaws collected from hunter harvest. This management goal persists as a priority; however, we have had very little success establishing a program to receive jaws from local hunters.

Movement and range overlap between herds has been previously observed (Person et al. 2007) and continued through the reporting period. The potential for immigration to influence and inflate populations remains a possibility, evidenced by the occurrence of collared caribou from neighboring herds during abundance estimates. For many years, all movements observed had been emigration of the TCH into the adjacent WAH and CAH. In recent years, however, movement, both temporary and permanent, has occurred from the WAH and CAH into the TCH as well. As these large herds move through peak abundance, it is possible that more interchange will occur if prolonged density dependence induces caribou to seek new range. Documenting the rates of herd switching, both temporary and permanent, will increasingly become a management priority.

The current estimated harvest rate is approximately 10% of the current population. A 10% harvest rate was also estimated for 2002–2005, a period of high growth. The poor quality of harvest data makes it difficult to conclude that the herd actually sustained those high harvest levels; spatially explicit data are also needed, because the estimated harvest rate depends a great deal upon the ratio of WAH to TCH in the harvest. Nevertheless, the conservative estimate of 10% is still approximately twice the estimated harvest rates for the adjacent WAH and CAH, and may be unsustainable in a declining herd. This relatively high harvest emphasizes the importance of this herd as a subsistence resource and the importance of making sure that development activities do not reduce its productivity. Carroll (2007) reviewed important habitat use issues to be considered when developing land management plans for the NPR-A. At the heart of these issues is the potential for declines in caribou populations in response to impacts from development on calving and insect relief areas. Further research is needed to quantify this potential, particularly through research regarding fitness in relation to habitat use.

At this time, regulatory change may need to be initiated. Decreasing productivity and recruitment has likely resulted in an age structure dominated by older adults that exacerbated the effect of difficult winters, resulting in the observed population decline from 2008 to 2011. Future declines may be quite rapid if adult mortality rates remain high. Confirming the trend and magnitude of decline and estimating harvestable surplus in future composition (age structure) and population regimes will be priority issues in future reporting periods. The need for accurate harvest data is greater than ever.

Research and Management Recommendations

- Improve the probability of detecting emigration/immigration between herds. This may require increased sample sizes of marked animals, increased communication and shared radiotracking between herd managers, or some combination of both.

- Improve our understanding of how habitat influences calf survival and weight gain in areas historically used for calving and insect relief.
- Continue to monitor mortality rates of adult females and attempt to make timely investigations into the sources and timing of mortality. Improve our understanding of additive and compensatory mortality to guide future estimates of harvestable surplus.
- Improve harvest reporting; proactively attempt to improve hunter registration and reporting. If changes in harvestable surplus result in Tier I or Tier II allocation and reporting systems, preparing hunters for a change is extremely important.

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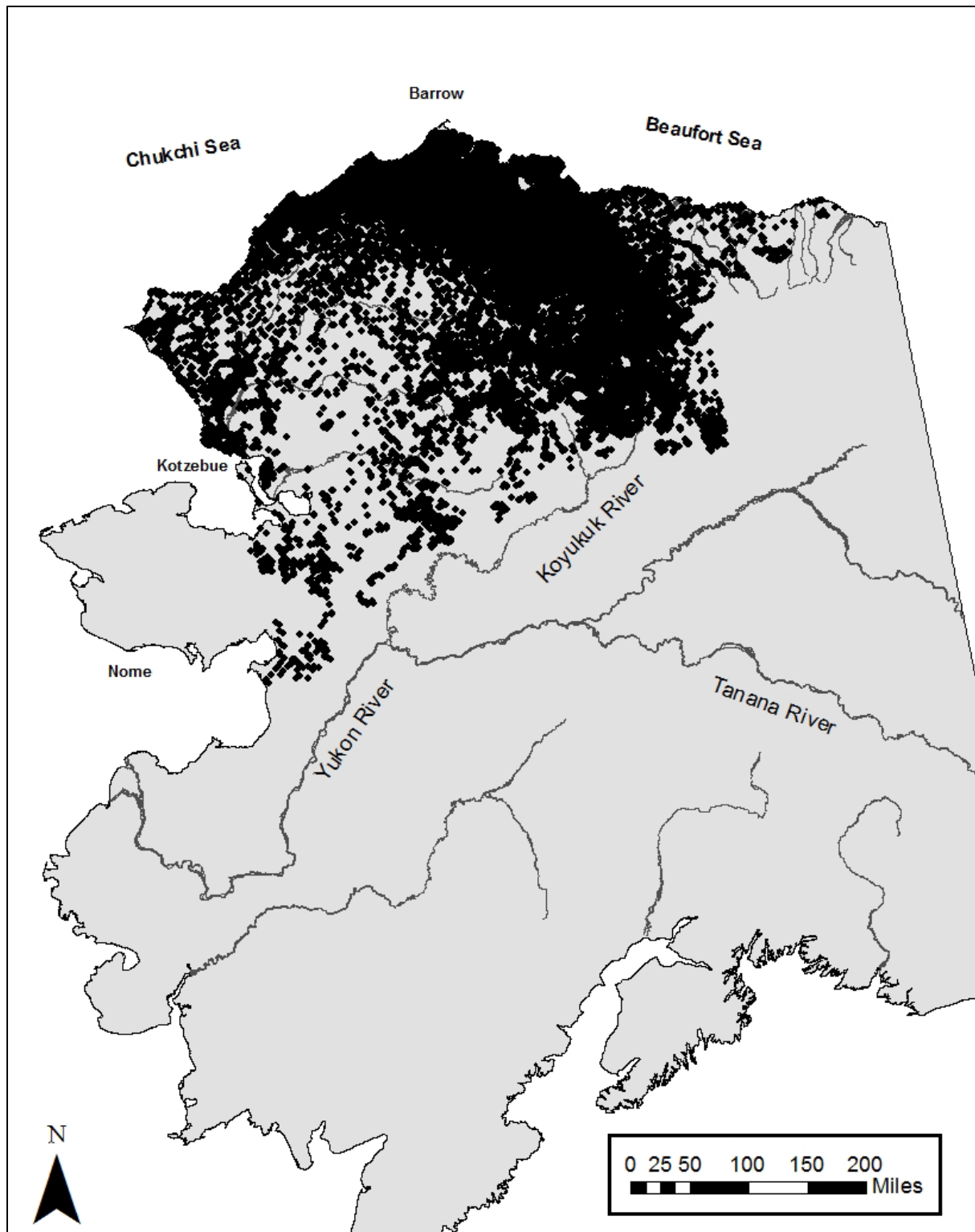


Figure 1. Locations of satellite-collared Teshekpuk caribou herd caribou (GPS and PTT), Alaska, 1990–2012. Locations were filtered for accuracy and the data set was reduced to no more than one location per-day per-caribou. These data come from collars purchased and deployed as part of a cooperative effort between ADF&G, BLM, North Slope Borough, and Conoco Phillips.

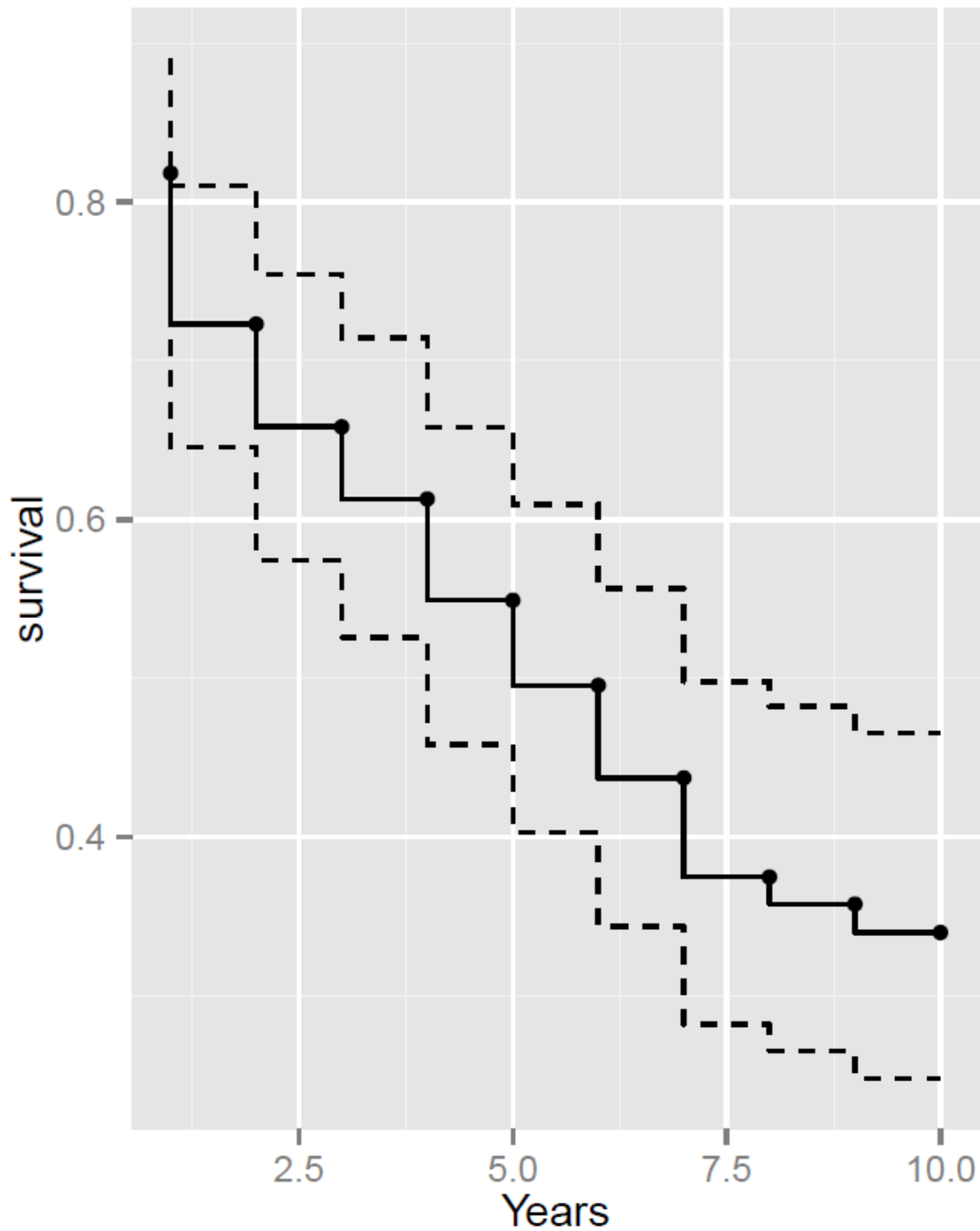


Figure 2. Kaplan-Meier Survival curve for Teshekpuk caribou herd female caribou, Alaska, initially captured as yearlings (13 month of age), and followed through 10 years of age.

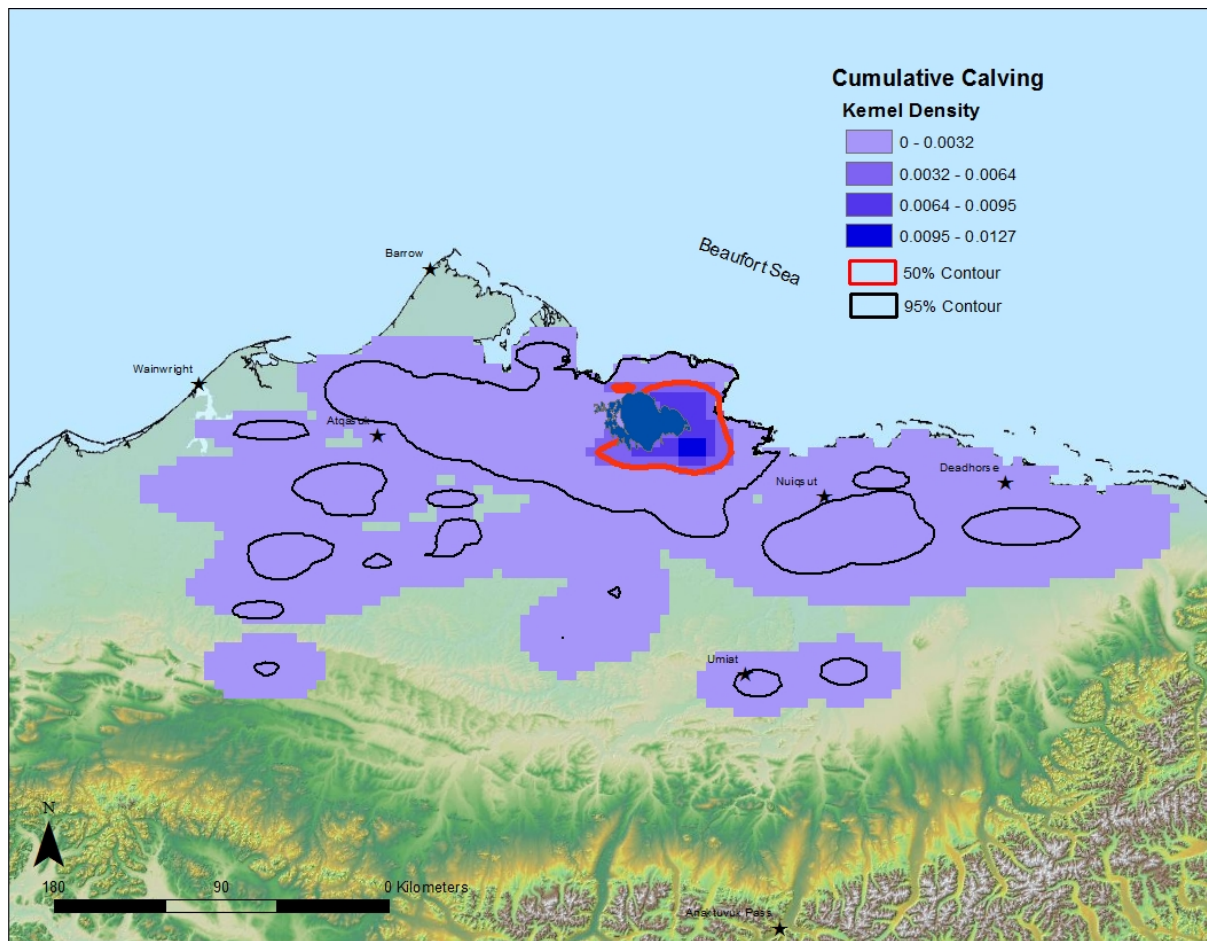


Figure 3. Cumulative calving distribution of the Teshekpuk caribou herd (TCH), Alaska, 1994–2012. Annual kernel density estimates were averaged using a static 5-km grid as the basis for comparison, using locations of parturient collared caribou to generate the utilization distribution. This estimate is unbiased with respect to annual sample size. Occasional use of Central Arctic herd and WAH calving grounds is depicted by the farthest east and southwest extent of calving. Historically, the highest density of calving TCH caribou has been within 30 km of Teshekpuk Lake.

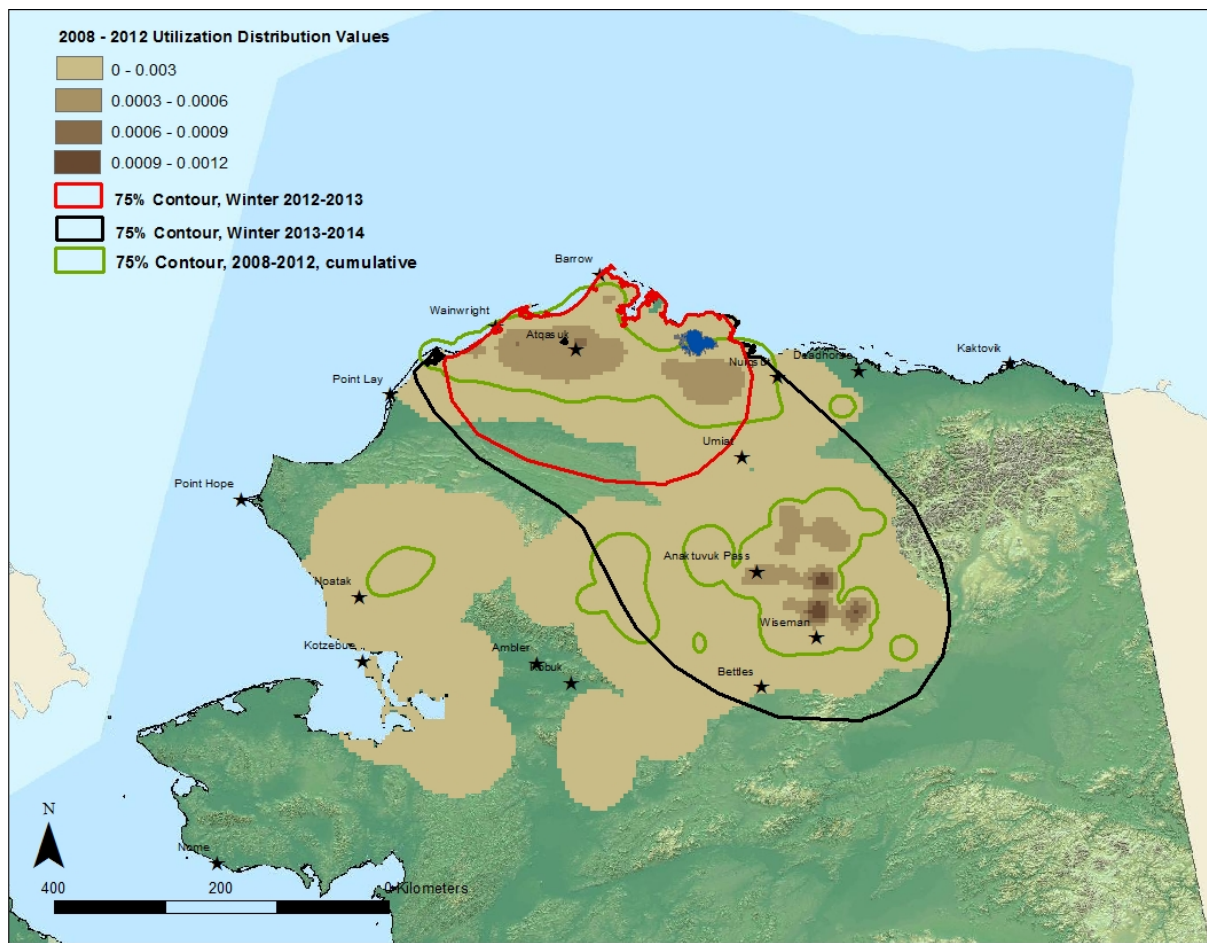


Figure 4. Cumulative Teshekpuk caribou herd winter range, Alaska, 2008–2012, with utilization distribution values depicted in shades of brown, and 75% kernel contour from the 2008–2012 winter in green. The 75% kernel contours from the 2 individual winters from this reporting period (2012–2013 and 2013–2014) are depicted by red and black outlines.

Table 1. Population estimates and exponential growth rates of the Teshekpuk caribou herd, Alaska, 1978–2013.

Year	Minimum population estimate	Population estimate (% SE) ^a	<i>r</i> (%) ^b
1978–1982	3,000–4,000 ^c	N/A	N/A
1984	11,822 ^d	18,292 (44%)	N/A
1985	13,406 ^c	N/A	N/A
1989	16,649 ^d	19,724 (33%)	6.8%
1993	27,686 ^d	41,800 (26%)	12.7%
1995	25,076 ^d	32,839 (34%)	-5.0%
1999	28,627 ^d	N/A	3.3%
2002	45,166 ^d	51,783 (11%)	15.2 ^e
2008	64,106 ^d	68,932 (10%)	5.8%
2011	52,673 ^f	55,704 (5%) ^g	-5.0%
2013	32,629 ^f	39,172 (15%)	-27%

^a Population estimate derived only from photographed groups that included radiocollared caribou, with expansions to account for missing collars and groups of caribou with no marked caribou as described by Rivest et al. (1998); in some years the data was not collected in such a manner as to allow an estimate.

^b $r = (\ln(N_2) - \ln(N_1)) / t$, where t = number of years between censuses, N = population estimated at time t .

^c Derived from visual estimate.

^d Derived using aerial photocensus minimum count.

^e It is unlikely that the herd increased at this rate. The 1999 count was probably an underestimation, and the herd had increased since 1995.

^f Minimum count includes an unknown number of Central Arctic herd (CAH) caribou.

^g This estimate is based on the number of caribou estimated using only collars deployed prior to 2011, with an estimated 3,687 CAH caribou removed from that estimate. SE was calculated from the original estimate, and biased low as a result, because it accounts for no error associated with estimating the number of CAH caribou. Note that the 2013 estimate was not corrected in a similar fashion, despite the inclusion of CAH collared caribou in the photo census.

Table 2. Teshekpuk caribou herd, Alaska, calving and short-yearling survey results, 1999–2014^a.

Year	Calving surveys (June)			Short-yearling surveys (April)			
	Cows observed	Parturition ^b (%)	Live calves ^c (%)	<i>N</i>	Short yearlings: 100 adults	Short yearlings (%)	95% confidence limits ^d
1999	36	–	67	2,040	27	21	13–25%
2000	29	–	85	1,985	25	20	14–26%
2001	36	–	44	1,369	17	15	7–22%
2002	32	94	71	2,270	10	9	7–11%
2003	34	94	65	2,141	26	20	15–26%
2004	36	58	48	2,692	22	18	11–23%
2005	30	73	56	1,564	9	8	0–16%
2006	40	88	82	2,177	20	16	11–22%
2007	48	69	60	2,357	23	19	15–23%
2008	42	74	67	3,718	19	16	13–19%
2009	48	50	40	4,491	14	13	11–14%
2010	47	74	47	4,102	15	13	11–16%
2011	46	59	41	3,653	13	12	10–14%
2012 ^e	45	60	42				
2013	36	61	44	3,566	13	12	10–13%
2014	32	28	16	2,614	15	13	9–17%
AVERAGE	39	68	55	2,658	18	15	

^a Data from 1990-1998 included in previous reports; see Parrett (2013).^b Number of collared cows with calf + collared cows with no calf with but hard antler or udder / number of mature collared cows observed.^c Number of collared cows with live calves at the end of calving surveys / number of mature collared cows observed.^d Calculated based on Cochran's cluster sampling method (1977). Cluster data unavailable for 1990–1992, 1994, 1997–1998.^e No spring short-yearling estimate was derived for 2012 due to extensive herd mixing and poor spatial coverage of the samples.

Table 3. Teshekpuk caribou herd, Alaska, fall composition counts, 2009–2013^a.

Year	Helicopter surveys				
	Bulls:100 Cows	% Bulls ^b (95% CI)	Calves:100 Cows	% Calves (95% CI)	<i>N</i>
2009	46	36 (26–37)	18	11 (10–12)	6,576
2010	46	32 (29–35)	29	17 (15–19)	1,208
2011	–	–	–	–	–
2012	39	28 (26–31)	35	21 (18–25)	5,010
2013	39	28 (22–34)	34	20 (17–23)	2,449

^a From 2009 onward, the helicopter survey took place in October, during rut; previous results of fixed-wing composition and July-timed surveys are reported elsewhere (Parrett 2013).

^b Percent bulls is the percentage of total adults, not the total of all caribou observed.

Table 4. Annual mortality of adult female radiocollared Teshekpuk caribou, Alaska, 2000–2014^a.

Collar year ^b	Sample Size ^c	Mortalities ^d	Mortality rate ^e (%)	95% Binomial confidence, %
2000–2001 ^f	45	5	11	5–24%
2001–2002	40	7	17	9–32%
2002–2003	36	4	11	4–25%
2003–2004	52	13	25	15–38%
2004–2005	46	8	17	9–31%
2005–2006	43	4	9	4–22%
2006–2007	60	5	8	4–18%
2007–2008	55	10	18	10–30%
2008–2009	61	8	13	7–24%
2009–2010	65	10	15	9–26%
2010–2011	68	13	19	11–31%
2011–2012	66	8	12	6–23%
2012–2013	65	21	32	21–45%
2013–2014	67	19	28	18–41%
Average			16.8	

^a Data for years prior to 2000–2001 can be found in Parrett (2013).

^b Collar year defined as 1 July–30 June.

^c Sample size = the total number of active radio collars at the beginning of the collar year.

^d Number of radiocollared caribou that died during the collar year.

^e Mortality rate = Known Mortalities/ Number of Active Female Collars.

^f Beginning in 2000–2001, caribou that were collared with PTT, GPS, or VHF radio collars were used in the analysis. Before 2000–2001 only VHF-collared caribou were used.

Table 5. Summary of community-based harvest assessments for communities within the range of the Teshekpuk caribou herd, Alaska, 1985–2007.

Community	Survey year	Human population	Average	
			No. caribou harvested/yr	Harvest information reference
Anaktuvuk Pass	1990	314	592	Pedersen and Opie 1990
Anaktuvuk Pass	1991	272	545	Pedersen and Opie 1991
Anaktuvuk Pass	1992	270	566	Fuller and George 1997
Anaktuvuk Pass	1993	318	574	Pedersen and Opie 1993
Anaktuvuk Pass	1994–1995	318	322	Brower and Opie 1996
Anaktuvuk Pass	2006–2007	277	697	Pedersen (pers. comm.)
Atqasuk	1994–1995	237	262	Hepa et al. 1997
Atqasuk	2002–2006	228	198	Braem et al. 2011
Barrow	1987–1989	3,016	1,595	Braund et al. 1991
Barrow	1992	3,908	1,993	Fuller and George 1997
Barrow	1995, 1996, 1999, 2000, 2003	4,378	2117	Bacon et al. 2009
Barrow	2002–2006	4,581	4,478	Braem et al. 2011
Nuiqsut	1985	337	513	Pedersen 1995
Nuiqsut	1992	418	278	Fuller and George 1997
Nuiqsut	1993	361	672	Pedersen 1995
Nuiqsut	1994–1995	418	258	Brower and Opie 1997
Nuiqsut	1999–2000	468	413	Pedersen 2001
Nuiqsut	2000–2001	468	600	Pedersen (pers. comm.)
Nuiqsut	2002–2006	433	398	Braem et al. 2011
Point Lay	1987	121	157	Pedersen 1989
Point Hope	1992	699	225	Fuller and George 1997
Wainwright	1988	506	505	Braund et al. 1993
Wainwright	1989	468	711	Braund et al. 1993
Wainwright	1992	584	748	Fuller and George 1997

Table 6. Estimated annual harvest of Teshekpuk herd caribou, Alaska, by residents living within Unit 26A during regulatory years^a (RY) RY12 and RY13.

Community	Human population ^a	Per capita caribou harvest	Approximate total community harvest ^a	Approximate % TCH in harvest	Estimated average annual TCH caribou harvest	Assessments used to estimate per capita caribou harvest ^b
Anaktuvuk Pass	331	1.8	582	30	174	Anak. Pass 1990–1995
Atqasuk	234	0.9	215	98	210	Atqasuk 2002-2007
Barrow	4,290	0.5	2,145	97	2,123	Barrow 1992, 1995, 1996, 1999, 2000, 2002
Nuiqsut	411	1.1	468	86	403	Nuiqsut 2002-2007
Point Lay	191	1.3	247	20	49	Pt. Lay 1987
Wainwright	559	1.3	710	60	426	Wainwright 1988, 1989, 1992
Total Harvest			4,582		3,387	

^a Population estimates averaged from the 2010 U.S. Census and 2012 Alaska Department of Commerce, Division of Community and Regional Affairs data.

^b Citations associated with each harvest assessment are in Table 5.