WILDLIFE

MANAGEMENT REPORT

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CARIBOU MANAGEMENT REPORT

From: 1 July 2002
To: 30 June 2004[a]

LOCATION

GAME MANAGEMENT UNIT: 21D, 22A, 22B, 22C, 22D, 22E, 23, 24 and 26A

HERD: Western Arctic

GEOGRAPHIC DESCRIPTION: Northwest Alaska

BACKGROUND

The Western Arctic Caribou Herd (WAH) ranges over approximately 140,000 mi^2 (363,000 km^2) of northwestern Alaska (Figs 1–3). Summer range encompasses the calving grounds and consists of the Brooks Range and its northern foothills west of the trans-Alaska pipeline. In most years during the mid 1980s through 1995 much of the WAH wintered in the Nulato Hills as far south as the Unalakleet River drainage. In many years since 1996 the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula. Since the mid 1990s, this herd has generally been more dispersed during winter than prior to that time.

In 1970 the WAH numbered approximately 242,000 caribou (Fig 4). By 1976 it had declined to about 75,000 animals. From 1976 to 1990 the WAH grew 13% annually, and from 1990 to 2003 it grew 1–3% annually. In 2003 the WAH numbered $\geq$490,000 caribou, and density over its total range was 3.5 caribou/mi^2 (1.3 caribou/km^2). This figure is misleading, though, because caribou exhibit a "clumped" distribution in both space and time. Seasonal densities provide a more useful measure for evaluating effects of density on range and on individual caribou. For example, during the 2003 census, 99% of the WAH (486,000 of 490,000 caribou) was on summer range for a density of 11.2 caribou/mi^2. However, caribou were extremely aggregated during the first 2–3 weeks of July and were distributed over <25% of their total summer range. Therefore, seasonal densities only reduce rather than correct for the effects of clumping behavior on annual and seasonal density estimates.

[a] This report also contains information collected outside the reporting period at the discretion of the reporting biologist.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect and maintain the WAH and its habitat.
- Provide for subsistence and recreational hunting on a sustained yield basis.
- Provide for viewing and other uses of caribou.
- Perpetuate associated wildlife populations, including carnivores.

MANAGEMENT OBJECTIVES

The following management objectives compose the 7 basic elements of the Western Arctic Caribou Herd Cooperative Management Plan (2003):

- Encourage cooperative management of the herd and its habitats among state, federal, and local entities and all users of the herd.
- Recognizing that caribou herds naturally fluctuate in numbers, manage for a healthy population using strategies adapted to population levels and trends.
- Assess and protect important habitats of the WAH.
- Promote consistent, understandable, and effective state and federal regulations for the conservation of the WAH.
- Seek to minimize conflict between reindeer herders and the WAH.
- Integrate scientific information, traditional ecological knowledge of Alaska Native users, and knowledge of all users into management of the herd.
- Increase understanding and appreciation of the WAH through use of scientific information, traditional ecological knowledge of Alaska Native users, and knowledge of all other users.

METHODS

Many of the terms used in this report are defined as follows:

> "Caribou" in the generic sense refers to individuals belonging to the WAH. Acronyms used for other caribou herds are: TLH for Teshekpuk Lake Herd; CAH for Central Arctic Herd; and PCH for Porcupine Caribou Herd.
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> "Local hunter" is anyone that resides within the range of the WAH.
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> "Nonlocal hunter" includes residents of Alaska that live outside the range of the WAH as well as nonresident and alien hunters.

"Winter" is 1 November–31 March.

"Adult caribou" is any caribou >12 mos old.

"Calf" is any caribou <12 mos old.

"Short yearling" is any caribou 10–11 mos old.

"Maternal cow" refers to a female caribou accompanied by a calf or having $\geq$1 hard antler during June.

"Recruitment survey" is used interchangeably with "short yearling survey." These surveys are conducted during late March through May to estimate the ratio of short yearlings:100 adult caribou.

"Conventional telemetry" refers to techniques using radio collars with very high frequency (VHF) transmitters and antennas mounted on airplanes to locate caribou. When referring to radio collars, the terms "VHF" and "conventional" are used interchangeably.

"Collar year" is the period 1 October–30 September of the subsequent year.

"Satellite collar" is a radio collar that contains both a VHF transmitter and a PTT (platform terminal transmitter). The terms "satellite collar" and "PTT" are used interchangeably.

"Light weight satellite collar" refers to model ST-10, ST-18 or ST-20 collars manufactured by Telonics, Inc. (Mesa, AZ). Model ST-3 or ST–14 satellite collars were not included in this definition.

"c.i." is the abbreviation for "confidence interval."

"Photocensus" is the aerial direct count photo extrapolation technique (Davis et al. 1979).

The acronym "BOG" refers to the state Board of Game, and "FSB" refers to the Federal Subsistence Board.

"Transporter" is a commercial operator who provides transportation services only to hunters and others.

"Guide" is a commercial operator who accompanies a hunter in the field and provides professional services to assist in the taking of trophy wildlife.

Population Status and Trend. The first conventional radio collars on WAH caribou were deployed in the Wild River Flats during late February 1975. These collars were actually intended for CAH caribou, and the mistake was discovered when they were later found on the WAH calving grounds (P. Valkenburg, personal communication). The WAH telemetry program was initiated during 1979 (Davis and Valkenburg 1985). The primary objectives of the first WAH telemetry work were to determine if caribou formed persistent social bonds and to evaluate winter range fidelity (P. Valkenburg, personal communication) Radio collars were not initially viewed as a tool to help census the WAH. In fact, some staff thought collars could compromise censuses because they would be used as a substitute for thorough visual searches. As a result, photocensuses conducted before 1986 did not use telemetry whatsoever to locate caribou. Instead, visual aerial searches were conducted using transects in selected areas. In all censuses during and after 1986, WAH caribou have been located mainly through conventional telemetry techniques; additionally, thorough visual searches have been conducted in the vicinity of groups containing collared individuals. During the early years of telemetry work, few collars were deployed in the WAH, and they were relocated infrequently compared to recent years. Although the number of VHF transmitters deployed in this herd has gone up in the ensuing years, we have never collared >0.03% of the herd. We have typically conducted ≥15–20 relocation flights annually since the late 1980s.

During this reporting period, conventional and satellite radiotelemetry techniques were used to estimate population size, adult mortality, calf production and recruitment, sex and age composition, movement patterns, and distribution. Telonics Inc. (Mesa, AZ) manufactured all radio collars deployed in the WAH. Configuration of conventional and satellite collars, PTT duty cycles, VHF relocation techniques, types of data collected, allocation of collars between bulls and cows, and sources of error in telemetry data have been previously described (Dau 1997, 1999).

As in the past, during this reporting period we attempted to complete each collar year with ≥100 functional transmitters on living caribou. To meet this goal we typically begin each collar year with 115–140 potentially active collars in the herd. We have not attempted to radiocollar a cross-section of ages and sexes in the population partly because the age structure is unknown. Instead, we attempt to maintain only ~15 collared bulls in the total marked sample annually; also, we only deploy collars on large, healthy, adult bulls so that skeletal growth does not add to seasonal enlargement of their neck during rut and choke them. Collars are randomly deployed on cows ≥2 years old annually irrespective of maternal status. Only cows in very poor physical condition are not collared.

We began the 2002–2003 collar year with 120 potentially active conventional collars on living caribou (104 cows and 16 bulls). Of these, 31 collars on cows and 4 on bulls were also equipped with a functional PTT. We began the 2003–2004 collar year with 123 potentially active conventional collars on living caribou (108 cows and 15 bulls), of which 26 cows and 6 bulls also had a functional PTT. Inconsistencies between consecutive WAH management reports regarding initial sample sizes of conventional- and PTT-collared caribou are because collars are retroactively dropped from the initial sample after we determine their batteries were likely exhausted or a caribou died prior to the start of a collar year.

During the reporting period all radio collars were deployed during September in Unit 23 at Onion Portage on the Kobuk River. The rationale and methods for this technique have been previously described (Dau 1997). Many residents of northwest Alaska object to chemical immobilization and helicopter capture techniques. Therefore, to avoid using these techniques, we have not removed or replaced radio collars on WAH caribou since at least the mid 1980s.

In 2004 we deployed model ST-20 (A33-10 option) satellite collars. This configuration enclosed both the PTT and a Mark 9 VHF transmitter in a single canister. This configuration of satellite collar has more battery power for the VHF transmitter than ST-18 satellite collars; however, the Mark 9 VHF transmitter requires more power to operate than earlier model VHF transmitters. Therefore, to maintain a minimum 36-month VHF transmitter life expectancy, we specified a 12-hr ON/12-hr OFF duty cycle in conventional transmitters contained in satellite collars (ON 8:00 a.m–8:00 p.m. daily). No duty cycle was used for conventional VHF collars. Dau (1997) reported the history and objectives of the WAH PTT program, configuration of satellite collars, PTT duty cycles, and use of data. We standardized all PTT data to a 1-day-on/5-days-off duty cycle for the entire year when depicting annual movement patterns because duty cycles vary among seasons and individual PTTs.

During 2002 we deployed 43 radio collars (30 conventional collars and 13 satellite collars) on 28 cows and 15 bulls. Three satellite collars deployed on cows in 2002 were provided by the Selawik National Wildlife Refuge (SNWR). Four satellite collars purchased by ADF&G in 2002 were deployed on bulls. In 2003 we deployed 33 radio collars: 22 conventional collars (19 cows and 3 bulls) and 11 satellite collars (9 cows and 2 bulls). In 2003 SNWR provided 3 satellite collars and Gates of the Arctic National Park (GAA) provided 1 satellite collar. In 2004 we deployed 32 radio collars: 23 conventional collars (19 cows and 4 bulls) and 9 satellite collars (7 cows and 2 bulls). In 2004 four of the PTTs were provided by the SNWR and one was provided by GAA. All satellite collars provided by federal agencies have been deployed on cows. All satellite collars provided by the SNWR have been equipped with a breakaway device (Telonics Cr-2a) programmed to release 3 years after the manufacture date.

<u>Population Size and Composition</u>. We determined population size using the aerial direct count photo extrapolation (photocensus) technique (Davis et al. 1979). Photographs were taken 9, 11 and 12 July 2003. Conditions were not ideal on any of the photography days. However, telemetry indicated about 98% of the herd was aggregated in the groups we located, and the weather pattern suggested we would get no better opportunities to photograph the herd during this attempt. As a result, we exposed 1157 photographs to completely photograph the herd; 1009 of these photos were eventually counted (the rest were redundant coverage and could be eliminated from the count). The Beaver photographed 37 groups of caribou. The large number of groups photographed by the Beaver in part reflected the diffuse distribution of the WAH. Additionally, we decided to minimize 35 mm photographs during visual mop-up operations. Region V staff put overlap lines on the photographs during 2 days in November 2003, and all photos were counted by early March 2004. We contracted Don Williams to count >80% of the photographs, which greatly expedited the process.

I calculated an expansion factor for caribou known to be alive at the time of the photography but not photographed based on radiocollared caribou. We located 2 collared individuals in 14 small groups totaling ~5000 caribou in the vicinity of the large aggregations photographed by the Beaver. This translated into approximately 1250 caribou/collar. We assumed missing collared caribou were distributed in small, widely scattered groups of similar size. Between July 2003 and March 2004 we located 3 radiocollared caribou that were alive but not found during the census. Three outstanding collared caribou at 1250 caribou/collar equates to an expansion factor of roughly 4000 caribou.

The greatest potential source of error in the 2003 census was visually estimating 26,300 caribou in small groups that were too dispersed for the Beaver to photograph on 12 July. ADF&G biologist Roger Seavoy and I made these estimates while flying 800–1500 ft above the ground in a PA-18 airplane. Most of the groups numbered <500 caribou, well within the range of group sizes we routinely deal with during other caribou work, and we ensured complete coverage of the area using a GPS (global positioning system) track record. Caribou were not moving rapidly, groups were not mixing, we were in low rolling hills, and the area was relatively small. Immediately after returning to camp we discussed our estimates with the rest of the census crew. Everyone involved felt these estimates were reasonably accurate.

Population composition for the WAH was estimated from calving surveys during June, composition counts during October, and short yearling surveys during April–May. Caribou collared at Onion Portage tend to move en masse through their first winter. Therefore, during the fall, winter, and spring we use ≤4 newly collared individuals for collecting composition information to avoid oversampling this segment of the population. Once caribou enter summer, individuals collared the preceding fall are thoroughly mixed throughout the population.

In 2002, calving surveys were conducted in C-185 and PA-18 airplanes during 1–3 and 5 June. Calving surveys were conducted via C-185 and PA-18 airplanes during 5–7, 9 and 12 June 2003, and via C-180 and PA-18 airplanes during 4–6 and 8 June 2004. In all years we attempted to conduct calving surveys on or slightly before the date of peak calving (assumed to be roughly 7–10 Jun); however, survey dates were ultimately dictated by weather. Calving survey techniques, criteria to determine maternal status, and geographic coverage were the same as previously described (Dau 1997).

Fall composition surveys were conducted 2–3 October 2004 (after this reporting period) using techniques previously described (Dau 1997). Fall composition surveys were not conducted during 2002 and 2003 because of poor weather, helicopter unavailability, or conflicts with other work.

Spring composition (short yearling or recruitment) surveys were conducted on 5, 6, 8, and 30 April and on 1 and 2 May 2003. In 2004 these surveys were conducted on 14, 18, 19, and 29 April. In 2005 (after the reporting period) they were conducted on 13 and 14 April, and on 16 and 20 May. In all years we used survey techniques previously reported (Dau 1997). Because we conduct recruitment surveys from a PA-18 airplane, we probably misclassify some 2-yr-old females as short yearlings and some short yearling males as 2-yr-olds. We feel these measurement errors are fairly constant through time; therefore, they likely do not affect temporal trends or negate its usefulness as an index of recruitment. Although we could reduce measurement error by conducting these surveys via helicopter, we don't believe the benefits would outweigh the costs. The expense of chartering a helicopter would be cost prohibitive, and helicopters are often not available when weather and caribou are conducive to count. Using the Kotzebue-based PA-18 to conduct spring composition is cost-effective and allows us to take advantage of brief periods of good survey conditions.

Distribution and Movements. Distribution and movements of the herd were monitored through rangewide conventional telemetry surveys and PTT data. Rangewide surveys were conducted during spring (Jan–May), summer (Jun) and fall (Aug–Dec), often in conjunction with composition surveys. Flights were based out of Barrow, Kotzebue, Nome, and Fairbanks using survey techniques previously described (Dau 1997).

I reanalyzed WAH calving data to delineate the calving grounds using a kernel analysis similar to Kelleyhouse (2001); however, I increased the sample of collared cows by using a broader definition of "maternal." I used the following conditions to select observations for this analysis:

1. I excluded nonmaternal cows because they often associate with bulls and lag toward the rear of the spring migration. Individual cows were excluded only during years when they were determined to be nonmaternal.

2. I combined data from 1987 to 2004 with 2 exceptions. I excluded data from 1990 because it appeared calving occurred early that year in relation to when calving surveys were conducted. No data were collected during 1991 because of poor weather.

3. I included all cows accompanied by a newborn calf, regardless of their location.

4. To maximize sample sizes, I excluded maternal cows not accompanied by a newborn calf that were south of the northernmost crest of the DeLong Mountains (latitude N68˚39′). Some collared PCH cows travel up to 20 km/day until giving birth (B. Griffith, personal communication). This was why Kelleyhouse (2001) used a conservative definition of "maternal female" when delineating WAH calving areas. A drawback of this approach is that it reduces an already small sample of collared cows to assess distribution. Maternal cows in the Utukok uplands that have not given birth are probably no farther from their eventual parturition site than cows observed with calves that are 3–7 days old. Rather than delineate "extent of" and "concentrated" calving areas as reported by Kelleyhouse (2001), I used the 90% kernel to create a single depiction of the calving grounds.

I evaluated winter and summer range as described by Dau (2003) using 9 subareas of WAH range (Figure 5). For the years following the 2003 photocensus I estimated population size assuming the WAH continued to grow 1% annually as it did during 1990–2003.

<u>Mortality</u>. Mortality rates for adult WAH caribou were estimated from cows with conventional radio collars or lightweight satellite collars on a collar-year basis. Estimated mortality includes all causes of death. Two collar years (2002–2003 and 2003–2004) span portions of this reporting period. Radiocollared bulls were not included in the sample of collared caribou to estimate mortality because we suspect some bulls slip their collar even though we began using expandable collar sections on them in 2001.

In previous reports I excluded cows collared with ST-3 or ST-14 PTTs from the sample to estimate mortality because these large, 2-cannister satellite collars may have predisposed some cows to early mortality (Dau 1997). We last deployed old style (i.e., heavy) satellite collars in 1998. Three cows collared with old style satellite collars in 1998 were still alive in March 2005, as was 1 cow collared in 1996. Obviously, these individuals were not predisposed to early mortality by these heavy satellite collars. Therefore, to maximize the sample size of collared cows, I included them in the mortality estimate.

Mortality rates reported in consecutive management reports are inconsistent for the most recent 1–3 years. This is because we retroactively adjust the sample of collared cows as we learn their fate. For example, radiocollared cows not located for 2 years are retroactively dropped from the sample of potentially active collars. Also, when a hunter returns a collar to ADF&G that had been harvested a number of years prior to that time, or we learn that a caribou lived many years after its radio collar exhausted its batteries, we adjust our sample size accordingly.

Harvest. We monitored harvest using 3 systems: 1) registration permits for local hunters; 2) statewide harvest tickets for nonlocal hunters; and 3) community-based harvest assessments for selected communities within the range of the WAH. Beginning in the 1998–1999 regulatory year, the Division of Wildlife Conservation resumed administering the statewide caribou harvest ticket system as it does for other big game species, e.g. moose.

Community-based harvest assessments have been conducted in selected villages within the range of the WAH since 1985. In past reports (Dau 2001, 2003) we used 2 approaches to analyze this data to estimate caribou harvests by hunters that reside within the range of this herd. The first approach calculated annual per capita caribou harvest rates for individual communities and summed them to generate a rangewide harvest estimate (this method is described in more detail by Dau 2003). The second approach employed statistical models based on Analysis of Covariance that considered the population size of individual communities and their accessibility to caribou. We developed the statistical approach because it was less time-consuming than the per capita approach. Also, the statistical approach could be more responsive to annual changes in caribou availability than the per capita approach, which uses average harvests calculated from previous years and similar communities. As we expanded the community harvest database, it became evident that harvest levels lacked independence through space and time. As a result, statistical harvest models were developed using a Generalized Least Squares technique because it accommodates dependent observations. Comparing estimates from the per capita approach vs. the statistical approach, in 2000–2001 the model estimate was within 0.4% of the per capita estimate, and in 2001–2002 within 2.4%. These differences are inconsequential considering the accuracy of either approach. Therefore, in this report I provide only estimates of local harvest based on the statistical harvest model. Harvests of WAH caribou in Game Management Units 21 and 24 were not incorporated into the model because they were inconsequential. The human population of communities was based on census data from the year 2000.

For communities in Unit 26A near areas where the CAH, TLH, and WAH mingled, we initially estimated total community caribou harvest as described above. The Unit 26A Area Biologist (G. Carroll) then estimated the percentage of total harvest composed of WAH caribou based on the distribution of collared caribou in each herd. Although there is uncertainty associated with assigning harvest levels to individual caribou herds where they mix, we felt this approach was better than ignoring mixing of herds altogether.

Disease. We collected blood samples from caribou while deploying radio collars at Onion Portage. Blood was collected from all caribou that were radiocollared, as well as from additional individuals. Caribou were captured, restrained, and released as previously reported (Dau 1997). In 2002 we sampled 55 bulls and 39 cows. In 2003 we sampled 65 bulls and 48 cows, and in 2004 (after this reporting period) 49 bulls and 33 cows. Body condition (very skinny, skinny, average, fat, very fat), abnormalities, and presence of a calf were recorded for caribou from which a blood sample was collected. Samples were analyzed to assess haptoglobin levels (Dau 2001) and antibodies against *Brucella suis* bacteria.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The July 2003 photocensus produced a minimum estimate of 490,000 caribou (Table 1, Figure 4). There were 3 components to this estimate:

9 X 9 photo counts		455,012
direct counts and estimates of group size during census photography		31,111
expansion for caribou not photographed		4,000
	Total estimate	490,123

The 2003 estimate supports our suspicion that we underestimated minimum population size during the 1999 census. In 1999 prolonged high wind prevented caribou from adequately aggregating until we were within a day of postponing the census until the following year. When the herd did aggregate, encroaching fog over the largest aggregation forced us to expose photographs at the highest possible altitude to expedite the process. As a result, images of caribou on the contact prints were small, and it appeared that calves were largely undetectable. Our failure to count a substantial portion of the calf cohort in early July 1999 could easily have caused us to undercount this herd by 30,000–40,000 caribou. Given trends in recruitment and adult cow mortality (see section below), it is unlikely this population actually declined from 1996 to 1999. Discounting the 1999 estimate, the WAH has increased about 1% annually since 1993.

In July 2003 density of this herd over its total range was 3.5 caribou/mi^2 (1.3 caribou/km^2). This is a conservative measure of density because it does not include reindeer or caribou from the TLH or CAH.

Population Composition

Calving. We conduct calving surveys to: 1) delineate calving areas; 2) monitor initial calf production; and 3) contribute to our annual estimate of adult caribou mortality. Additionally, the neonate:cow ratio provides a “backhanded” way to assess body condition of mature cows the previous fall (Cameron and Ver Hoef 1994). Calf production per se has probably had little effect on the population dynamics of this herd since at least the mid 1980s.

We observed 68 calves:100 cows in 2003 and 59 calves:100 cows in 2004 (Table 2). There has been no clear trend in calf production since 1987; however, calf production generally declined from 1987 through 1998 and increased since 1998 (Fig 6). We assume WAH calving peaks during the first week of June; however, we have no data to evaluate that assumption beyond qualitative observations of antler status and distention of cows’ bellies during calving surveys. Since the mid 1990s we have attempted to conduct calving surveys during the first week of June. However, poor weather has often prolonged calving surveys into and even slightly past mid June.

There has been no correlation between the median date of calving surveys and the calf:cow ratio (Spearman rank correlation=-0.17, P=0.52, n=17). Our estimates of calf production are probably conservative because we do not record udder status for collared cows (Whitten 1995) and undoubtedly misclassify some cows that have lost their antlers and their calf as nonmaternal.

The strong negative correlation between the calf:cow ratio and the proportion of cows with velvet antlers during calving previously reported (Dau 1997) continued through this reporting period (1987–2004 excluding 1991, Spearman rank correlation = –0.89, n = 17 years). The median proportion of cows with velvet antlers during years when the calf:cow ratio was $\geq$70:100 (2.6%, n=7) was significantly lower (Kruskal-Wallis P=0.002) than during years when this ratio was <70:100 (15.2%, n=10). Cows with substantial growth of velvet antlers during calving probably failed to conceive the previous fall. This suggests low WAH calf:cow estimates are real and not artifacts of sampling error.

Between 1992 and 2004 there was no correlation between the June and subsequent fall calf:cow ratios (r = 0.13, n = 10). This suggests calf survival through summer has a greater effect on the fall calf:cow ratio than initial production.

Fall Composition. We observed 35 calves:100 cows and 48 bulls:100 cows in a sample of 11,157 caribou classified during October 2004 (Table 3). No fall composition surveys were conducted in 2002 or 2003 because of poor weather, helicopter unavailability, and conflicts with other work.

Since 1992 the fall calf:adult ratio has ranged 24–33:100. This ratio is less vulnerable to misclassification than the calf:cow ratio because calves are easy to distinguish from adults. In contrast, inexperienced observers may misclassify young bulls as cows if they focus on antler characteristics rather than the presence of a vulva. Even so, spatial and temporal segregation of bulls and cows likely confounds even calf:adult estimates because we do not sample the entire WAH and the degree of sexual segregation varies among years. Between 1992 and 2004, the fall calf:cow ratio was correlated to the subsequent spring calf:cow ratio (Spearman rank correlation=0.65, P=0.04, n=10).

Since 1992 the fall bull:cow ratio has ranged 38–64:100 (Table 3). Sexual segregation and our inability to sample the entire herd probably account for more annual variability in this parameter than actual changes in population composition. From 1975 to 2004, the median bull:cow ratio has been 51:100. This is probably more representative of the actual WAH bull:cow ratio than any individual year.

Spring Composition. We observed 19 short yearlings:100 adults in spring 2003, 22:100 in spring 2004 and 12:100 in 2005 (Table 4, Fig 7). Recruitment has slowly declined since the early 1980s; even so, this parameter has exhibited 1–3-year spikes every 4–5 years. The general overall declining trend would not be evident without this long-term data set.

Distribution and Movements

Historical Summary. Our historical understanding of the distribution of the WAH has been previously reported (Dau 2001). During rangewide telemetry surveys we located 114 out of 130 (88%) radiocollared caribou through conventional telemetry techniques in fall 2003, 114 out of

130 collared caribou (88%) during spring 2004, and 108 out of 138 (78%) collared caribou during fall 2004 (after this reporting period).

Since spring 1995 when we began conducting rangewide surveys, we've located through conventional telemetry techniques an average 74% (SD = 10, n = 10) of all potentially active collars during spring and 75% during fall (SD=9, n = 10) surveys. Often, collars missed during a rangewide survey are located during the subsequent survey period mixed with caribou that were found. This suggests long telemetry receiver scan times, topography, errors while programming receivers, and infrequent relocation flights are responsible for "missed" collars, rather than incomplete coverage of the herds' range or unusual movements of caribou. The distribution of collars located during rangewide surveys is probably a reasonably accurate though rough approximation of the distribution of the entire WAH (i.e., there have been no "pockets" of caribou in areas we did not search).

General Movement Pattern: Pregnant cows and some nonmaternal caribou begin migrating from winter range toward the calving grounds in April. Typically, most pregnant cows reach the calving grounds by late May. Bulls, nonmaternal cows, and immature caribou lag behind pregnant cows during the spring migration, perhaps in part to exploit the northward progression of snowmelt and green-up. Most cows give birth in the Utukok uplands during late May through early June (Figures 1 and 2; see section below). By mid June large postcalving aggregations begin forming as cows with neonates move west toward the Lisburne Hills. As mosquitoes begin to emerge in mid to late June, bulls and nonmaternal caribou move into the western North Slope and DeLong Mountains. Mosquito harassment intensifies and oestrid flies emerge in early July. During the first half of July, insect harassment causes WAH caribou to form aggregations sometimes numbering >100,000 individuals in this area. Even during the period of maximum insect harassment, WAH caribou begin moving east-northeast through the Brooks Range and its northern foothills toward Howard and Anaktuvuk Passes. By early to mid August insect harassment begins to diminish, and some caribou disperse north and west onto the North Slope, some going as far as Cape Lisburne and Barrow, while other caribou remain in the mountains between Howard and Anaktuvuk Passes. The fall migration begins in mid August as caribou in the vanguard move southwest toward Kotzebue and Norton Sounds. By late September, before some WAH caribou have even begun to migrate, caribou near the front of the migration have reached the southernmost portions of winter range. The fall migration extends through mid to late November. No matter where WAH caribou are, directed and lengthy migratory movements generally cease by this time, and they become relatively sedentary until April when the spring migration begins. Distribution and, to some extent, movements of this herd are shown in Figure 3.

Winter Range. Winter range is the most difficult of all WAH seasonal ranges to delineate because of the substantial annual variability in where caribou overwinter. The area identified as winter range on the seasonal range map (Figures 1 and 2) represents where most of the herd has wintered in most years since the mid 1980s. In reality, of course, caribou seasonal ranges are not mutually exclusive, and during winter, WAH caribou occur throughout most of their annual range, albeit at very low densities in some areas (Tables 5 and 6). Although radio collars have been deployed in the WAH only since 1979 and sample sizes of collared caribou have always been small in relation to the size of the herd, telemetry data provide rough estimates of winter range distribution through time (too few locations of caribou were recorded to evaluate winter range use before 1983–1984).

During winter 2003–2004, an unusually high percentage of the WAH wintered in the central Brooks Range (sub area 5, Figure 5) and Koyukuk River drainage (sub area 6; Figure 5 and Table 5). We located radiocollared caribou up to 40 mi east of Chandalar Lake, substantially farther east than previously observed. Residents of that area indicated it had been decades since large numbers of caribou had wintered in there (E. Jaynes, personal communication). Additionally, a substantial proportion of the herd wintered in the Nulato Hills (sub area 8, Figure 5) during 2003–2004 following 2 years of little use (Tables 5 and 6).

Most of the WAH wintered in the Nulato Hills or on the Seward Peninsula (sub area 7, Figure 5) during winter 2004–2005 (after this reporting period). The importance of the Nulato Hills to the WAH and expansion of WAH winter range onto the Seward Peninsula have been previously described (Dau 2003). Few WAH caribou wintered north of the DeLong Mountains during this reporting period.

The estimates of winter range density reported here do not include reindeer or caribou from the TLH or CAH; therefore, the figures reported here represent minimum densities. This would primarily affect densities reported for the central Brooks Range, the foothills of the Brooks Range east of the Utukok River, and the Seward Peninsula.

Calving Grounds. Two approaches have been used to delineate the WAH calving grounds, one qualitative and the other quantitative (Kelleyhouse 2001). Strengths and weaknesses of each approach have been previously discussed (Dau 2003). In this report, all references to the calving ground refer to the area delineated on the seasonal range map (Figures 1 and 2).

In 2003 we observed 80 collared cows during calving surveys (Table 2). Of these, 50 were within the calving grounds, 29 were south of it, and 1 was east of the calving grounds. Of the 30 individuals off the calving grounds, 19 were nonmaternal, 8 were maternal but did not have a newborn calf, and 3 were accompanied by a neonate. In 2004 we observed 86 collared cows during calving surveys and only 2 (both nonmaternal) were substantially outside the calving grounds. In 2005 we observed a collared cow with a newborn calf on the ridge dividing the headwaters of the Kallarichuk River and Timber Creek. This is the southernmost observation of a WAH calving site ever recorded.

The 90% kernel produced by our reanalysis of WAH calving data agrees closely with the area qualitatively delineated in the seasonal range map (Figs 1 and 2). Although the 1990 calving surveys were conducted within the range of dates that surveys were conducted in other years, the concentrated distribution of cows, the total absence of hard antlers on collared cows, and the extreme westerly distribution of collared cows all suggest postcalving aggregations were forming at the time we observed them. Additionally, during the 1990 calving surveys, we observed many large groups of caribou moving west as is typical of the WAH postcalving period. Therefore, we feel that including data from 1990 is probably misleading.

We included maternal cows not accompanied by a calf that were north of the De Long Mountain crest in the kernel analysis to maximize the sample size while minimizing the problem of cows traveling long distances between when we observed them and when they gave birth. Because we locate collared cows only once during calving surveys, some cows have calves that are several days old based on the calves' mobility, while other cows appear on the verge of parturition based on their distended stomach. Cows observed on the calving grounds that possess $\geq$1 hard antler but lack a calf are probably no farther from their birthing site than cows with newborns that are several days old. In contrast, pregnant cows that are far from the calving grounds during the calving period are probably most likely to travel rapidly to get there; therefore, we excluded observations of these individuals. We modified the calving grounds shown on the WAH seasonal range map to correspond with the 90% and 95% kernels from this data set.

Summer Range. Conventional telemetry relocation flights associated with calving surveys and photocensuses, as well as PTT data, all indicate the vast majority of the WAH uses the western North Slope and Brooks Range during summer. The size of this area is about 43,000 mi^2 (111,400 km^2, Figures 1 and 2). In recent years up to several thousand WAH caribou, primarily bulls and immature cows, have reportedly summered on the Seward Peninsula as well (ADF&G biologist K. Persons, personal communication). In fact, during June 2005, 2 radiocollared bulls were located in 2 separate groups numbering approximately 150 caribou on the Seward Peninsula in the vicinity of Kougarouk Mountain. The importance of summer range to the WAH has been previously discussed (Dau 2003).

Satellite Collars. In 1987, when we began deploying satellite collars in the WAH, our primary objective was to use them to more effectively search for conventional radiocollared caribou. From 1987–1988 through 1997–1998 no more than 10 satellite collars were deployed in the WAH during any collar year. Given this small sample size, no one was tempted to use them as an independent sample for monitoring movements and distribution of the WAH. We first exceeded 20 PTTs in this herd during the 1999–2000 collar year, and since 2001–2002, we have begun each collar year $\geq$20 PTTs on living WAH caribou. Since 2000, ADF&G has mapped real-time locations of PTT-collared WAH caribou and distributed them via Internet to federal management agencies, the Reindeer Herder's Association, and local government organizations. The PTTs provide a reasonably accurate depiction of general movement and distribution patterns and have been especially useful for notifying reindeer herders of potential conflicts with caribou. Even so, the maximum number of satellite collars ever deployed in this herd (35 individuals) constituted only 0.01% of the entire population (using a population size of 490,000 caribou). Although PTT data sets now include thousands of locations, they are still based on only a tiny number of individual caribou. Additionally, we have deployed very few PTTs on bull caribou. Conventional telemetry and direct observations of caribou suggest PTT data should be used cautiously as a representation of the entire herd.

MORTALITY

Our estimates of adult mortality are conservative because they exclude bulls that tend to experience higher mortality rates than cows. Also, we do not collar emaciated, injured, or clinically diseased cows, even though such animals compose part of the population. Although these factors would elevate the WAH mortality curve, they should not affect its temporal trend (Dau 1997). We believe our estimates provide a reasonably accurate index of adult caribou mortality for the entire herd.

Since 1985, annual mortality has ranged from 8 (1997–1998) to 22 (1992–1993) deaths:100 collared adult cows (Table 7, Figure 8). Annual estimates of adult mortality have shown no statistically significant trend through time ($R^2 = 0.10$) and have exhibited more variability among years since 1992–1993 than prior to that time. Three-year moving averages reduce the effects of annual variability and suggest mortality has generally increased very slowly since the mid 1980s (Figure 9). Adult caribou mortality is most meaningful in relation to recruitment. The significance of Figure 9 is that these parameters have slowly trended toward convergence since the early to mid 1980s.

Harvest

Season and Bag Limit. On state-managed lands the following seasons and bag limits were in effect throughout the reporting period:

2002–2003 and 2003–2004 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Units 21D, 22A, 22B, 23, 24, and 26A		
Resident Hunters:		
5 caribou per day		
Bulls	No closed season	
Cows	1 Jul–15 May	
Nonresident Hunters:		
5 caribou total per year		
Bulls		No closed season
Cows		1 Jul–15 May

Federal hunting seasons were identical to state regulations during this reporting period. However, the bag limit under federal subsistence regulations was 15 caribou per day in Unit 23 and 10 caribou per day in Unit 26A. The federal bag limit in other units used by the WAH was 5 caribou per day.

Board of Game Actions and Emergency Orders. During this reporting period 2 emergency orders (EOs) were issued for caribou hunting within the range of the WAH, and both pertained to portions of Game Management Unit 22:

1. EO 05-03-02 closed caribou hunting in that portion of Unit 22D within the Pilgrim River drainage south of the Pilgrim River Bridge between 31 August 2002 and 30 June 2003. The purpose of this EO was to prevent people from taking reindeer because no caribou were in the area.

2. EO 05-04-02 opened caribou hunting in that portion of Unit 22D within the Pilgrim River drainage south of the Pilgrim River Bridge beginning 17 October 2002 through 30 June

2003. The purpose of this EO was to provide hunting opportunity after caribou had moved into the area.

The BOG did not pass a proposal to increase the state bag limit on WAH caribou to 10 per day in Unit 23 at its November 2003 meeting. This proposal was submitted with the understanding that a companion proposal would be submitted to the FSB to reduce the federal bag limit to 10 caribou per day in Unit 23. The intent of both proposals was to achieve consistency between state and federal caribou regulations. However, no proposal was submitted to the FSB, and the BOG voted against the proposal.

<u>Human-Induced Harvest</u>. Hunters (recreational and subsistence hunters combined) reported harvesting about 14,700 WAH caribou during the 2002–2003 regulatory year, and 11,600 caribou during 2003–2004 (Table 8). This constituted 3% and 2% of the population, respectively, using the 2003 population estimate of 490,000 caribou.

These harvest estimates do not include caribou killed but not retrieved. Each year some harvested caribou are left in the field when suspected to be diseased or found to be heavily parasitized or skinny. Additionally, some caribou are unintentionally wounded and later die. The number of caribou killed but not retrieved is unknown and virtually impossible to estimate; however, opportunistic observations by ADF&G staff suggest this number could be substantial each year.

<u>Permit Hunts</u>. By statute, all caribou hunting by residents that live north of the Yukon River and within the range of the WAH is by registration permit. Registration permits are available at license vendors and ADF&G offices in northwestern, western, and interior Alaska. The permits are free, and there is no limit to the number of permits issued each year. Comparisons of registration permit harvest data and community harvest assessments indicate only about 10% of the actual harvest is reported through the registration permit system (Georgette 1994). The exception to this is the community of Nome, where compliance with reporting requirements is believed to be much better (K. Persons, personal communication). As a result of the low compliance with reporting requirements, the department has not sent letters to permit holders requesting harvest information since the year 2000.

Nonresidents and residents that live outside the range of the WAH must carry a statewide caribou harvest ticket when hunting. Alaska Bureau of Wildlife Enforcement officers indicate most nonlocal hunters possess a statewide caribou harvest ticket when hunting caribou (C. Bedingfield, J. Rodgers and D. Hildebrand, personal communication). We think this system is reasonably accurate for monitoring caribou harvested by nonlocal hunters.

<u>Hunter Residency and Success</u>. During the 2002–2003 regulatory year, 693 nonlocal hunters reported harvesting 697 caribou (650 bulls and 47 cows). In 2003–2004, 572 nonlocal hunters took 549 caribou (510 bulls and 39 cows; Table 9). As in the past, during this reporting period most WAH caribou taken by nonlocal hunters were harvested in Unit 23 (73% in 2002–2003 and 67% in 2003–2004).

Combining data from the 1998–1999 through 2003–2004 regulatory years, 63% of all nonlocal hunters took $\geq$1 caribou. Fifty-four percent of all nonlocal hunters took fewer than 3 caribou per year, and only 8% harvested ≥3 caribou annually. The maximum number of caribou harvested by a nonlocal hunter was 8 during a regulatory year. Only 5% of all nonlocal hunters reported taking ≥1 cow.

Using the harvest estimation model (Table 8), hunters residing within the range of the WAH harvested about 14,000 caribou in 2002–2003 (80% c.i.=15,552–17,714 caribou), and 11,000 caribou in 2003–2004 (80% c.i.=12,743–14,906 caribou). Numerous community harvest assessments have been conducted within the range of the WAH (Table 10). We intend to check the accuracy of the harvest estimation model roughly every 6 years by comparing it to estimates derived from per capita harvest rates.

Harvest Chronology. Subsistence harvest patterns are primarily affected by seasonal movements and availability of caribou, and secondarily, by ease of travel while hunting. For example, Point Hope and North Slope villages harvest Western Arctic caribou mainly during July and August while the WAH is on its summer range. In contrast, Shaktoolik and Unalakleet hunters primarily take WAH caribou during September through March. In Unit 23, harvests are typically high during fall and spring migration periods, and also when caribou winter near communities. Even so, caribou harvests all but cease during periods of freeze-up and breakup, when travel by boat or snowmachine is impossible. Unlike many subsistence activities that are seasonally specific, subsistence hunting of caribou occurs whenever they are available and accessible.

During early fall, most subsistence hunters select large bulls because they provide the best meat. Once bulls enter rut and become unpalatable, typically after 7–10 October, most subsistence hunters take cows until approximately March or April. In decades past, subsistence hunters resumed harvesting bulls in roughly mid to late December (W. Uhl, personal communication). During the rest of the year, subsistence hunters take caribou of both sexes based on availability and the body condition of individual animals.

Despite no closed season on bulls, most caribou taken by nonlocal hunters were harvested during late August through September (88% in 2002–2003 and 93% in 2003–2004). This temporal concentration of nonlocal hunters, combined with their disproportionate use of Unit 23, continued to frustrate local residents. Residents of Anaktuvuk Pass have expressed similar concerns.

Transport Methods. Most subsistence hunters harvest WAH caribou using snowmachines during late October–early May and boats or 4-wheelers during the rest of the year. Few local hunters use aircraft to hunt caribou. In contrast, nonlocal hunters depend almost entirely on aircraft to initially access caribou hunting areas. Once in a hunting area, many nonlocal hunters use boats to float rivers. Guides now rely heavily on 4-wheelers for hunting. This practice dramatically increased during the mid 1990s in Unit 23, and most guides now cache 4-wheelers at remote camps.

In Unit 23 some village residents transport nonlocal moose and caribou hunters via boats. This has proven divisive in some villages because many local residents feel: 1) nonlocal hunters compete with them for choice hunting locations; 2) nonlocal hunters leave litter behind when they leave an area; 3) transporters disrupt and displace animals from river corridors when they use loud jet boats; and 4) nonlocal hunters want only trophies and waste meat.

Other Mortality

Disease. Serology results show no temporal trends in exposure to 8 selected bacteria and viruses in the WAH for samples collected during 1992–2000 (Table 11). This may be at least partly because serologic surveys are inherently poor for monitoring the prevalence of disease in wildlife populations (J. Blake and T. O'Hara, personal communication). Since 2001, WAH serum samples have been analyzed only for brucellosis and haptoglobin levels. Follow-up diagnostic serological tests may be conducted for individual caribou with an elevated haptoglobin level. Our primary objective for collecting caribou sera is to provide a "red flag" indicator of disease. Overall, about 9% of all caribou tested during 1992–2003 have had an elevated haptoglobin level. There has been no temporal trend in the percentage of caribou with an elevated haptoglobin level (Table 11).

Levels of exposure to brucellosis have been low since 1996 (Table 11). The primary impact of this disease on caribou populations is reduced reproductive success (Dieterich 1981). The low proportion of WAH cows exposed to this disease in recent years suggests brucellosis is probably not affecting the population dynamics of the WAH at this time.

HABITAT

Assessment

The department did not monitor range condition for the WAH during this reporting period.

During the summer of 2000 the National Park Service (NPS) evaluated heavy metal levels in mosses and soils along the Red Dog Road (Ford and Hasselbach 2001). Although the results showed high concentrations of lead (Pb), zinc (Zn), and cadmium (Cd) near the road and indicated ore concentrate from the Red Dog Mine was the source of these metals, Teckcominco staff questioned whether the methods used near Red Dog were comparable to other studies. Even so, Tek Cominco has since taken steps, e.g., complete coverage of transport truck payloads, to reduce or eliminate escapement of ore dust from transport vehicles.

Enhancement

There were no WAH habitat enhancement activities during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

WAH Cooperative Management

The Western Arctic Caribou Herd Working Group (WG) was organized in 1997. The purpose of the working group is to ensure the conservation of the Western Arctic caribou herd, safeguard the interests of all users of the herd, and integrate indigenous knowledge with Western science. The working group consists of 20 voting chairs representing multiple stakeholders. It is a nonregulatory body that emphasizes shared decision-making. The Bureau of Land Management, U.S. Fish and Wildlife Service, NPS and ADF&G support the WG.

During this reporting period, the WG held 1–2 meetings each year and produced a newsletter, *Western Arctic Caribou Trails*, that was mailed once or twice annually to about 9000 box holders within the range of the WAH. The technical committee, composed of agency staff with at least 2

WG members, met for the first time in January 2004 and again in January 2005 to discuss interagency cooperation, identify information needs, and begin a peer review of WAH management activities. During this reporting period the WG elected an executive committee and formed several subcommittees. These subcommittees are: 1) NPR-A committee; 2) education/newsletter committee; 3) planning committee; 4) membership committee; and 5) user knowledge committee.

Resource development

The Kuparuk and Prudhoe Bay oil fields as well as the trans-Alaska pipeline are located on the easternmost extent of WAH range. Most of this herd has little or no contact with oil-related structures throughout their lives. The Red Dog Mine, Road and Port Site are located wholly within the northwestern portion of WAH range. To date, this complex appears to have had only limited, localized effects on the movements and distribution of WAH caribou. This is partly because NANA-Teck Cominco has attempted to minimize its impacts on subsistence resources and users. It is also partly because locally hired truck drivers and other employees have voluntarily minimized activities that could affect caribou or other wildlife.

A number of new developments within the range of the WAH are currently being considered. These are:

1. Oil and gas development in NPR-A south. Roughly 80% of the WAH calving grounds are within this area, and the area contains important insect relief habitat during summer.

2. Coal development. Vast, high-grade coal deposits occur in a broad band beneath the northern foothills of the Brooks Range. Coal underlies virtually the entire WAH calving grounds. The high cost of transporting this product to market has been a major barrier to its development. One alternative being considered for development of this resource is transporting coal to the Red Dog Mine via a road to provide a cheaper source of power than diesel. Another option is to burn coal at the deposit to generate electricity that would then be transported to the Red Dog Mine via high voltage power lines.

3. Expansion of the Red Dog Mine. Test drilling for additional lead and zinc deposits has been conducted in this area for several years. The western De Long Mountains are heavily used by WAH caribou during summer for insect relief terrain.

4. Construct a road linking the community of Noatak to the Red Dog Mine-Port Site road. This would reduce the cost of transporting fuel to this community and enable individuals to commute between their homes and jobs at Red Dog.

5. Construct a new airport near the community of Noatak capable of handling large jet service (e.g., Boeing 737s). This is being considered to reduce risks associated with jet service to the Red Dog Mine in a mountainous area.

6. Develop mining in the Ambler Mining District (Bornite Mine). Nova Gold is currently conducting assessment work to evaluate the feasibility of mining in this area. One option being considered for transporting ore is a road from the Dalton Highway through the Ambler Mining District to the Red Dog Mine-Port Site road.

More information about potential industrial development within the range of the WAH is provided by Schoen and Senner (2002).

School programs

As in the past, department staff made presentations regarding WAH caribou in schools throughout the range of this herd. In 2002 eight high school students from Noorvik with their teacher and 4 chaperones (including an elder, Minnie Morris, who chaperoned the first group of students to ever participate in the collaring project during 1991) participated in the Onion Portage collaring project. In 2003 eight high school students from Noatak with 2 chaperones (a subsistence hunter from Noatak and a geneticist from the University of Alaska) participated in the project. Some Noatak students used caribou blood collected during the project for science fair projects to sequence selected genes. In 2003 nine White Mountain junior high school students and their teacher participated in this project. The White Mountain students published a book about their experiences at Onion Portage, hosted a community feast (featuring a caribou the students had harvested, butchered, and cooked) during which they showed PowerPoint presentations about the collaring project and participated in an oral presentation with department staff describing student involvement in the project at the 10th North American Caribou Workshop (Girdwood, Alaska, May 2004). Although students from Buckland and Deering were scheduled to participate in this project during September 2004, school district staff turnover and other factors forced them to cancel shortly before the project began. As a result, no students participated in the project during 2004. Student involvement in this project has been a positive experience for the students, school district staff and agency staff since its inception in 1991.

Conflicts between the WAH and reindeer industry

As in the past (Dau 2001, 2003), the Seward Peninsula reindeer industry continued to lose deer to the WAH during this reporting period. Relatively few caribou wintered on the Seward Peninsula during the winter of 2003–2004, and as a result, fewer reindeer were lost than in any year since 1996. Only the Davis, Kakaruk (Teller) and Ongtowasruk (Wales) herds are still commercially viable as of spring 2005. The department posts a Web page showing real-time locations of satellite-collared WAH caribou on the Seward Peninsula to help herders avoid conflicts with caribou.

User conflicts

Conflicts among nonlocal hunters, commercial operators (guides and transporters) and local hunters continued in portions of WAH range during this reporting period. These conflicts were most pronounced in Unit 23. This complex issue involves all hunters, not just caribou hunters, and is affected by: 1) use of aircraft by nonlocal hunters and commercial operators in contrast to local hunters’ use of boats and snowmachines; 2) shortened seasons, reduced bag limits, crowding, and few trophy animals in other portions of Alaska; and 3) fewer places to hunt multiple big game species, especially for nonresidents. The limiting factor driving this conflict in Unit 23 is not inadequate numbers of wildlife, certainly not with regard to WAH caribou. Rather, the limiting factors are access points and space to accommodate all users. During this reporting period, some high-volume transporters virtually controlled entire drainages within Unit 23 by contracting numerous clients and monopolizing access points.

CONCLUSIONS AND RECOMMENDATIONS

The WAH is still very large. However, converging trends in adult cow mortality and recruitment, isolated starvation events, and occasional years of generally poor pre-rut (September) body condition suggest this herd could decline in the foreseeable future. There is no evidence that any single factor, e.g., human harvests, predation, environmental contaminants, or disease is currently limiting the size of this herd.

Our current level of investment in harvest assessment is probably adequate as long as the WAH is large and relatively stable because it illustrates levels of human demand when access to caribou is limited only by their distribution and not population size. Once this herd begins to substantially decline, however, and harvests become a potential limitation to population growth, community harvest assessments should be conducted more frequently and in more communities within the range of this herd than in recent years. The department should continue to monitor harvest of WAH caribou by nonlocal hunters through the statewide caribou harvest ticket system.

Seward Peninsula reindeer continued to be lost to the WAH during this reporting period. The department should continue to provide real-time information regarding caribou movements and distribution to herders within the constraints of staff, weather, aircraft, and budgets.

The department should explore the feasibility of conducting a WAH health assessment program to monitor disease in this herd.

A number of large-scale developments are being considered for northwest Alaska. Potential impacts of individual projects on caribou and users should not be evaluated in isolation. Instead, the cumulative effects of all existing and proposed development should be considered collectively over the short and long term to predict impacts on people and caribou.

Conflicts between local subsistence hunters, nonlocal sport hunters, and commercial operators have intensified in portions of WAH range since 1992. The primary factor driving these conflicts is inadequate space to accommodate all users. The department should hire a planner position for Region V in part to address these issues.

The department should continue to support the WAH Working Group and help identify management issues to focus on now that the Cooperative Management Plan has been finalized.

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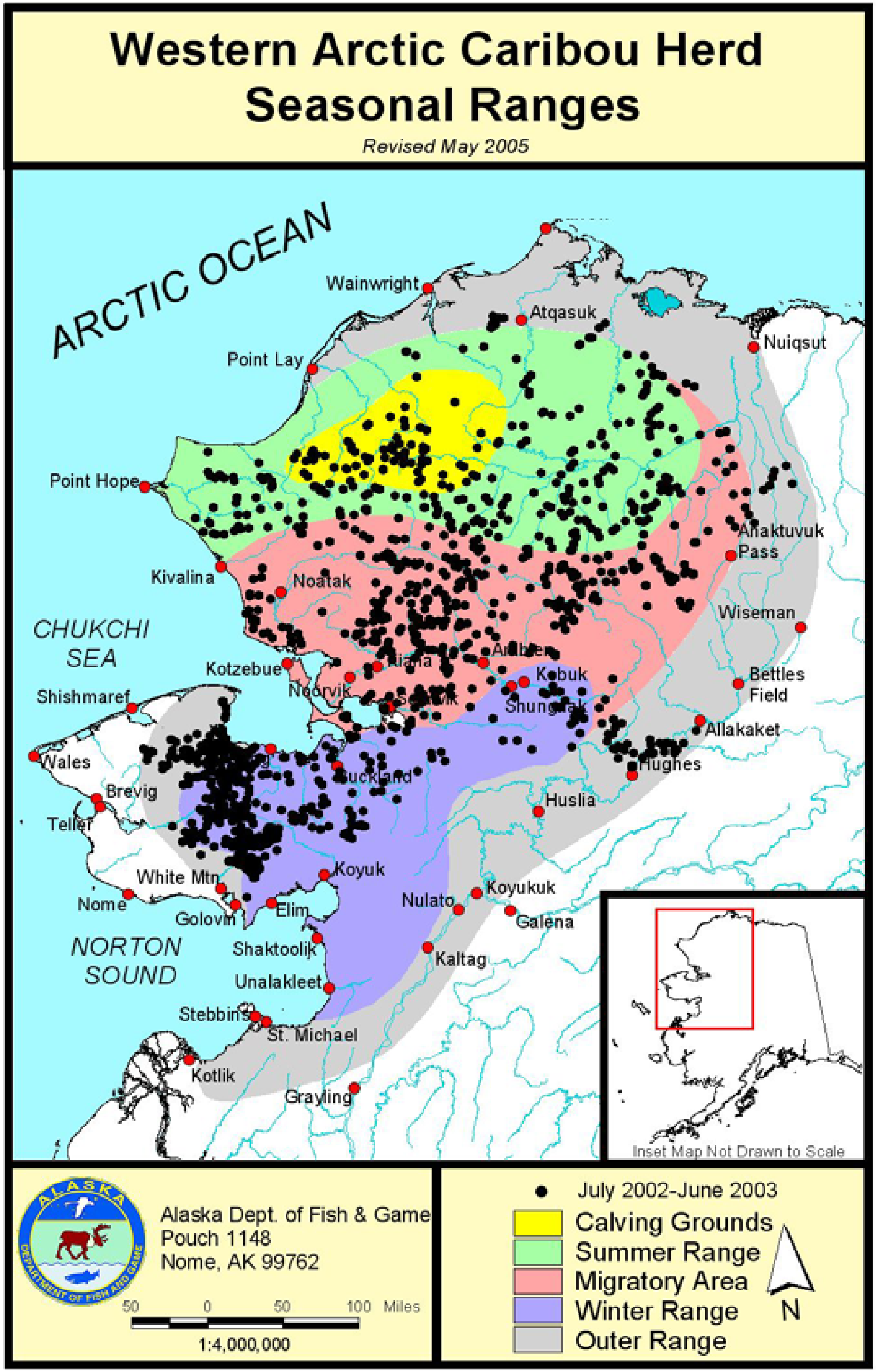

Figure 1 Seasonal ranges of the Western Arctic caribou herd with locations of satellite-collared caribou collected during regulatory year 2002–2003

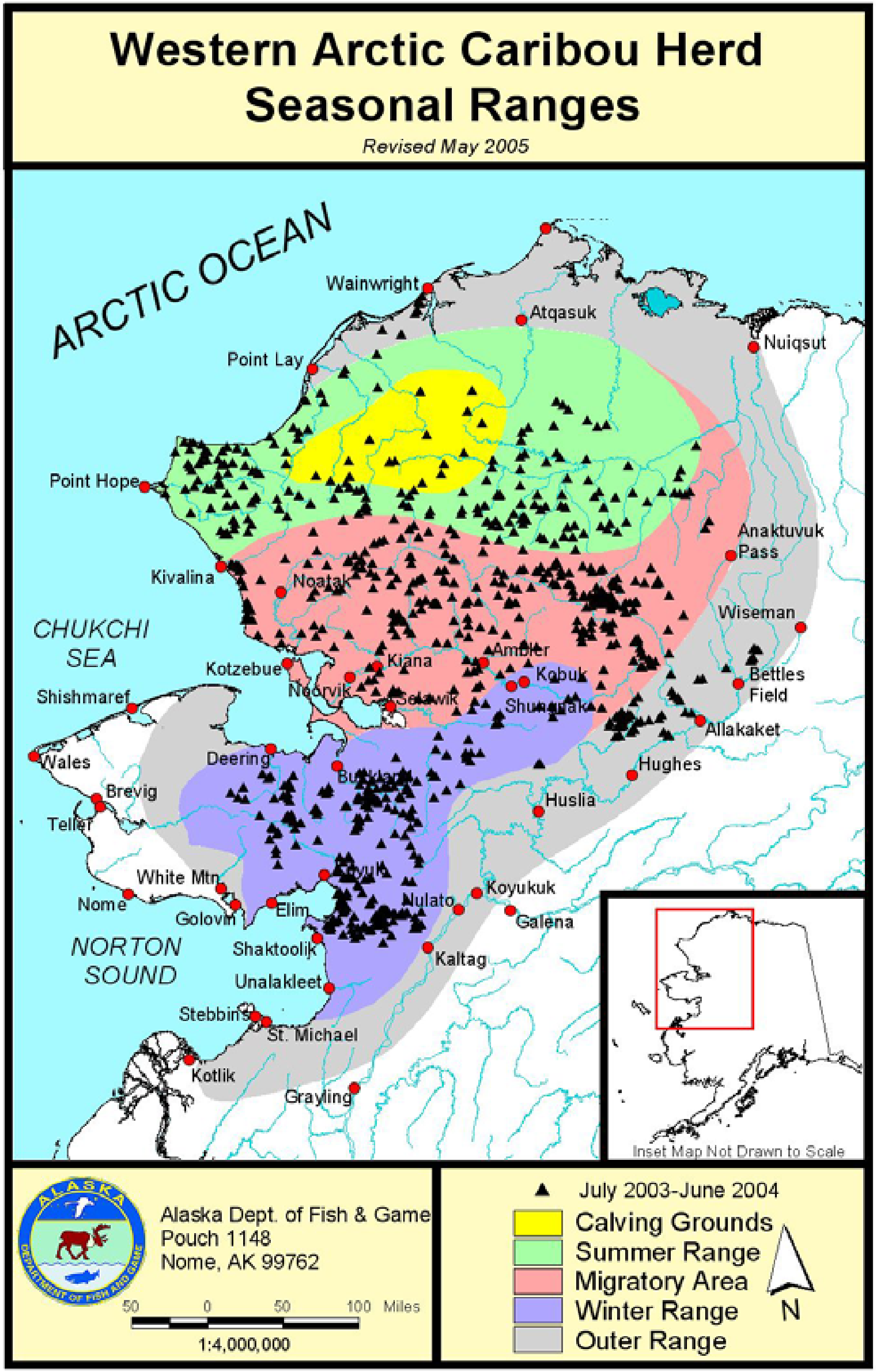

Figure 2 Seasonal ranges of the Western Arctic caribou herd with locations of satellite-collared caribou collected during regulatory year 2003–2004

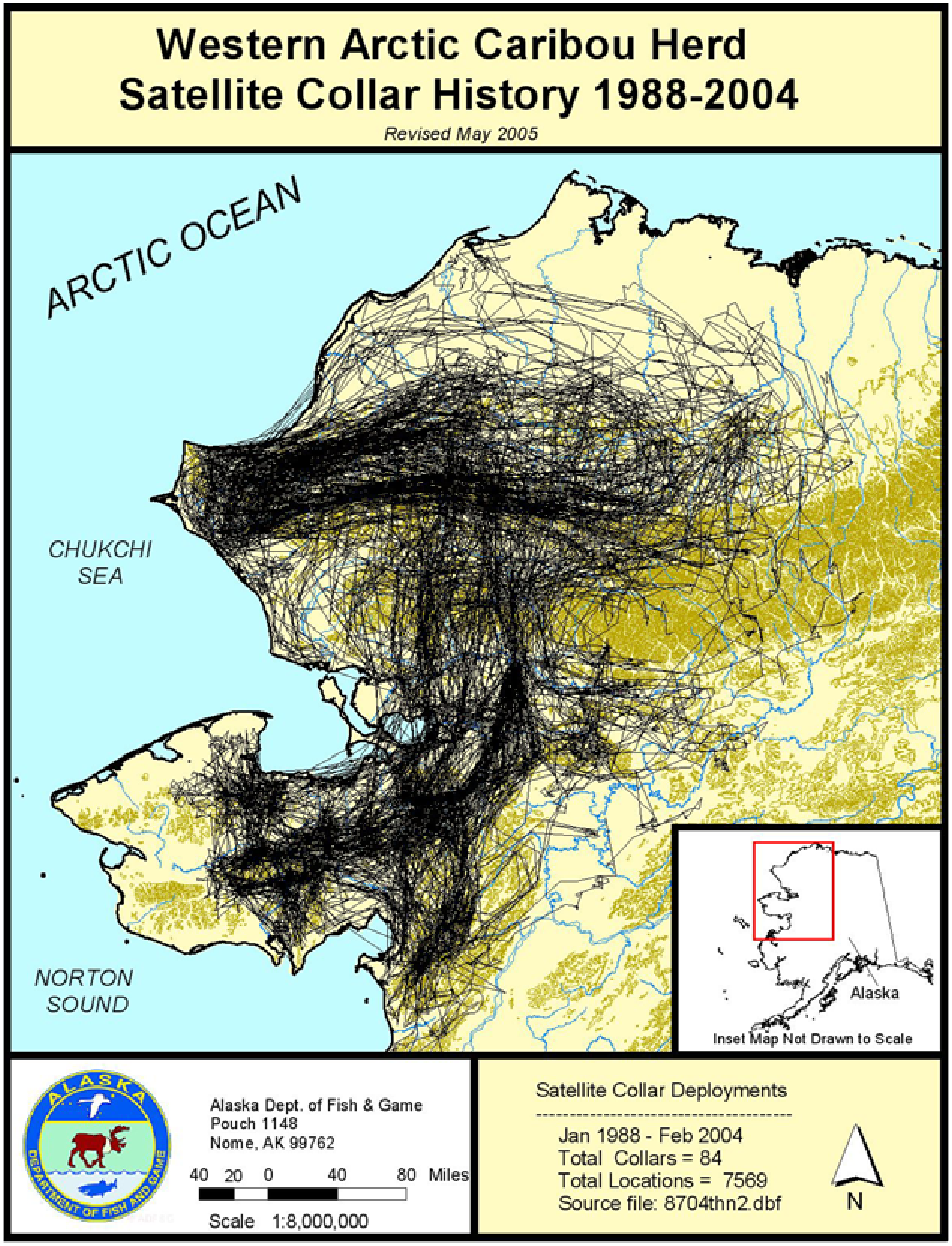

Figure 3 Distribution and movement of satellite-collared Western Arctic herd caribou, 1988–2004

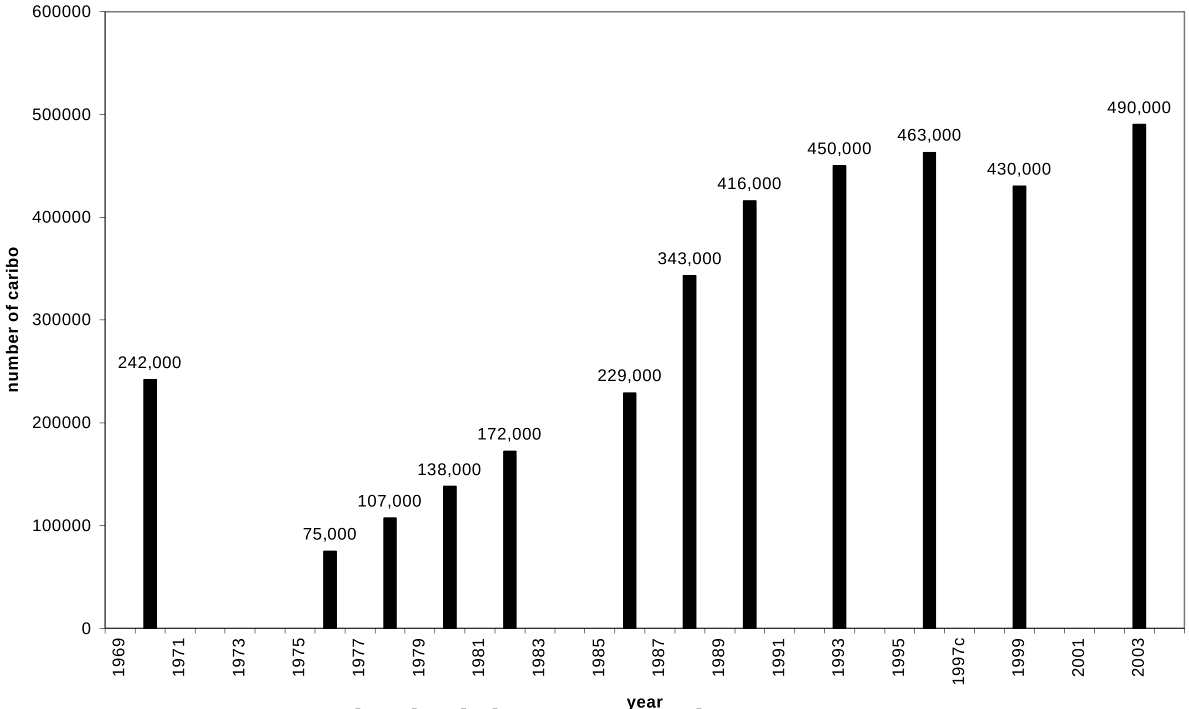

Figure 4 Western Arctic caribou herd photocensus results, 1970–2003

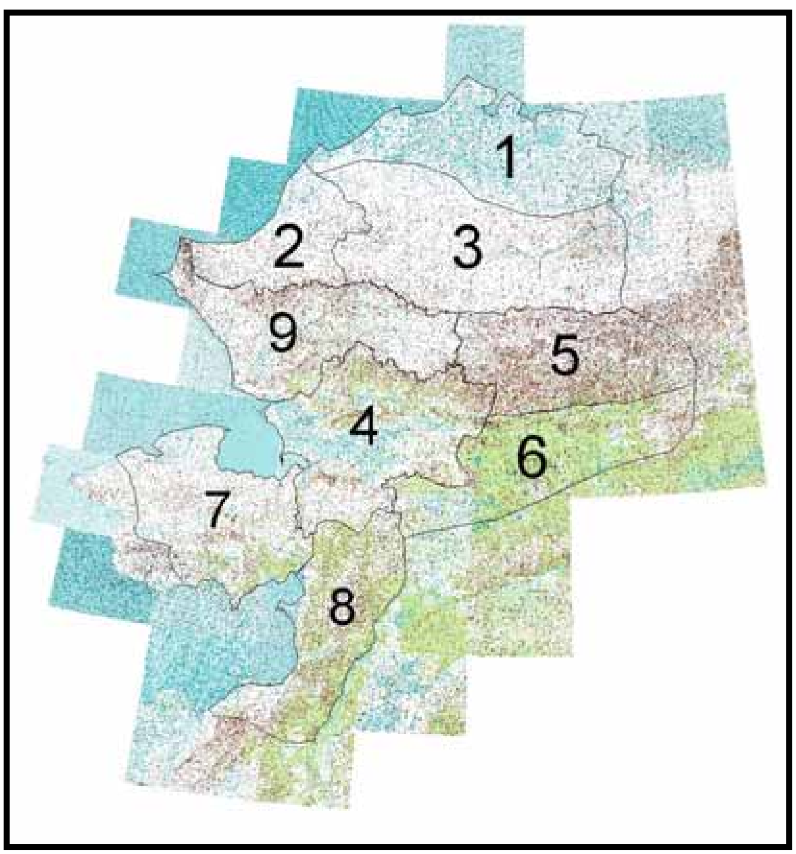

Figure 5 Sub-areas of Western Arctic herd range used to assess winter distribution

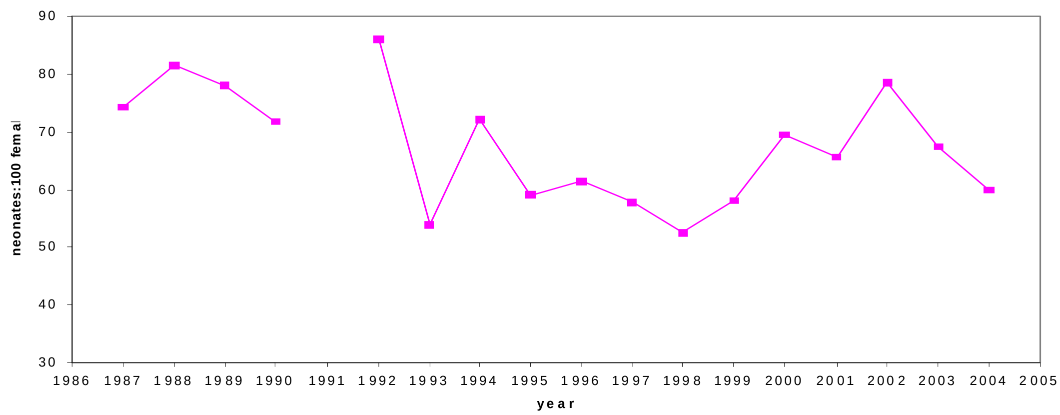

Figure 6 Western Arctic caribou herd June calving survey results, 1987–2004

Figure 7 Annual estimates of Western Arctic caribou herd spring calf recruitment, 1980–2005

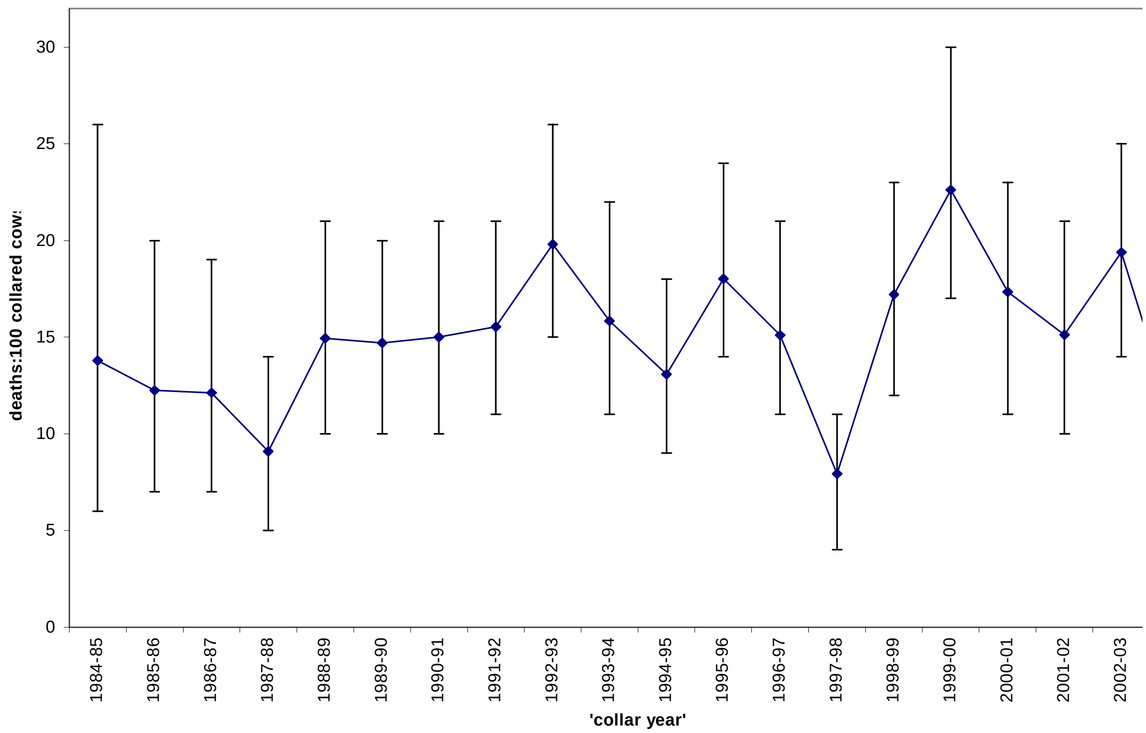

Figure 8 Annual estimates of adult cow mortality for the Western Arctic caribou herd, 1984–1985 through 2003–2004 (brackets indicate 80% binomial confidence intervals)

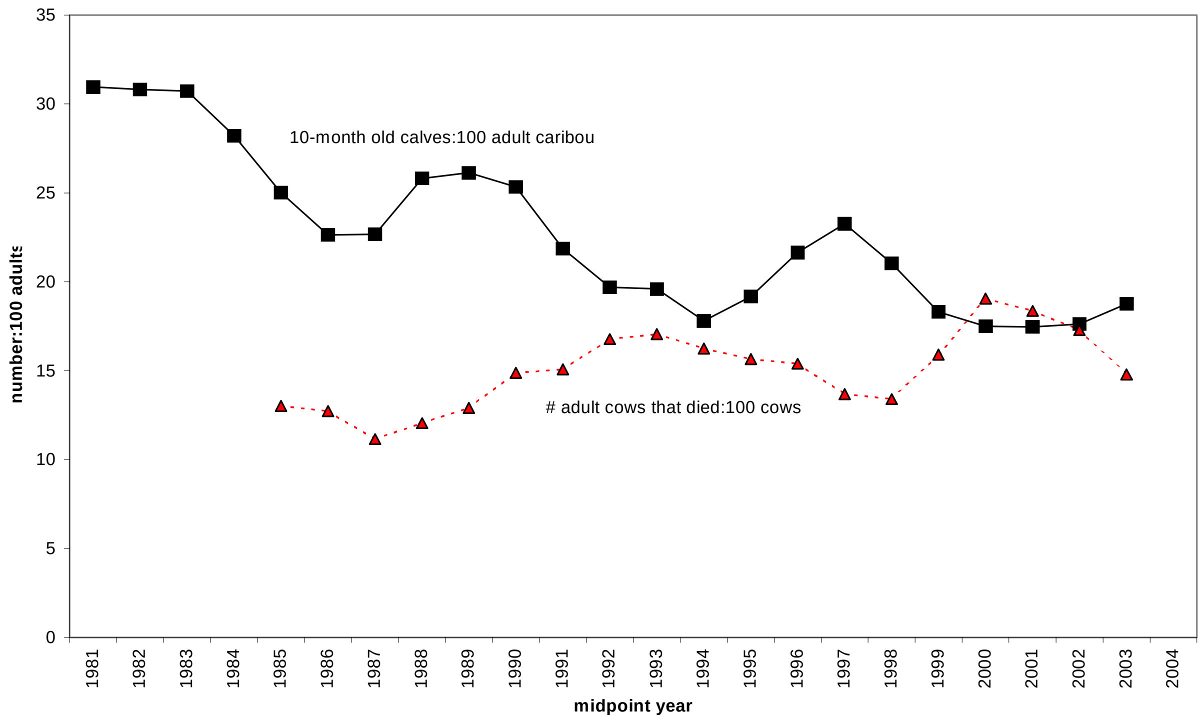

Figure 9 Three-year moving averages of Western Arctic caribou herd calf recruitment and adult cow mortality (Note: these indices of recruitment and adult mortality show trends but are not directly comparable)

Table 1 Photocensus population estimates of the Western Arctic caribou herd, 1970–1999

	Minimum population size	Mean annual growth rate[a]	Estimated population size
1970	242,000		
1971		-18	200,000
1972		-18	164,000
1973		-18	135,000
1974		-18	111,000
1975		-18	91,000
1976	75,000		
1977		19	89,000
1978	107,000		
1979		14	121,000
1980	138,000		
1981		12	154,000
1982	172,000		
1983		7	185,000
1984		7	198,000
1985		7	213,000
1986	229,000		
1987		22	280,000
1988	343,000		
1989		10	378,000
1990	416,000		
1991		3	427,000
1992		3	438,000
1993	450,000		
1994		1	454,000
1995		1	459,000
1996	463,000		
1997		1	466,800
1998		1	470,600
1999[b]	430,000	1	474,400
2000		1	478,200
2001		1	482,100
2002		1	486,000
2003	490,000		

[a] Mean annual rate of change = e^r

$e = 2.7183$; $r = [\ln(N_{t2}) - \ln(N_{t1})]/t$

t = number of years between censuses; N_{t1} = pop. estimate at $time_1$; N_{t2} = pop. estimate at $time_2$

[b] 1999 census probably underestimated population size; therefore, annual rate of change computed from 1996 to 2003.

Table 2 Aerial calving surveys from observations of radiocollared cows in the Western Arctic caribou herd, 1987–2003

Year	Median June survey date	With Calf	No Calf ≥1 hard antler	No Calf soft antler	No Calf no antler	Total	Maternal	Non-Maternal	Calves: 100 Cows
1987	16	29	0	1	9	39	29	10	74
1988	5	27	17	1	9	54	44	10	81
1989	12	34	5	2	9	50	39	11	78
1990	11	51	0	5	15	71	51	20	72
1991									
1992	12	55	6	0	10	71	61	10	86
1993	14	39	3	17	21	80	42	39	52
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

Table 3 Fall population composition of the Western Arctic caribou herd, 1961–2001

Year	Bulls	Cows	Calves	Total	Calves: 100 Cows	Calves: 100 Adults	Bulls: 100 Cows
1961	276	501	187	964	37	24	55
1970	1748	2732	1198	5678	44	27	64
1975	720	2330	1116	4166	48	37	31
1976	273	431	222	926	52	32	63
1980	715	1354	711	2780	53	34	53
1982	1896	3285	1923	7104	59	37	58
1992	1600	2498	1299	5397	52	32	64
1993	859	2321	859	4039	37	25	37
1994	1354	3284	1118	5756	34	24	41
1995	1176	2029	1057	4262	52	33	58
1996	2621	5119	2525	10265	49	33	51
1997	2588	5229	2255	10072	43	29	49
1998	2298	4231	1909	8438	45	29	54
1999	2059	4191	1960	8210	47	31	49
2001	1117	2943	1095	5155	37	27	38
2004	2916	6087	2154	11157	35	24	48

Table 4 Short yearling[a] survey results of the Western Arctic caribou herd, 1980–2005

Year	Number of caribou			Number			
	Adults	SY[a]	Total	Groups	Radio-collared cows	SY[a]:100 adults	3-yr moving average
1980	7823	2559	10382			33	
1981							31[b]
1982	3988	1164	5152			29	31
1983	5079	1648	6727			32	31
1984	1646	503	2149			31	28
1985	2776	600	3376			22	25
1986	5372	1227	6599			23	23
1987	4272	1003	5275			23	23
1988	6047	1312	7359	31	45	22	26
1989	5321	1718	7039	29	37	32	26
1990	5231	1278	6509	25	36	24	25
1991	7111	1371	8482	47	48	19	22
1992	7660	1678	9338	49	52	22	20
1993	4396	814	5210	19	33	19	20
1994	8369	1587	9956	44	53	19	18
1995	13283	2196	15479	53	86	17	19
1996	5044	1111	6155	32	36	22	22
1997	9298	2438	11736	40	56	26	23
1998	7409	1585	8994	34	46	21	21
1999	6354	975	7329	34	36	15	18
2000	8568	1559	10127	42	48	18	18
2001	6814	1294	8108	32	33	19	17
2002	8268	1258	9526	38	42	15	18
2003	8748	1633	10381	43	50	19	19
2004	7262	1627	8889	34	43	22	18
2005	8376	1026	9402	35	40	12	

[a] Short yearlings are 10–11-month-old caribou.

[b] Calculates average using values from 1980–1982.

Table 5 Geographic distribution of radiocollared Western Arctic herd caribou during winter (Nov–Mar); numbers represent percentage of radiocollared caribou located in each subarea (Note: 9 subareas[a] are shown in Figure 5)

	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Area[a]	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
1	14	13	6	12	0	0	0	5	5	9	0	1	10	4	6	9	0	5	0	5	2	0
2	0	16	6	0	0	0	0	0	0	0	0	1	0	0	0	0	9	0	0	0	0	0
3	7	13	0	0	0	0	11	0	0	2	4	0	5	0	5	1	1	4	0	4	0	0
4	24	32	12	38	49	28	20	2	53	6	1	26	33	12	6	11	42	12	22	21	12	16
5	14	11	18	0	8	1	9	0	9	6	8	3	26	4	25	31	5	5	9	13	31	5
6	0	0	0	0	0	1	1	0	6	19	4	1	2	1	0	2	12	0	2	8	20	0
7	2	0	0	0	1	5	2	3	4	4	7	6	9	59	29	24	17	43	30	42	14	19
8	17	5	53	38	39	64	56	89	21	54	75	55	16	20	30	20	5	29	5	0	20	53
9	21	11	6	12	3	1	2	0	2	0	0	8	1	0	0	1	9	2	26	7	1	6
n_i[b]	14	19	17	34	38	76	57	75	60	70	90	77	63	79	87	67	72	62	56	67	86	77

[a] Areas: 1 North Slope coastal plain west of Colville drainage; 16,378 mi^2

2 Foothills of Brooks Range west of Utukok River; 8,817 mi^2

3 Foothills of Brooks Range east of Utukok River and west of Dalton Highway; 24,082 mi^2

4 Kobuk drainage below Selby River; Squirrel drainage below North Fork; Selawik drainage; Buckland drainage; 18,928 mi^2

5 Kobuk drainage above Selby R; central Brooks Range north of Koyukuk R & west of Dalton Hwy; Noatak drainage above Douglas Crk; 12,436 mi^2

6 Koyukuk drainage south of Brook Range mountains, including Kanuti Flats, Galena Flats; 13,089 mi^2

7 Seward Peninsula west of Buckland and Koyukuk villages; 15,436 mi^2

8 Nulato Hills; 14,418 mi^2

9 Noatak drainage below Douglas Creek; Squirrel drainage above North Fork; Wulik and Kivalina drainages; Lisburne Hills; 16,541 mi^2

[b] Number of radiocollared caribou; excludes the year in which a caribou was initially collared; when a collared caribou wintered in >1winter range, we assumed time was spent equally among ranges and included appropriate fractions of use

Table 6 Caribou density (number/mi^2) in 9 subareas (Figure 5) of Western Arctic Caribou Range during winter (1 Nov–31 Mar)

Area[a]	83 84	84 85	85 86	86 87	87 88	88 89	89 90	90 91	91 92	92 93	93 94	94 95	95 96	96 97	97 98	98 99	99 00	00 01	01 02	02 03	03 04	04 05
1	1.73	1.71	0.82	2.01	0.00	0.00	0.00	1.39	1.34	2.55	0.00	0.18	2.69	1.08	1.65	2.59	0.00	1.42	1.56	1.34	0.70	0.00
2	0.00	3.81	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	4.89	0.00	0.00	0.00	0.00	0.00
3	0.59	1.16	0.00	0.00	0.00	0.00	1.82	0.00	0.00	0.40	0.73	0.00	0.92	0.00	0.90	0.29	0.28	0.81	0.00	0.76	0.00	0.00
4	2.49	3.55	1.42	5.66	8.82	5.65	4.43	0.55	12.34	1.53	0.27	6.30	7.96	2.97	1.38	2.80	10.52	3.08	5.63	5.54	3.04	4.12
5	2.27	1.80	3.25	0.00	2.18	0.40	2.93	0.00	3.23	2.07	3.04	0.96	9.75	1.43	9.58	11.66	1.87	1.88	3.43	6.37	12.49	2.09
6	0.00	0.00	0.00	0.00	0.00	0.19	0.28	0.00	1.95	6.38	1.54	0.46	0.56	0.45	0.00	0.81	4.31	0.00	0.65	2.98	7.40	0.00
7	0.30	0.00	0.00	0.00	0.29	1.13	0.47	0.86	1.18	1.25	2.12	1.93	2.62	17.81	8.88	7.33	5.38	13.35	9.94	12.32	4.54	6.31
8	2.30	0.78	8.41	7.43	9.39	16.90	16.20	26.39	6.33	16.72	23.62	17.36	5.10	6.56	9.70	6.62	1.61	9.71	1.77	0.00	6.79	18.47
9	2.57	1.36	0.81	1.99	0.55	0.15	0.44	0.00	0.44	0.00	0.00	2.16	0.22	0.00	0.00	0.43	2.61	0.70	7.47	2.21	0.35	1.96
N[b]	*198*	*213*	229	*280*	343	*378*	416	*426*	*438*	450	*454*	*459*	463	*467*	*471*	*474*	*478*	*482*	*486*	490	*495*	*500*

[a] Areas: 1 North Slope coastal plain west of Colville drainage; 16, 378 mi^2
2 Foothills of Brooks Range west of Utukok River; 8,817 m
3 Foothills of Brooks Range east of Utukok River and west of Dalton Highway; 24,082 mi^2
4 Kobuk drainage below Selby River; Squirrel drainage below North Fork; Selawik drainage; Buckland drainage; 18,928 mi^2
5 Kobuk drainage above Selby River; central Brooks Range north of Koyukuk R & west of Dalton Hwy; Noatak drainage above Douglas Crk; 12,436 mi^2
6 Koyukuk drainage south of Brook Range mountains, including Kanuti Flats, Galena Flats; 13,089 mi^2
7 Seward Peninsula west of Buckland and Koyukuk villages; 15,436 mi^2
8 Nulato Hills; 14,418 mi^2
9 Noatak drainage below Douglas Creek; Squirrel drainage above North Fork; Wulik and Kivalina drainages; Lisburne Hills; 16,541 mi^2

[b] Western Arctic Herd population size in thousands. Numbers in italics represent estimates based on population growth rates. Other numbers are census estimates; 2003–2004 population estimate assumes 1% herd growth rate.

Table 7 Annual mortality rate and binomial confidence intervals for Western Arctic caribou herd cows collared with conventional or lightweight satellite radio collars[a], 1984–1985 through 2004–2005 collar years (1 Oct–30 Sep)

				Binomial Confidence Level		
Collar year	Sample size	Nr died	Mortality rate[b] (%)	80%	90%	95%
1984–1985	29	4	14	6–26	5–29	4–32
1985–1986	49	6	12	7–20	5–23	5–25
1986–1987	66	8	12	7–19	6–21	5–22
1987–1988	88	8	9	5–14	5–16	4–17
1988–1989	87	13	15	10–21	9–23	8–24
1989–1990	102	15	15	10–20	9–22	8–23
1990–1991	100	15	14	10–21	9–22	9–24
1991–1992	104	16	15	11–21	10–22	9–24
1992–1993	107	21	20	15–25	14–27	13–28
1993–1994	102	16	16	11–21	10–23	9–24
1994–1995	108	14	13	9–18	8–20	7–21
1995–1996	112	20	18	13–23	12–25	11–26
1996–1997	107	16	15	11–20	10–22	9–23
1997–1998	102	8	8	5–12	4–14	3–15
1998–1999	94	16	17	12–23	11–25	10–26
1999–2000	86	19	22	16–29	15–31	14–32
2000–2001	77	14	18	13–25	11–27	10–29
2001–2002	87	13	15	10–21	9–23	8–24
2002–2003	99	19	19	14–25	13–27	12–28
2003–2004	100	11	11	7–16	6–18	6–19
2004–2005	115	18	16	11–21	10–22	10–24

[a] Sample size = total number of potentially active conventional or lightweight satellite radio collars active on adult cows at the beginning of the collar year

[b] Mortality rate = (Number caribou died/Sample size)100

Table 8 Annual harvests of Western Arctic herd caribou by game management unit and hunter residence ("%" is percent of total annual harvest)

		Residents within WAH range		All other hunters		Total harvest	
Reg. year	GMU	# Caribou	%	# Caribou	%	# Caribou	%
1999–00	21	16	0	3	0	19	0
	22	2128	14	36	0	2164	14
	23	10,478	69	439	3	10,917	72
	24	582	4	58	0	640	4
	26A	1340	9	53	0	1393	9
	Total	14,544	96	589	4	15,133	
2000–01	21	7	0	2	0	9	0
	22	2612	17	32	0	2644	17
	23	10,424	68	412	3	10,836	71
	24	447	3	13	0	460	3
	26A	1386	9	53	0	1439	9
	Total	14,876	97	512	3	15,388	
2001–02	21	0	0	0	0	0	0
	22	2326	16	43	0	2369	16
	23	10,279	69	402	3	10,681	72
	24	418	3	8	0	426	3
	26A	1381	9	55	0	1436	9
	Total	14,404	97	508	3	14,912	
2002–03	21			0	0		
	22	2247	15	69	0	2316	16
	23	9979	68	533	4	10,512	71
	24			19	0	19	0
	26A	1783	12	76	1	1859	13
	Total	14,009	95	697	5	14,706	
2003–04	21			0	0		
	22	1860	16	32	0	1892	16
	23	7268	63	406	4	7674	67
	24			17	0	17	0
	26A	1899	16	94	1	1993	17
	Total	11,027	95	549	5	11,576	

Table 9 Number of hunters residing outside the range of the Western Arctic caribou herd and number of caribou they harvested by sex, regulatory year, and game management unit

		Hunters			Caribou Harvested		
Reg.	GMU	Succ.	Unsucc.	Total	Bulls	Cows	Total
1998–99	21	2	5	7	2	0	2
	22	14	12	26	17	1	18
	23	340	100	440	511	51	562
	24	17	51	68	19	2	21
	26A	34	17	51	46	4	50
	Total	407	185	592	595	58	653
1999–00	21	1	2	3	2	0	2
	22	24	12	36	28	4	32
	23	279	160	439	391	21	412
	24	10	48	58	12	1	13
	26A	39	14	53	49	4	53
	Total	353	236	589	482	30	512
2000–01	21	0	5	5	0	0	0
	22	38	15	53	67	3	70
	23	383	102	485	595	28	623
	24	12	46	58	15	2	17
	26A	44	19	63	65	3	68
	Total	477	187	664	742	36	778
2001–02	21	0	2	2	0	0	0
	22	22	57	59	34	9	43
	23	252	172	424	377	25	402
	24	6	36	42	7	1	8
	26A	35	21	56	52	3	55
	Total	315	288	603	470	38	508
2002–03	21	0	4	4	0	0	0
	22	42	30	72	62	7	69
	23	343	164	507	501	32	533
	24	8	37	45	14	5	19
	26A	50	15	65	73	3	76
	Total	443	250	693	650	47	697
2003–04	21	0	1	1	0	0	0
	22	20	36	56	26	6	32
	23	236	146	382	381	25	406
	24	10	43	53	12	5	17
	26A	65	16	81	91	3	94
	Total	331	242	573	510	39	549

Table 10 Summary of community-based harvest assessments (conducted by ADF&G unless otherwise noted) for communities within the range of the Western Arctic caribou herd, 1985–2002; human population numbers in parentheses estimated during household interviews rather than by Department of Commerce and Economic Development.

Unit	Community	Survey Year	Human Population[a]	Number of WAH Caribou Harvested	Reference
21					
	Galena	1996	548	40	ADF&G[b]
	Galena	1997	536	39	ADF&G[b]
	Galena	1998	481	7	ADF&G[b]
	Galena	1999	592	8	ADF&G[b]
	Galena	2001	675	0	ADF&G[b]
	Kaltag	1996	227	16	ADF&G[b]
	Kaltag	1997	247	8	ADF&G[b]
	Kaltag	1998	227	6	ADF&G[b]
	Kaltag	1999	251	0	ADF&G[b]
	Kaltag	2001	227	0	ADF&G[b]
	Nulato	1996	328	13	ADF&G[b]
	Nulato	1997	311	3	ADF&G[b]
	Nulato	1998	282	5	ADF&G[b]
	Nulato	1999	347	0	ADF&G[b]
	Nulato	2001	341	0	ADF&G[b]
	Ruby	1999	179	1	ADF&G[b]
	Ruby	2001	192	0	ADF&G[b]
22					
	Brevig Mission	2000	276	74	ADF&G[b]
	Golovin	1989	169	40	ADF&G[b]
	Golovin	2001	146	94	ADF&G[b]
	Koyuk	1998	277	263	ADF&G[b]
	Shaktoolik	1998	235	167	ADF&G[b]
	Shaktoolik	1999	216	125	ADF&G[b]
	Shismaref	1989	472	197	ADF&G[b]
	Shishmaref	1995	560	342	ADF&G[b]
	Shishmaref	2000	562	286	ADF&G[b]
	Wales	1993	152	4	ADF&G[b]
	Wales	2000	152	0	ADF&G[b]

Unit	Community	Survey Year	Human Population[a]	Number of WAH Caribou Harvested	Reference
	Elim	1999	306	227	ADF&G[b]
	White Mountain	1999	197	93	ADF&G[b]
23					
	Deering	1994	147	142	ADF&G[b]
	Kivalina	1992	344	351	ADF&G[b]
	Kotzebue	1986	(2681)	1917	ADF&G[b]
	Kotzebue	1991	2751	3782	ADF&G[b]
	Noatak	1994	379	615	ADF&G[b]
	Noatak	1999	423	683	ADF&G[b]
	Shungnak	1998	245	561	ADF&G[b]
	Shungnak	2002	249		ADF&G[b]
	Kiana	1999	398	488	ADF&G[b]
	Point Hope	1992	699	225	Fuller and George 1997
	Selawik	1999	767	1289	ADF&G[b]
	Noorvik	2002	677		ADF&G[b]
24					
	Alatna	1997	25	21	ADF&G[b]
	Alatna	1998	25	11	ADF&G[b]
	Alatna	1999	34	0	ADF&G[b]
	Alatna	2001	36	0	ADF&G[b]
	Allakaket	1997	176	11	ADF&G[b]
	Allakaket	1998	191	43	ADF&G[b]
	Allakaket	1999	197	13	ADF&G[b]
	Allakaket	2001	97	9	ADF&G[b]
	Allakaket	2002	136	106	ADF&G[b]
	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	1994–95	318	322	Brower and Opie 1996
	Bettles	1997	23	0	ADF&G[b]
	Bettles	1998	31	25	ADF&G[b]
	Bettles	1999	36	21	ADF&G[b]
	Bettles	2002	31	0	ADF&G[b]
	Evansville	1997	44	3	ADF&G[b]

Unit	Community	Survey Year	Human Population[a]	Number of WAH Caribou Harvested	Reference
	Evansville	1998	28	4	ADF&G[b]
	Evansville	1999	24	2	ADF&G[b]
	Evansville	2002	24	0	ADF&G[b]
	Huslia	1997	218	56	ADF&G[b]
	Huslia	1998	245	264	ADF&G[b]
	Huslia	1999	283	78	ADF&G[b]
	Huslia	2001	285	0	ADF&G[b]
	Huslia	2002	217	82	ADF&G[b]
26					
	Barrow	1987	3016	1595	Braund et al. 1991
	Barrow	1988	3379	1533	Braund et al. 1991
	Barrow	1989	3379	1656	Braund et al. 1991
	Barrow	1992	3908	1993	Fuller and George 1997
	Barrow	2002–03	4581	494	Pedersen 2005
	Barrow	2003–04	7769	777	Pedersen 2005
	Atqasuk	1994–95	237	262	Hepa et al. 1997
	Atqasuk	2002–03	228	52	Pedersen 2005
	Atqasuk	2003–04	228	42	Pedersen 2005
	Nuiqsut	1985	337	513	Pedersen 1995
	Nuiqsut	1992	418	278	Fuller and George 1997
	Nuiqsut	1993	361	672	Pedersen 1995
	Nuiqsut	1994–95	418	258	Brower and Opie 1997
	Nuiqsut	1999	468	413	Pedersen 2001
	Nuiqsut	2000–01	468	600	Pedersen 2001
	Nuiqsut	2002–03	433	36	Pedersen 2005
	Nuiqsut	2002–04	433	54	Pedersen 2005
	Point Lay	1987	(121)	157	Pedersen 1989
	Wainwright	1988	506	505	Braund et al 1993
	Wainwright	1989	468	711	Braund et al 1993
	Wainwright	1992	584	748	Fuller and George 1997

[a] Human population figures from Alaska Department of Commerce and Economic Development, Alaska Community Database (www.dced.state.ak.us/mra/CF_CUSTM.htm)
[b] Alaska Department of Fish and Game Community Profile Database

Table 11 Percent positive results and sample sizes (in parentheses) for selected pathogens and haptoglobin levels from serology analyses of the Western Arctic caribou herd, 1962–2003 (Note: percentages reflect levels of exposure to pathogens rather than incidence of actual infection)

	IBR[a]		BVD[b]		PI3[c]		RSV[d]		EHD[e]		BT[f]		Lepto.[g]		Bruc.[h]		Hapto.[i]	
Year	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)	%	(*n*)
1962															30	(56)		
1963															19	(74)		
1964															14	(37)		
1965															12	(149)		
1975	18	(11)	18	(11)	0	(12)		(40)					0	(9)	14	(14)		
1981	0	(20)	0	(19)	0	(20)		(55)	0	(20)	0	(20)	0	(19)	39	(23)		
1986	5	(40)	3	(40)	24	(41)	0	(63)	2	(41)	0	(41)	0	(41)	19	(37)		
1992	5	(59)	3	(59)	22	(58)	0	(60)	0	(59)	0	(59)	3	(59)	4	(52)	0	(14)
1993	2	(63)	8		8	(63)	0	(44)	5	(63)	0	(63)	5	(63)	12	(51)	4	(25)
1994	0	(61)	5	(61)	8	(61)	0	(71)	11	(61)	0	(61)	2	(61)	11	(47)	19	(27)
1995	2	(44)	18	(44)	2	(44)	0	(75)	0	(44)	0	(44)	0	(44)	12	(34)	5	(19)
1996	6	(71)	18	(71)	11	(66)	7	(112)	0	(71)			1	(70)	3	(76)	1	(73)
1997	0	(75)	15	(75)	16	(73)	1	(52)	0	(71)			0	(75)	0	(76)	11	(62)
1998	4	(112)	21	(11)	7	(111)	8	(72)	0	(104)			15	(112)	7	(113)	16	(112)
1999	6	(70)	14	(64)	4	(52)	0	(72)	0	(74)	6	(72)	12	(77)	5	(77)	10	(77)
2000	0	(116)	10	(11)	4	(70)	0				0	(116)			6	(115)	10	(116)
2001															2	(85)	0	(83)
2002															1	(92)	3	(92)
2003															6	(107)	5	(108)

[a]IBR = Infectious Bovine Rhinotracheitis
[b]BVD = Bovine Viral Diarrhea
[c]PI3 = Parainfluenza type 3
[d]RSV = Respiratory Synctial Virus
[e]EHD = Epizootic Hemorrhagic Disease
[f]BT = Bluetongue
[g]Leptospirosis = *Leptospira* spp.
[h]Brucellosis = *Brucella suis* type 4
[i]Haptoglobin level