# Production and Early Calf Mortality in the Northern Alaska Peninsula Caribou Herd

## Final Report

Cooperative Agreement 07-022

US Fish and Wildlife Service
and
Alaska Department of Fish and Game

*by*

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*September 2007*

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## ABSTRACT

The Northern Alaska Peninsula caribou herd has declined by approximately 88% since 1989 and currently has an average fall calf ratio of 10 calves:100 cows (2003 to 2006). Calf recruitment will play a central role in the population dynamics of this herd in the coming years. This project was initiated to examine the influence of nutrition, disease, and predation on calf production and survival. Parturition surveys indicate an overall herd pregnancy rate of 64%, approximately 15% lower than the herd's estimated pregnancy rate in 1998 and 2003, which is indicative of poor nutritional condition. The survival rate of 143 radio-marked calves was 40% during their first two weeks of life, which is lower than rates reported for several stable or increasing herds of similar size in interior Alaska. The survival rate remained low after two weeks of age at 34%, approximately 30-50% lower than rates reported for those same interior Alaska herds. The majority of calf mortality site investigations revealed evidence of predation, and we hypothesize that calves may not be developing at a sufficient rate to decrease their vulnerability to predation after reaching the two-week-old milestone. We conclude that poor nutrition has adversely impacted calf production in this herd and that predation is the leading proximate cause of calf mortality.

**Key words:** Alaska, brown bear, *Canis lupus*, calf mortality, caribou, disease, predation, *Rangifer tarandus*, parturition, recruitment, survival, *Ursus arctos*, wolf.

## INTRODUCTION

The Northern Alaska Peninsula Caribou Herd (NAP) ranges throughout Game Management Units 9C and 9E on the Alaska Peninsula. Historically, herd size has fluctuated widely, reaching peaks at the turn of the century, the early 1940s, and during the late 1980s. During the late 1980s and early 1990s, liberal hunting regulations were maintained to reduce the herd to the lower limit of the population objective (15,000) because evidence suggested the traditional range could not sustain 20,000 caribou. The herd declined at a rate of 1,000 caribou per year since 1989 to an estimated population size of 2,500 by 2005 (Butler 2005).

Indications of nutritional stress and increased susceptibility to parasitism and predation, compared to caribou in herds where nutrition is good, have been documented since the mid-90's. In October 1995, 10 calves were collected to assess nutritional condition; and lung lesions, later determined to be consistent with lungworm infection, were discovered in most of the calves. In June 1996, 2 calves (approximately 1 month old) were found dead south of Port Heiden. Both had lung abscesses, and lung tissue from 1 was submitted to a pathology lab and diagnosed as bacterial pneumonia. In October 1996, 10 calves were collected for further investigation of body condition and exposure to pathogens. No evidence of viral or bacterial pathogens was found, but there was evidence of lungworm in all 10 caribou calves, which can be a major source of mortality in bighorn sheep and other free-ranging species (Forrester 1971).

In 1998, Alaska Department of Fish and Game (ADF&G) and the US Fish and Wildlife Service (FWS) cooperatively monitored pregnancy rates of breeding-aged cows and investigated causes of early calf mortality (Sellers et al. 1998). Indications of pregnancy were recorded in 81% of females ≥2 years of age (n = 620). Mortality during the first 2 weeks of life was 19% and primarily attributed to brown bears. Total mortality by 2 months of age was 35% with as much as 31% of all deaths not caused by predators. Evidence of respiratory disease was observed in several calves. The fall calf ratio observed in 1998 was 30 calves:100 cows.

By 1999 allowable harvest limits for caribou from the NAP had decreased sufficiently to preclude the use of this herd by the general public. The Alaska Board of Game and ADF&G evaluated intensive management options including habitat enhancement, predator management, and changes to hunting regulations to promote the herd's recovery. It was concluded that harvest management was the only feasible management option available. A Tier II permit was established to limit human harvests and limit permit holders to people that could show a dependence on the resource. In 1999 the Federal Subsistence Board enacted similar restrictions.

Fall calf ratios decreased from an average of 33.3 calves:100 cows (SE = 2.7) in the 1990's to an average of 10 calves:100 cows (SE = 1.7) between 2003 to 2006 (Figure 1). After evaluation of the herd's status, recruitment rates, and survival rates, managers concluded that the NAP caribou herd could no longer sustain even a limited harvest, and both state and federal hunting seasons were closed in 2005.

In an effort to better understand factors influencing the decrease in calf recruitment and continued population decline, ADF&G and FWS initiated a cooperative study to assess herd health and simultaneously investigate calf production and survival. Heavy parasite burdens and infectious disease exposure were detected in each of the eight calves and three adults that were examined during a health assessment of this herd. Clinical pathology indicated that parasites were adversely affecting the health of surveyed animals (Beckman and Hansen 2005). The calf mortality study had the following objectives:

1. Estimate pregnancy rates of cow ≥2 years of age;
2. Capture, measure, and monitor up to 60 neonate caribou annually;
3. Investigate cause of death to assess the relative roles of nutrition, disease, and predation on the recruitment process.

This report documents the findings of the 2005-2007 calf mortality study in the NAP during a period of population decline.

## METHODS

*Study Area*

The Alaska Peninsula is bordered on the north by the Bering Sea and on the south by the Pacific Ocean. The Bristol Coastal Plains on the Bering Sea side consist of flat to rolling tundra, lakes, shrub habitat, and poorly drained meadows. The Pacific side consists of mountainous terrain with steep faces and cliffs, sandy beaches, shrub habitat and sedge meadows. The Aleutian Mountain Range, which separates these areas, is characterized by glaciated mountains, steep canyons, and several active volcanoes.

NAP caribou traditionally calve between the Ugashik River and the Bear River on the Bristol Bay coastal plains in 4 primary areas (Cinder River, Meshik River, Ilnik River and Bear/Sandy River calving areas) with some calving dispersed throughout the Aleutian Range. Use of these areas has varied since the 1970's and has diminished in some areas as herd size decreased.

Caribou predators occur throughout the Alaska Peninsula at varying densities. Predators include bald eagles (*Haliaeetus leucocephalus*), brown bears (*Ursus arcticos*), coyotes (*Canis lantrans*), golden eagles (*Aquila chrysaetos*), wolverines (*Gulo gulo*), and wolves (*Canis lupus*).

*Parturition Survey*

Caribou distribution was assessed based on previously marked caribou with VHF or ARGOS satellite collars. Pregnancy rates were estimated based on a random sample of cows, ≥2 years of age encountered in calving areas between May 27 and June 1, 2005, between May 23 and June 3 in 2006 and 2007. Pregnancy was evaluated based on the presence of antlers, udder development, and/or calf presence (Whitten 1995) using a Robinson R-44 helicopter. Yearling cows were excluded based on body size.

*Calf Capture*

Beginning May 28, 2005, May 25, 2006, and May 23, 2007 daily flights were conducted using a using fixed-winged aircraft (Aviat Husky, Bellanca Scout, and Piper Supercub) to locate post-parturient cows and to evaluate the parturition status of all previously marked cows. The timing of calf collar deployment was matched as closely as possible to the progression of calving based on the calving of marked cows and the number of neonates encountered per day.

When a decision was made to deploy collars, the age of each calf encountered was evaluated from a R-44 helicopter and an attempt was made to catch all calves >2 hr old. When a candidate was located the helicopter landed to drop off one or two crew members to capture the calf by hand. To avoid abandonment, we only captured dry calves (i.e. calves that were several hours old) and avoided capturing calves that were in groups of caribou. Latex gloves were discarded after each use to avoid scent transfers that might lead to abandonment (Adams et al. 1995b).

Each calf captured was marked with VHF transmitters attached to elastic, expandable nylon collars designed to break off if the animal grows sufficiently. Radio collars weighed 134g (1.7% of body mass on average). Weight of the calf was measured using a

spring scale and cloth sling that was discarded after each use to avoid sent transfer. The calf's sex was recorded along with the condition of the umbilicus, hoof characteristics, posture, and running ability which were later used to evaluate age (Table 1). We used analysis of variance (ANOVA) to test for differences in capture weights. Birth mass was estimated using an equation developed from a large sample of calves in interior Alaska (Adams 2005).

The majority of calves were captured in the 2 core calving areas (north of the Meshik River and south of the Meshik River) used by NAP caribou during this study, but several were captured in disperse calving areas. Handling time averaged less than one minute. The total time from when a calf was selected to the time it reunited with its dam averaged three minutes.

*Survival*

Calf survival was monitored daily for all marked calves north of the Meshik River on the Bristol Bay Coastal Plain until June 10. All other marked calves were monitored in 2 to 3 day intervals until June 10 due to funding and logistical constraints. After June 10 all calves were monitored weekly until the end of June and bi-weekly until the end of August. Date of death after June 10 was assumed to be the midway point between the date the mortality was detected and the date the calf was last located alive (Adams et al. 1995b).

When a mortality was detected an investigation crew flew to the site in a helicopter to evaluate cause of death. Prior to June 10, mortality investigations typically occurred within a few hours of death and remains were transported to a field camp for a detailed necropsy. After June 10, mortalities could not be evaluated in a timely manner (>1 week transpired) for an accurate investigation although an attempt was made to determine cause of death when possible. Evidence of predation was based on wounding patterns, tracks, scat, or hair signs. We also examined all remains to determine if other factors contributed to death.

We considered the first 15 days of life to be the neonatal period (Adams 1995b). Calf survival rates were calculated using for the neonatal period and from age 16 days to 2 months of age the Kaplan-Meier staggered entry procedure and compared survival functions using the generalized log-rank test (Pollock et al. 1989). We used analysis of variance (ANOVA) to test for differences in birth mass associated with sex and year and to examine the influence of year, sex, age, and calving location on survival to a given age.

## RESULTS

*Parturition*

The pregnancy rate for NAP cows ≥2 years of age during parturition surveys was 64% (Table 2). Use of core calving areas also varied between years. During 2005 calving

occurred primarily in the Cinder River area, north of the Meshik River, and between the Bear and Sandy Rivers, south of the Meshik River. In 2006 the core calving area north of the Meshik River shifted north into the Dog Salmon River area. During 2007 the majority of caribou calved in the Aleutian Range east of the Cinder River calving area and south of the Dog Salmon River. Calving distribution south of the Meshik was similar between years, but the number of caribou observed calving near the Bear and Sandy Rivers was noticeably less in 2006 and 2007. The peak of calving was approximately May 28 in 2006 and 2007 based on the number of newborn calves observed.

*Calf Capture*

Newborn calves were observed between 20 May and 3 June each year. We captured 148 neonates estimated to be 1, 2, 3, or 4 days old at capture (49, 36, 14, and 1% respectively). This sample includes 42 calves captured and marked in 2005, 53 calves in 2006, and 52 in 2007. The number of males and females was similar (77 and 68 respectively, 3 not sexed).

Calves averaged 8.0 kg at capture. Calf weights varied by age at capture ($F_{3,87} = 3.205$, $P < 0.001$) and are generally low compared to other caribou herds in Alaska (Table 2). Birth mass estimates for males and females were 7.9 kg (SE = 0.18, n=45, range 4.5 to 10.8) and 7.5 kg (SE = 0.15, n=45, range 5.5 to 10.2) respectively. Birthmass differed between years for males ($F_{1,73} = 3582.1$, $P < 0.001$) and females ($F_{1,66} = 4970.7$, $P < 0.001$).

*Survival*

Calf survival was estimated based on the monitoring of 143 calves. Radio collar failure prevented 3 calves from being monitored through duration of the study. These 3 calves were excluded from survival estimation with the exception of 1 calf which was monitored until 19 days of age and was included in survival estimates for the first age interval (i.e. survival to 15 days). Three calves were censored from survival estimates because they failed to reunite with their dam after capture, and their deaths were assumed to be study related.

Calf survival in the NAP did not vary by year ($\chi^2 = 3.43$, df = 1, $P = 0.064$) or by calving area ($\chi^2 = 0.13$, df = 1, $P = 0.718$). Calf survival (0.15, SE = 0.04) was lower than that reported for stable increasing caribou herds of relatively small size (i.e. less than 25,000 caribou) in interior Alaska (1984-89 Denali Herd calf survival = 0.47, $\chi^2 = 9.71$, df = 1, $P = 0.002$; 1994-96 Fortymile Caribou Herd calf survival = 0.44, $\chi^2 = 22.83$, df = 1, $P < 0.001$; and 1995-96 Denali Caribou Herd calf survival = 0.35, $\chi^2 = 10.28$, df = 1, $P = 0.001$).

The low calf survival in the NAP was a combination of low calf survival to 15 days of age (0.43, SE = 0.05) and low survival for calves 16 days or older (0.36, SE = 0.08). Calf survival to 15 days of age was comparable to that reported for stable or increasing caribou herds from interior Alaska, but survival for calves 16 days or older in the NAP was significantly lower that that reported in the same herds (Figure 2).

Other factors that may have contributed to calf survival were also not significant. Birth mass was not a significant factor for explaining survival to any age interval (<15, 15-30, 31-60, and >61 days of age, $F_{3,83} = 0.011$, $P = 0.998$). Similarly timing of birth (before, during, or after the peak of calving) was also not significant ($F_{2,85} = 1.820$, $P = 0.168$).

The primary cause of mortality for calves, age 15 days or less, was predation (85% of all mortalities), primarily by wolves and brown bears (Figure 3). Other sources of mortality included 1 drowning and 2 cases of starvation. Cause of death could not be determined in 5 mortality investigations due to a lack of remains or other conclusive evidence. Starvation was concluded during the post-mortem examination of the stomach contents of 2 calves in 2006. We assume these calves starved because the dams failed to lactate. This conclusion was supported by the lack of udder development in one of the dams and a loose maternal bond.

Logistical constraints precluded timely investigations of mortality sites after June 10, but an attempt was made to determine cause of death when sufficient evidence remained. Predation was the most likely cause of death for calves older than 16 days of age based on our investigations (73%, n = 11). Determining the predator species was typically impossible due to the large amount of time that elapsed between the death and mortality investigation (mean = 24 days).

No evidence was found to suggest calves died from disease or parasites, although it is unclear how these factors may have influenced the body condition of dams or maternal investments.

## DISCUSSION

The primary goal of this project was to gain insight into the influence of nutritional condition, disease, and predation on recruitment in the NAPCH. Research in other areas has highlighted how variable caribou populations and the factors that influence them are, and how long it takes to gain insight into complex ecological relationships between caribou and other aspects of the ecosystems that they inhabit (Adams 2005, Valkenburg et al. 2002, Boertje and Gardner 1998). In spite of this, management needs and variable agency budgets require that some comparisons and preliminary conclusions be drawn. These conclusions are tentative, and data interpretations are likely to change as more data accumulate.

The low calf recruitments observed recently in the NAP result from a combination of low production and poor calf survival. Birth masses and pregnancy rates tend to decline in caribou populations that are in poor nutritional condition (Valkenburg et al. 2002). Birth mass data was somewhat ambivalent regarding the nutritional condition of the herd. NAPCH birth masses were approximately average compared to data spanning increasing and decreasing phases of the Denali Caribou Herd (Adams 2005). This may indicate that NAPCH neonates are not in peak condition, nor are they in poor condition. Comparisons

with herds other than the Denali Herd are not straightforward because caribou neonatal growth rates are typically not accounted for. Most caribou calves can be captured by hand during their first three days of life (Adams et al. 1989), and growth can exceed 10% of body mass during this period (Adams 2005). Comparisons of mass between caribou herds are also problematic in general due to baseline differences between mass and growth rates between herds (Valkenburg et al. 2002). This suggests that more data are required to document the range of variability in NAPCH birth masses before accurate extrapolations using the birth mass- nutritional condition relationship can be made. That said, after handling and weighing 96 neonates for this study, we have no evidence that low birth mass or poor neonatal condition are major factors contributing to the poor recruitment in this herd.

Parturition survey data provides more substantial evidence for poor nutritional condition in NAPCH caribou. The estimated overall pregnancy rate for the NAPCH was 60%, which is low for an Alaskan caribou herd (Valkenburg et al. 2002). Due to our methods, two- and three-year-old cows are included in our parturition sample, and these age classes have lower pregnancy rates than older caribou (Adams and Dale 1998a). This may cause a low bias in our pregnancy rate estimate. However, due to low recruitment rates in recent years (Figure 1), the proportion of cows in the NAPCH that are two- and three-year-olds should be minimal. Further, NAPCH pregnancy rates have been estimated in previous years using the same methodology employed here, resulting in pregnancy rate estimates more than 20% higher than those recorded for 2005 (Sellers et al. 2003). The low NAPCH pregnancy rate suggests that the herd may be in poor nutritional condition, in concurrence with previous hypotheses regarding the cause of the NAPCH decline (Sellers et al. 2003).

Survival data from marked calves also supports the notion that NAPCH calves may have poor development rates. The primary cause of death detected for calves was predation (Figure 3), indicating that predators play a role in the survival of NAPCH calves. This pattern is consistent with every caribou herd where calf survival rates have been studied (ex. Arthur and Del Vecchio 2003, Valkenburg et al. 2002, Boertje and Gardner 1998, Adams et al. 1995a,b). We detected 57% mortality during the first 15 days of life in NAPCH caribou, which is common even in stable and increasing caribou herds (Valkenburg et al. 2002, Boertje and Gardner 1998, Adams et al. 1995a,b; Figure 2).

In stable or increasing herds, survival rates of calves typically increase dramatically beginning at approximately 16 days of age (Adams et al. 1995a,b), and can approach survival rates of adult animals (Boertje and Gardner 1998, Adams et al. 1995b). This pattern may reflect decreasing vulnerability of calves to predation as they rapidly grow and develop motor and sensory skills (Adams 2003, Adams et al. 1995a,b). NAPCH calf survival rates for animals age 16 days or older were approximately 30-50% lower than survival rates of similar-age calves in stable or increasing herds of similar size (Figure 2). Definitive causes of death could not be determined for calves older than 16 days and older due to the large amount of time that elapsed between death and site investigation. Evidence collected during mortality investigations indicates that predators were present at

the mortality sites and consumed all or part of the carcass, but other causes of mortality can not be ruled out. Assuming these animals were killed by predators, this may indicate that calves are not developing at a rate sufficient to decrease their vulnerability to predation.

A pattern of high late-summer mortality of caribou calves due to predation has been detected in at least one other decreasing caribou herd of similar size to the NAPCH (Adams et al. 1995a). In this caribou herd, the late summer calf mortality pattern was attributed to poor development rates of calves resulting from poor nutritional condition of cows following severe winter conditions (Adams 2003). We hypothesize that the pattern of high late-summer calf mortality observed in the NAPCH in 2005 can also be attributed to poor development rates of calves resulting from poor nutritional condition of cows. While poor nutritional condition in cows can be caused by a multitude of factors including depleted range (Valkenburg et al. 2002) and environmental conditions in winter and summer (Adams 2005, Cook et al. 2004), we hypothesize that NAPCH cows may be in poor condition due, in part, to heavy parasite burdens and disease and that these factors are working alone or in combination with range limitations and predation to limit herd growth.

To evaluate these hypotheses, ADFG and FWS biologists began a collaborative project in the fall of 2005. This project involves the experimental decreases in parasite burdens from a sample of NAPCH cows to evaluate the influence of parasites on nutritional condition, health, pregnancy rates, and calf recruitment. This project will provide information necessary for effective NAPCH management strategies, and will be reported on in coming years.

## ACKNOWLEDGMENTS

This study was conducted under Assurance of Animal Care #05-06 approved by the ADF&G Division of Wildlife Conservation Animal Care and Use Committee. The U.S Fish and Wildlife Service, Alaska Peninsula and Becharof National Wildlife Refuges provided majority funding for this project and the Alaska Department of Fish and Game provided funding support. Special thanks to pilots, Dave Cox (USFWS), Patrick Valkenburg (WRAM), Troy Cambier (Chena River Aviation), and Chris Maurer (Quicksilver Air), for their expertise and assistance and to field assistants, Christina Hansen, Nicole Phillips, Dominique Watts, Erica, Kristin Sesser, and Patricia Rivera.

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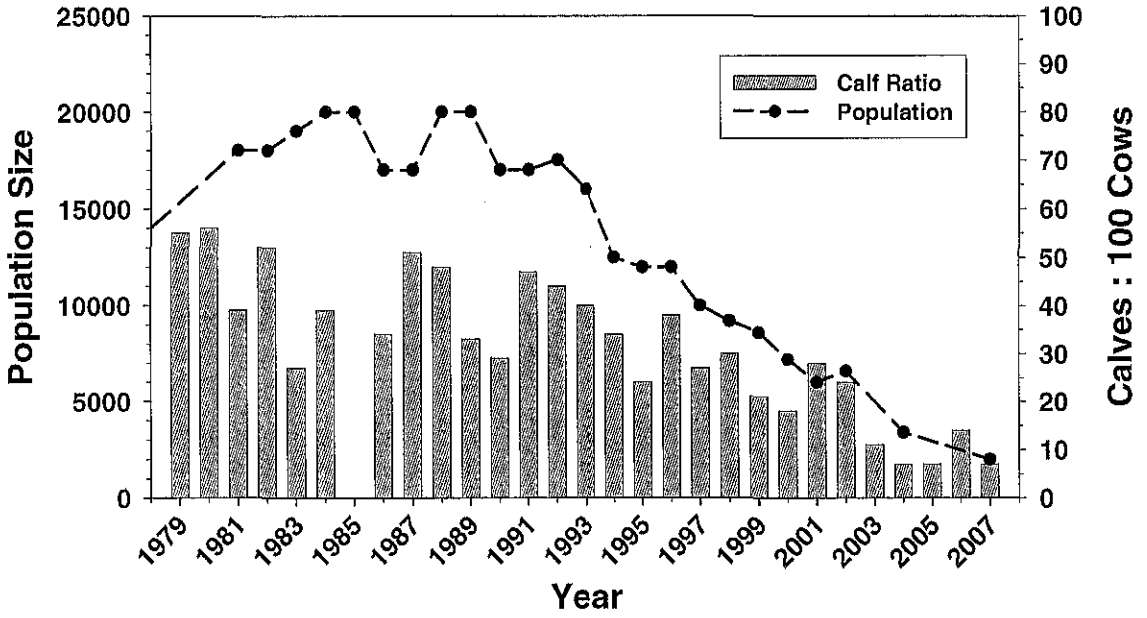


Figure 1. Population trend of the NAPCH as indexed by summer post-parturition counts and calf ratios from fall composition surveys.

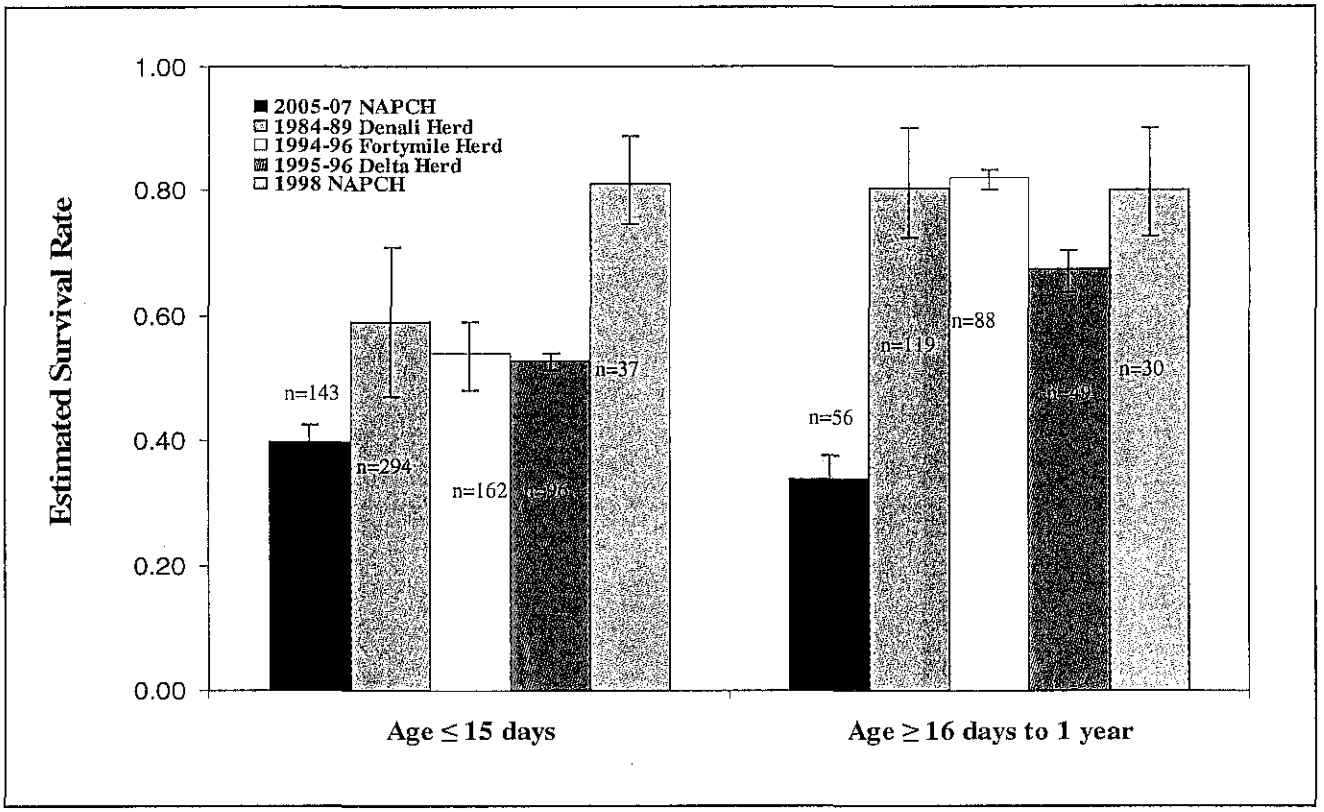


Figure 2. Estimated Kaplan- Meier survival rates of NAPCH calves in 2005 compared to survival rates of small, stable or increasing interior Alaskan herds. The reporting period for the NAPCH data is May 28- August 31. The Denali Herd numbered approximately 2500 animals and was increasing at approximately 6-8% annually during the time period depicted (data from Adams et al. 1995a,b). The Fortymile Herd numbered approximately 23,000 animals and was increasing at approximately 11% annually during the time period depicted (data from Boertje and Gardner 1998). For the Fortymile Herd, calf deaths reported during the months of May-June are included in the age ≤15 days category, and calf deaths reported during the months of July-October are included in the age ≥16 days to 1 year category (see Boertje and Gardner 1998). The Delta Herd numbered approximately 2600 animals and was approximately stable during the period depicted (data from Valkenburg 1997). For the Delta Herd, calf deaths reported during the period from May 15 - June 15 are included in the age ≤15 days category, and calf deaths reported during the period from June 16 - September 30 are included in the age ≥16 days to 1 year category (see Valkenburg 1997). Error bars for the NAPCH data represent 1 SE; error bars for other herds represent the range of estimates observed in those studies. Asterisks indicate significant difference from the NAPCH at the 0.05 level.

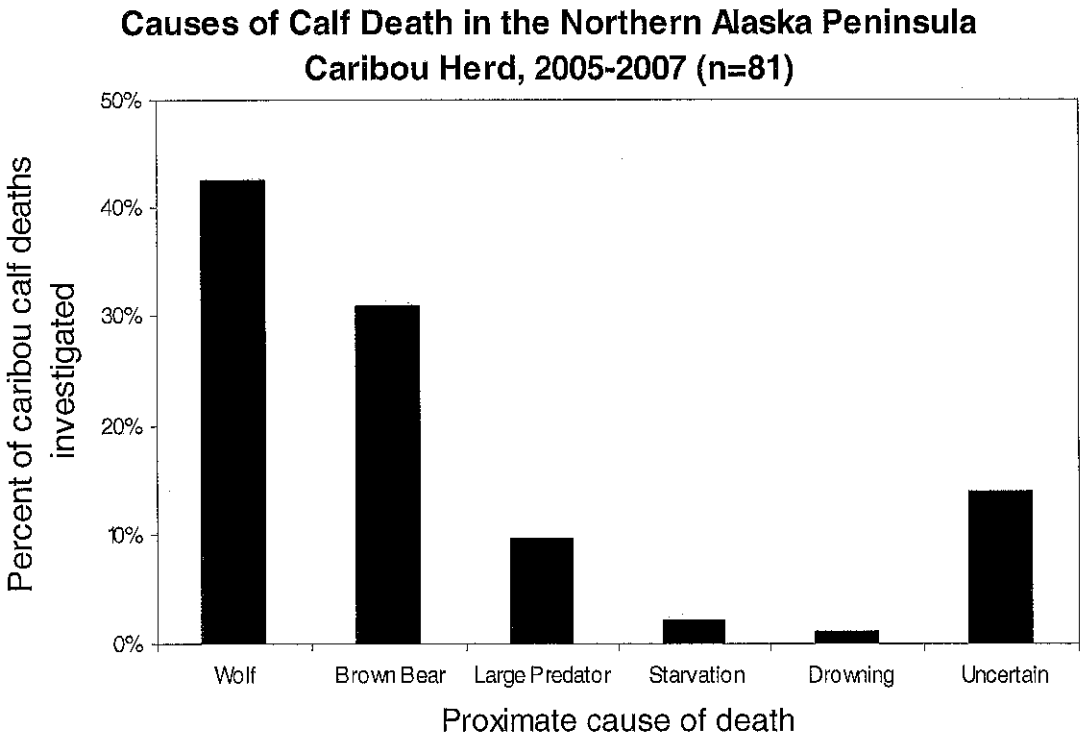


Figure 3. Proximate causes of death for 81 neonate NAPCH calves as determined from mortality site investigations and detailed necropsies.

Table 1. Criteria used for aging caribou calves, assuming that calves three or more days old could not be captured by hand. Table adapted from Adams et al. (1989).

| Age | Criteria |
|---|---|
| 1 Day (< 24 hrs) | -Running ability: Not, Barely, Wobbly<br>-Umbilicus condition: Bloody, Wet<br>-Hoof characteristics<br>Color of rim: Light<br>Hardness of rim: Soft, Partially Hard<br>Hoof wear: Not, Lightly Worn<br>-Posture<br>Back: Hunched, Straight<br>Hind legs: Bent and Splayed, Partially Straightened |
| 2 Days (24-48 hrs) | -Running ability: Wobbly, Strong<br>-Umbilicus condition: Wet, Dry<br>-Hoof characteristics<br>Color of rim: Light, Dark<br>Hardness of rim: Partially Hard, Hard<br>Hoof wear: Lightly Worn, Worn<br>-Posture<br>Back: Straight<br>Hind legs: Partially Straightened, Straight |
| 3 Days (48-72 hrs) | -Running ability: Strong<br>-Umbilicus condition: Dry<br>-Hoof characteristics<br>Color of rim: Dark<br>Hardness of rim: Partially Hard, Hard<br>Hoof wear: Worn<br>-Posture<br>Back: Straight<br>Hind legs: Straight |

Table 2. Pregnancy rate of randomly encountered caribou ≥2 years of age in the Northern Alaska Peninsula Caribou Herd during 2005 and 2006.

| Status | Determining Characteristic | May 27, 2005 (n=314) | May 23, 2006 (n=395) | May 23, 2007 (n=266) | Overall |
|---|---|---|---|---|---|
| Parturient | w/ calf | 52 | 7 | 27 | 86 |
| | Hard antlers | 58 | 218 | 116 | 392 |
| | Distended udder | 68 | 22 | 53 | 143 |
| | Total | 178 (57%) | 247 (63%) | 196 (74%) | 621 (64%) |

Table 3. Capture weights of newborn calves from selected Alaskan Herds

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Herd and year | Weight (kg) | $S_{\bar{x}}$ [a] | *N* | Weight (kg) | $S_{\bar{x}}$ | *N* |
| Delta 1995 [c] | 8.72 | 0.29 | 26 | 8.31 | 0.24 | 19 |
| Delta 1996 [c] | 8.39 | 0.23 | 22 | 7.40 | 0.19 | 28 |
| Delta 1997 [c] | 8.33 | 0.21 | 40 | 7.99 | 0.20 | 35 |
| Delta 1998 [c] | 8.41 | 0.22 | 15 | 7.70 | 0.29 | 15 |
| Delta 1999 [c] | 8.86 | 0.32 | 26 | 7.89 | 0.19 | 35 |
| Delta 2000 [c] | 7.82 | 0.28 | 25 | 7.76 | 0.32 | 16 |
| Delta 2001 [c] | 9.56 | 0.61 | 8 | 8.70 | 0.32 | 10 |
| Denali 1986–1987 [b] | 9.00 | 0.11 | 67 | 7.80 | 0.11 | 60 |
| Denali 1998 [d] | 9.4 | 0.30 | 15 | 8.4 | 0.32 | 14 |
| Fortymile 1994 [c] | 7.71 | 0.20 | 22 | 7.55 | 0.27 | 22 |
| Fortymile 1995 [c] | 8.65 | 0.16 | 24 | 7.94 | 0.19 | 25 |
| Fortymile 1996 [c] | 8.54 | 0.24 | 26 | 8.09 | 0.17 | 32 |
| Fortymile 1997 [c] | 8.52 | 0.25 | 24 | 7.97 | 0.21 | 32 |
| Fortymile 1998 [c] | 8.43 | 0.14 | 30 | 8.00 | 0.15 | 39 |
| Fortymile 1999 [c] | 8.54 | 0.18 | 35 | 7.17 | 0.17 | 40 |
| Fortymile 2000 [c] | 8.30 | 0.17 | 27 | 7.64 | 0.18 | 39 |
| Fortymile 2001 [c] | 8.10 | 0.14 | 34 | 7.53 | 0.17 | 26 |
| Mentasta 1993 [e] | 8.90 | 0.23 | 15 | 7.91 | 0.20 | 23 |
| Mentasta 1994 [e] | 8.83 | 0.21 | 18 | 8.09 | 0.19 | 23 |
| Mentasta 1998 [d] | 8.66 | 0.27 | 15 | 7.98 | 0.32 | 12 |
| Nelchina 1996 [c] | 8.26 | 0.24 | 23 | 7.19 | 0.19 | 17 |
| Nelchina 1997 [c] | 8.43 | 0.18 | 30 | 7.91 | 0.21 | 30 |
| Nelchina 1998 [c] | 8.97 | 0.20 | 30 | 8.57 | 0.18 | 30 |
| Nelchina 1999 [c] | 9.17 | 0.23 | 26 | 8.14 | 0.21 | 27 |
| Nelchina 2000 [c] | 7.66 | 0.19 | 25 | 7.02 | 0.15 | 31 |
| Nelchina 2001 [c] | 8.25 | 0.21 | 25 | 7.72 | 0.19 | 25 |
| **NAP 1998** | **8.44** | **0.24** | **19** | **7.17** | **0.30** | **20** |
| **NAP 1999** | **8.35** | **0.25** | **22** | **7.14** | **0.24** | **22** |
| **NAP 2005** | **7.93** | **0.24** | **27** | **8.14** | **0.35** | **15** |
| **NAP 2006** | **8.68** | **0.37** | **19** | **7.63** | **0.16** | **30** |
| **NAP 2007** | **9.20** | **0.24** | **28** | **8.37** | **0.13** | **22** |
| SAP 1989 | 6.70 | 0.67 | 9 | 5.40 | 0.57 | 9 |
| SAP 1999 | 7.7 | 0.28 | 25 | 7.14 | 0.16 | 29 |
| Porcupine 1983 [g] | 7.40 | 0.19 | 24 | 6.60 | 0.16 | 28 |
| Porcupine 1984 [g] | 7.30 | 0.22 | 33 | 6.70 | 0.18 | 23 |
| Porcupine 1985 [g] | 7.70 | 0.23 | 27 | 7.30 | 0.20 | 26 |
| Porcupine 1993 [h] | na | na | Na | 6.2 | 0.7 | 68 |

[a] With standard errors of about 0.2 kgs, a difference in means of 0.6 kgs would be significant at the 0.05 level.

[b] Denali data is corrected for calf age; uncorrected weights would be 0.3–0.5 kgs higher (Adams et al. 1995).

[c] Data from Valkenburg (2002)

[d] Unpublished data from L Adams.

[e] Data from Jenkins (1996).

[f] Data from Pitcher (1991).

[g] Data from Whitten et al. (1992).

[h] Data from Whitten (1995)

Table 4. Sources of calf mortality in the Northern Alaska Peninsula Caribou Herd during 2005, 2006, and 2007.

| Age Interval (days) | Cause of Death | 2005 (n=41) | 2006 (n=52) | 2007 (n=52) | 2005 - 2007 Combined (n=145) |
|---|---|---|---|---|---|
| 1-15 | Brown Bear | 9 | 10 | 9 | 28 |
| | Wolf | 9 | 14 | 16 | 39 |
| | Large predator | 2 | 1 | | 3 |
| | Drowning | 1 | | | 1 |
| | Starvation | | 2 | | 2 |
| | Undetermined | 3 | 2 | 8 | 13 |
| | Total Deaths | 24 (59%) | 29 (56%) | 33 (66%) | 86 (59%) |
| 16-30 | Brown Bear | 1 | | | 1 |
| | Wolf | 1 | | | 1 |
| | Large Predator | 6 | | | 6 |
| | Undetermined | 1 | 6 | 7 | 14 |
| | Total Deaths | 9 (22%) | 6 (12%) | 7 (13%) | 22 (15%) |
| 31-60 | Undetermined | 4 | 6 | 5 | 10 |
| | Total Deaths | 4 (10%) | 6 (12%) | 45 (13%) | 10 ( 7%) |