

**PROJECT TITLE:** DYNAMICS OF THE DENALI CARIBOU HERD, DENALI NATIONAL PARK, ALASKA: PROGRESS REPORT (OCTOBER 2005 - SEPTEMBER 2006)

**INVESTIGATORS:** Layne G. Adams and Gretchen H. Roffler, USGS-Alaska Science Center, 1011 East Tudor Road, Anchorage, AK 99503

**DATE:** JANUARY 2007

\*\*\*\*\*

Research on the population dynamics of the Denali Caribou Herd has been supported by the National Park Service since 1983. Current methodologies were put into practice in 1986 to census the population annually and estimate calf production, calf recruitment, adult female survival, and herd composition, representing the longest and most consistent effort of its kind on caribou in North America. One unique aspect of the research design is that since 1986, a sample of approximately 50 radiocollared females representative of the herd's age structure has been maintained, thus providing annual assessment of population vital rates faithful to the herd's age structure. Even with the general acceptance of the important influences of age on productivity and survival, this age-structured sample is the only one of its kind ever attempted in a wildlife population and has been maintained for 20 years.

To date, we have learned much about the interactions between predation and weather that drive the dynamics of the Denali Caribou Herd. When this study began, the caribou population was increasing at about 7%/year through a period of relatively mild winters in the mid-1980s. Winter survival of caribou cows was high (96%/year) and about 50% of the calves produced were recruited into the herd. With the onset of a period of severe winters in 1988, caribou numbers plateaued at about 3,200 in Autumn 1989 and then declined by a third over 2 years reaching about 2,300 caribou by fall 1992. During the period of decline, adult cow winter survival dropped substantially (85%/year) and calf recruitment dropped to a mere 5%. Since 1992, winter snowfall has been moderate and the caribou herd has declined slowly at about 2% annually. Adult cow survival has been comparable to the mid-1980s, but calf recruitment has continued to be relatively low (35 calves:100 cows during Autumn 1984-89 vs. 14:100 during Autumn 1994-2002).

With the overall decline in calf recruitment since 1990, the female age structure became heavily weighted towards older females. We expected that the loss of these old females over a few years would result in another period of decline for the herd, particularly that the poorest adult female survival we have recorded occurred in winter 02-03 coincident with the lowest snowfall on record for the park. However, calf recruitment has been somewhat improved the last 3 years and the herd has shown some slight growth. Although the female age structure of the herd is still somewhat weighted to older females, compared to that at the beginning of the study, the situation has improved and we expect the herd to maintain its numbers, particularly if the increase in calf recruitment continues.

This progress report summarizes research and monitoring of the Denali Caribou Herd conducted during October 2005-September 2006 (FY05). During this period, our objectives were to:

- 1) Monitor herd size and composition, adult female survival, female age structure, and calf production and recruitment;
  - 2) Relate caribou population characteristics to winter snowfall and wolf predation.
- Products from this research program are listed in Appendix 1.

## **METHODS**

### **Capture and Radiocollaring**

Caribou were captured by helicopter darting and radiocollared to monitor their survival, productivity and movements and to aid in conducting composition surveys and herd counts. We maintained an age-structured sample of approximately 60 caribou  $\geq 1$  year old by recollaring individuals every 4 years, annually recruiting yearling females relative to the ratio of female calves to adult females in the herd in the previous September, and adding additional adult females as needed to maintain sample size. In addition we instrumented 12 female calves from each cohort at 10 months of age to provide recruits for the age-structured sample and monitor productivity as 2 and 3 year-olds. Individuals that are captured as 10-month-olds but not recruited into the age-structured sample have their collars removed by 4 years of age to limit the number radiocollared individuals being monitored. All captures of new individuals were well-distributed throughout the range of caribou herd based on the distribution of existing radiocollared individuals.

Caribou captures occur primarily in March. Currently we are using a combination of carfentanil citrate and xylazine hydrochloride as an immobilant, with specific doses for adult females and 10-month-olds. A PA-18 Supercub, working with the helicopter located caribou for darting, monitored darted caribou during induction and checked on caribou captured on previous days. Once a caribou is immobilized, it was fitted with a mortality-sensing radiocollar, standard body measurements were taken, and blood sample were drawn for disease screening. All caribou were weighed to the nearest 0.1kg. A canine tooth was extracted for age determination from all adults on their first capture. Once processing was completed, caribou were given naltrexone hydrochloride and yohimbine hydrochloride to antagonize the effects of carfentanil and xylazine, respectively. Each caribou we handled was relocated within 1-3 days of capture to assess their post-capture condition.

### **Radiotelemetry: Survival, Calf production, and Seasonal Distribution**

All radiocollared caribou were relocated by aerial radiotracking from fixed wing aircraft approximately every 2 months throughout the year to determine the distribution of the herd and survival of individuals. In addition, caribou were located to assess calf production (mid-May at approximately the peak of calving), and to aid in composition surveys and the annual census (early June, late September). The annual radiotracking schedule was as follows: mid-May (natality assessment by observing calves at heel or distended udders); early June (post-calving composition survey and census); late July;

late September (fall composition survey); late November; mid-January; mid-March; and end of April. All mortalities were noted and investigated by helicopter as soon as practical.

### **Composition Surveys**

We conducted 2 composition surveys each year via helicopter. During these surveys, a predetermined search area based on the distribution of radiocollared caribou was scanned and all caribou encountered classified as cows, bulls and calves. Data were recorded on a small hand-held tape recorder. The postcalving survey was conducted annually in early June to determine calf:cow ratios and served as the basis for population estimates (see below). The annual fall composition survey was conducted near the end of September, near the peak of the rut, to determine calf:cow ratios, calf sex ratios, bull:cow ratios. During this survey, calves were differentiated by sex and bulls were classified by antler size as small (antlers indistinguishable from those of adult cows), medium (antlers larger than adult cows, but having smaller beam diameters, fewer points, and/or shorter antler length than the large bull class), and large (antlers fully developed with large diameter beams, many points, and long antler length).

### **Population Estimation**

Population size was estimated each year with continuation of current techniques. Each year in June, the distribution of radiocollared caribou was determined and a survey area that included > 50% of the marked caribou in the herd was established. That area was then searched intensively by helicopter to determine the total number of cows  $\geq 1$  year old within the survey area. Simultaneously, all radiocollared caribou in the survey area were radiotracked to determine the marked groups that are missed to allow assessment of sightability relative to group size. Because caribou tend to be in large groups at this time of the year, sightability has been consistently high. An estimate of the total number of cows in the herd was then calculated by dividing the number of cows observed in the census by the proportion of radiocollared caribou within the survey area. In addition to the estimate for a given year ( $t$ ), we used available information on seasonal adult female survival from radiotelemetry, and calf sex ratios and calf recruitment from fall composition surveys, to derive estimates based on counts of adult females in the previous ( $t-1$ ) and subsequent ( $t+1$ ) years, then used the mean of the 3 estimates as the number of adult females for year  $t$ . Finally, we determine a fall population estimate by applying the survival rate for adult females for June-September and by using the fall herd composition to account for bulls and calves.

## **FIELDWORK RESULTS**

As of 1 October 2005, 73 female caribou were radiocollared in the Denali Herd, including 56 in the age-structured sample. We conducted capture operations in March 2006 to replace radiocollars on individuals ( $n = 11$ ); remove radiocollars from individuals no longer needed per our study design ( $n = 1$ ); and to add female calves from the 2005 cohort to our sample ( $n = 12$ ). During the year, 9 radioed caribou died. Therefore, on

30 September 2006, 76 female caribou in the Denali Herd, including 60 in the age-structured sample, were instrumented with radiocollars.

### **Herd Size**

We tentatively estimated herd size in late September 2006 at 2,150 caribou (Table 1, Fig. 1), and indicative of continued modest increases of about 4% annually over the last 3 years. Herd size has increased during 2004-2006 primarily as a result of increased calf recruitment. During the last 3 years, calf:cow ratios and estimated calf numbers have averaged about twice that of 1998-2003, while estimates of adult females are about the same and bull numbers have increased slightly. Herd trend over the next few years will largely depend on whether the increases in calf recruitment continue.

### **Adult Sex Ratio**

We noted a bull:cow ratio of 39:100 during the September 2006 composition survey (Table 1). Adult sex ratios declined from an average of 56:100 during 1984-1989 to a low of 29:100 during 1997-98 as a result of increased mortality of males during severe winters in the late 1980s and early 1990s. The sex ratio has increased since then, averaging 37:100 over the last 4 years.

### **Calf Production and Survival**

We estimated a natality rate of 70% for cows  $\geq 1$  year old in mid-May 2006, based on observations of 63 radiocollared cows that comprised the age-structured sample at that time (Table 2). Natality rates have averaged 78% over the 20 years of the study. The lower than average rate in 2006 was largely due to the preponderance of yearlings and 2-year-olds in the population resulting from increased calf recruitment in 2004 and 2005. These age-classes accounted for 13 of the 19 nonpregnant females in the radioed sample. Productivity of 2-year-olds was high with 4 of 12 radiocollared individuals producing calves.

In early June 2006, we observed 38 calves:100 cows during the annual census and post-calving composition survey (Table 3). By late September, the calf:cow ratio had declined to 21:100, indicating 29% survival of the 2006 calf cohort (Table 1, Fig. 2). During 1990-2003, fall calf:cow ratios have been chronically low, averaging 13.1 calves:100 cows. Calf recruitment has improved since 2004. Given the calf sex ratio (Table 1), approximately 13 female calves were recruited per 100 older females.

### **Adult Female Survival and Age Structure**

During October 2004 – September 2005, 2 radiocollared caribou from the age-structured sampled died for an annual mortality rate of 3.2%. Interestingly, these mortalities all occurred during the summer. Thus summer survival was comparable to the long-term average of 96.4%, while overwinter survival was higher than the average (91.1%).

As with last year, changes in the female age structure in 2006 were largely due to recruitment of a relatively large number of individuals from the 2005 cohort that entered the age structure as yearlings (Fig. 4). The proportion of old cows ( $\geq 13$  years

old) in the population differed little from the last few years (Fig. 5). Although the proportion of old cows in the herd has declined markedly since 2001-2002, it is still nearly double that of 1987-1989 when calf recruitment was high and the herd was growing at about 8% per year (Fig. 5).

#### **PLANNED ACTIVITIES (OCTOBER 2006 - SEPTEMBER 2007)**

In the upcoming year, we plan to continue efforts to assess population dynamics of the DCH and investigate influences of environmental variation on those dynamics. Specifically, we plan to:

1. Capture and radiocollar caribou females as needed to maintain an age-structured sample of 60 individuals for estimation of calf production, age structure, survival patterns and seasonal distribution, and to aid in population monitoring. Instrumented caribou will be radiotracked in late November, late January, mid-March, late April, mid-May, early June, late July, and late September, or as needed to meet study objectives.
2. Conduct post-calving census and composition survey and the fall composition survey to determine herd size, calf recruitment, and adult sex ratio.

Table 1. Results of helicopter composition surveys in late September and fall population estimates for the Denali Caribou Herd, Denali National Park and Preserve, Alaska, 1984-2006.

Date	Fall Survey Results										Estimated Fall Herd Composition		
	Cows <sup>a</sup>	Calves	Bulls	Ratios (:100 Cows)		Calf Sex Ratio	Bulls% <sup>b</sup>			Fall Herd Size	Cows	Calves	Bulls
				Calves	Bulls	(m:100f)	S	M	L				
9/27/1984	375	154	184	41	49	--	--	--	--	2,200	1,158	475	567
9/25-26/1985	654	183	368	28	56	72	--	--	--	-	-	-	-
9/27/1986	547	210	305	38	56	--	--	--	--	2,470	1,272	488	709
9/25/1987	631	234	356	37	56	73	28	39	33	2,430	1,256	466	709
9/27-28/1988	678	221	451	33	67	70	27	34	39	2,950	1,482	483	986
9/28/1989	830	246	428	30	52	84	34	34	32	3,210	1,771	525	913
9/26-27/1990	777	130	387	17	50	59	39	28	33	3,100	1,861	311	927
9/26/1991	1,067	72	409	6.7	38	112	32	39	29	2,610	1,799	121	690
9/25/1992	643	103	282	16	44	66	31	40	29	2,340	1,464	234	642
9/27/1993	849	54	336	6.4	40	74	26	46	28	1,970	1,350	86	534
9/27-28/1994	648	128	253	20	39	88	21	38	41	2,140	1,348	266	526
9/25/1995	685	131	204	19	30	75	29	29	42	2,170	1,457	279	434
9/29/1996	820	103	243	13	30	69	32	26	42	2,060	1,449	182	429
9/26/1997	777	124	228	16	29	110	38	28	34	2,070	1,425	227	418
9/26/1998	718	87	205	12	29	98	41	27	32	1,790	1,272	154	363
9/29/1999	667	92	261	14	39	51	30	34	36	1,760	1,151	159	450
9/24-26/2000	730	52	257	7.1	35	86	32	31	37	1,930	1,356	97	477
9/27/2001	778	90	248	12	32	64	22	38	40	1,750	1,220	141	389
9/29/2002	453	72	145	16	32	76	22	17	61	1,960	1,325	211	424
9/30/2003	743	58	264	7.8	36	71	23	23	54	1,810	1,263	99	449

Table 1. continued.

Date	Fall Survey Results									Estimated Fall Herd Composition			
	Cows <sup>a</sup>	Calves	Bulls	Ratios (:100 Cows)		Calf Sex Ratio (m:100f)	Bulls% <sup>b</sup>			Fall Herd Size	Cows	Calves	Bulls
				Calves	Bulls		S	M	L				
9/27/2004	774	214	309	28	40	69	19	30	50	2,110	1,259	348	503
9/26/2005	848	163	279	19	33	52	32	27	41	1,920	1,262	243	415
9/28/2006	691	145	269	21	39	59	30	29	41	2,150 <sup>c</sup>	1,344 <sup>c</sup>	282 <sup>c</sup>	523 <sup>c</sup>

<sup>a</sup> Cows  $\geq$  1 year old.

<sup>b</sup> S = small: antlers indistinguishable from those of adult cows, body size comparable to cows.

M= medium: antlers larger than adult cows, but having smaller beam diameter, fewer points, and/or shorter antler length than the large bull class.

L = large: antlers fully developed with large diameter beams, many points, and long antler length.

<sup>c</sup> 2006 herd size estimate and composition are tentative.

Table 2. Estimated natality rates for the Denali Caribou Herd, Denali National Park and Preserve, Alaska during 1987-2006. Rates are based on observations a sample of radiocollared females  $\geq 1$  year old, designed to approximate the age structure of the population, during the calving season.

Year	n	Pregnant	Not Pregnant.	Natality Rate % (95% CI)
1987	37	26	11	70.3 (53.0-84.1)
1988	46	33	13	71.7 (56.5-84.0)
1989	55	37	18	67.3 (53.3-79.3)
1990	49	29	20	59.2 (44.2-73.0)
1991	44	29	15	65.9 (50.1-79.5)
1992	46	41	5	89.1 (76.4-96.4)
1993	41	27	14	65.9 (49.4-79.9)
1994	47	43	4	91.5 (79.6-97.6)
1995	50	43	7	86.0 (73.3-94.2)
1996	53	46	7	86.8 (74.7-94.5)
1997	53	42	11	79.3 (65.9-89.2)
1998	46	39	7	84.8 (71.1-93.7)
1999	48	43	5	89.6 (77.3-96.5)
2000	55	46	9	84.6 (71.2-92.2)
2001	52	43	9	82.7 (69.7-91.8)
2002	45	38	7	84.4 (70.5-93.5)
2003	42	31	10	73.8 (58.0-86.1)
2004	53	45	8	84.9 (72.4-93.3)
2005	58	43	15	74.1 (61.0-84.7)
2006	63	44	19	69.8 (57.0-80.8)

Table 3. Results of post-calving composition surveys of the Denali Caribou Herd, Alaska, 1984-2006.

Date	Cows > 1 YO	Calves	Calf: Cow Ratio
5/30,31,6/3/1984	519	201	39:100
1985		NO SURVEY	
5/28/1986	335	134	40:100
5/29-30/1987	1124	487	43:100
5/27-29/1988	1002	435	43:100
5/30/1989	1263	500	40:100
6/1/1990	1402	512	37:100
6/4-5/1991	1213	220	18:100
6/1/1992	909	278	31:100
6/2-3/1993	822	177	22:100
6/1-2/1994	985	376	38:100
5/30/1995	693	238	34:100
5/29/1996	682	139	20:100
5/31/1997	759	101	13:100
5/29-30/1998	624	141	23:100
5/29/1999	522	108	21:100
6/7/2000	665	68	10:100
6/6/2001	736	140	19:100
6/8/2002	431	120	28:100
6/8/2003	613	104	17:100
6/6/2004	673	236	35:100
6/8-9/2005	798	193	24:100
6/9,11/2006	576	218	38:100

Fig. 1. Population estimates for the Denali Caribou Herd, Denali National Park, Alaska, late September, 1986-2006. Estimate for 2006 is tentative.

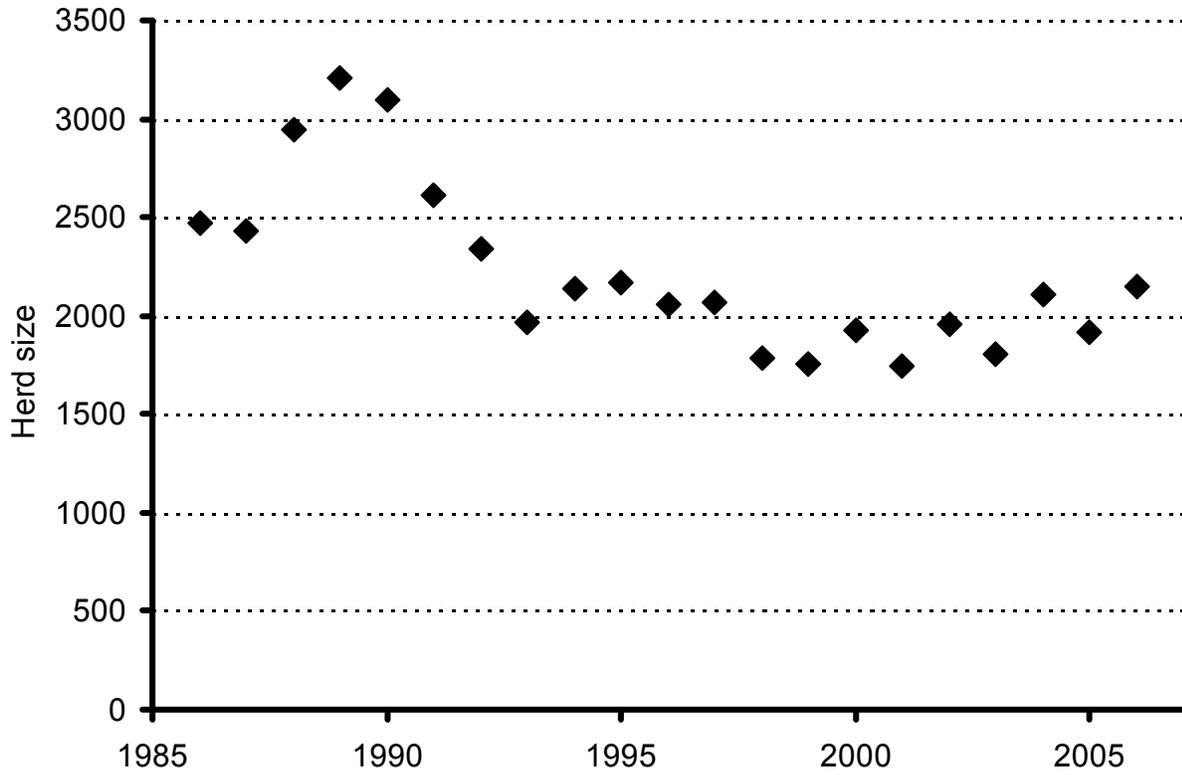


Fig. 2. Calf:cow ratios for the Denali Caribou Herd, Denali National Park, Alaska, late September, 1984-2006.

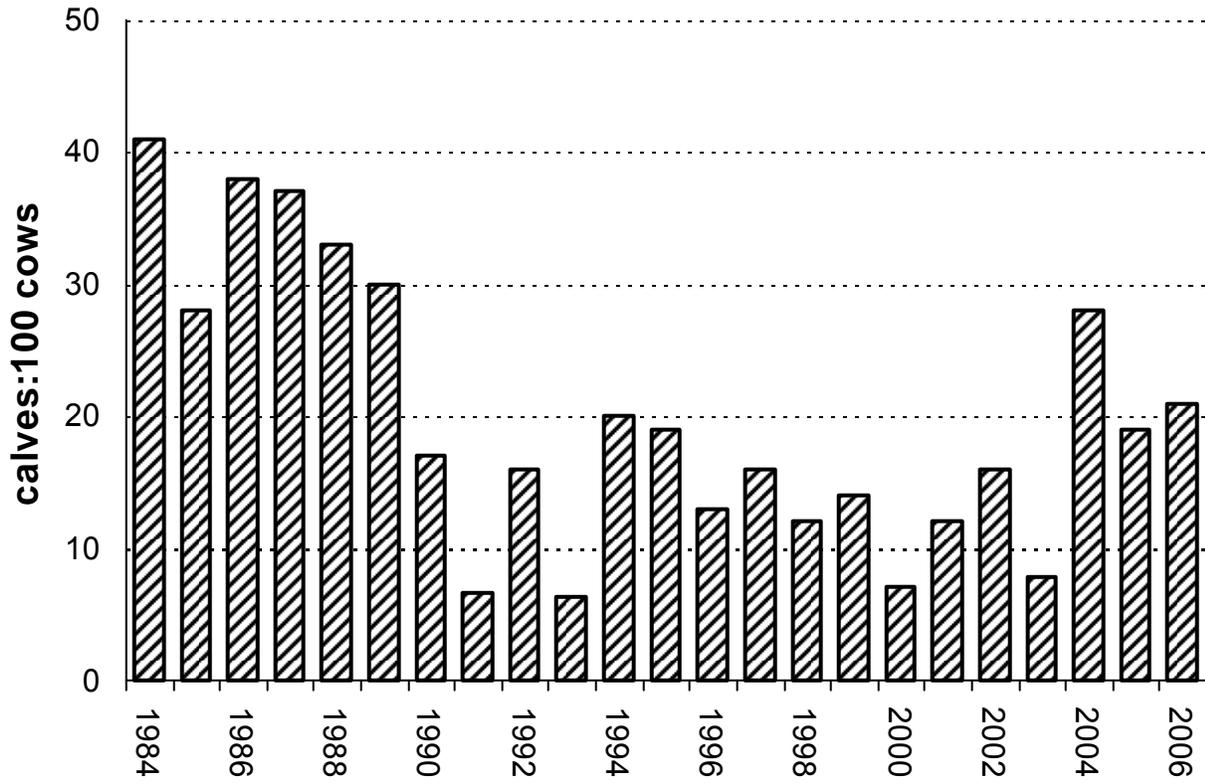


Fig. 3. Estimated winter survival rates (October–May) of caribou cows in the Denali Caribou Herd, Alaska relative to winter snowfall during 1987-2005.

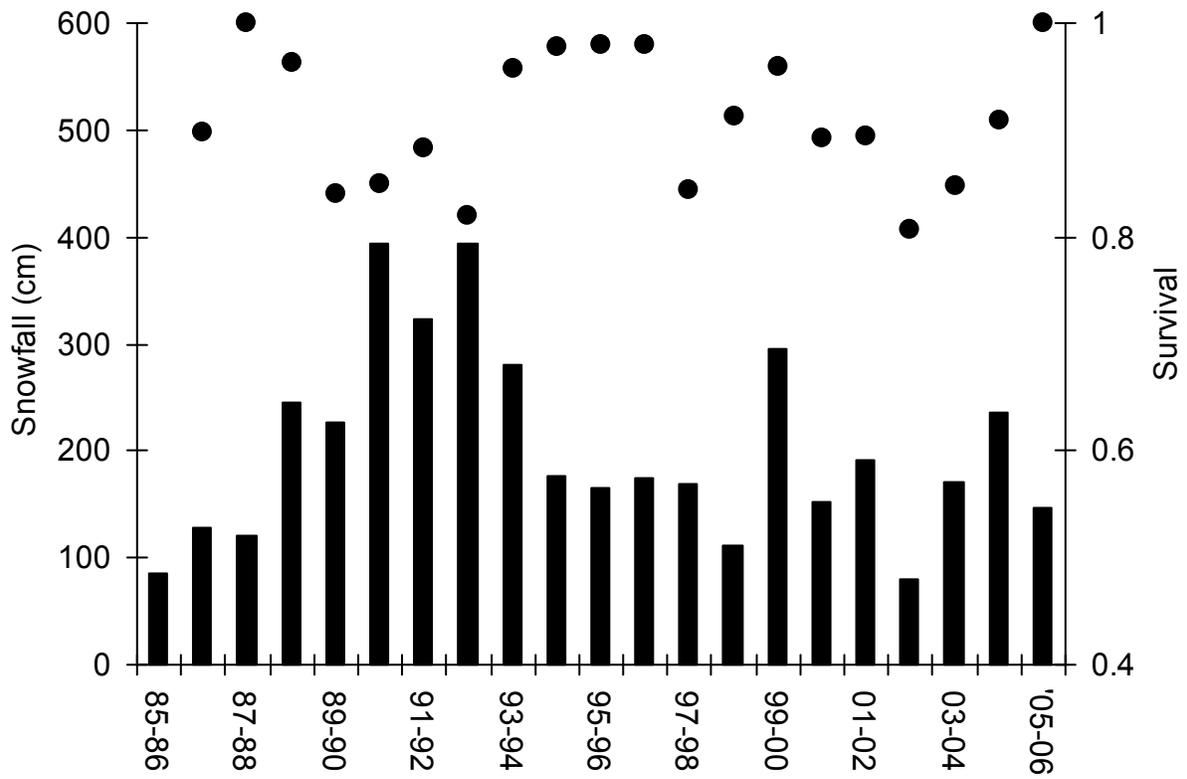


Fig. 4. Estimated age structure of the female segment of the Denali Caribou Herd on 1 May 2006 ( $n = 63$  cows).

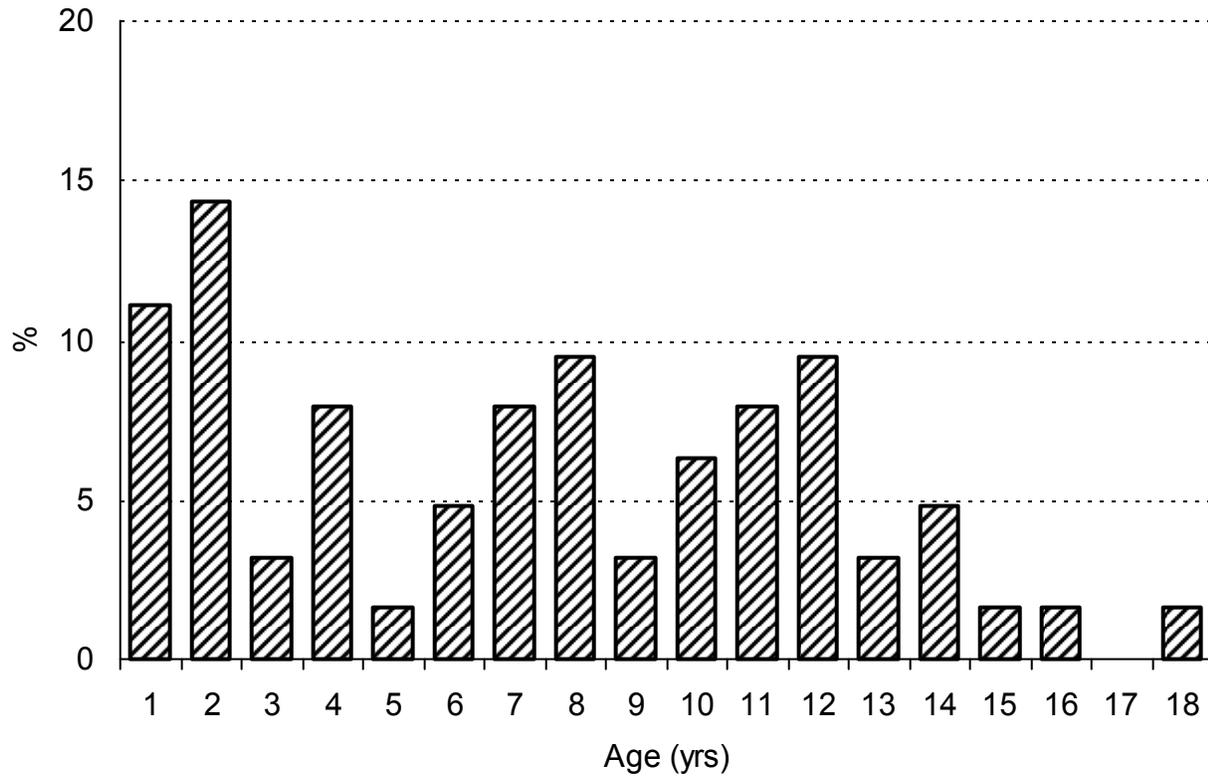
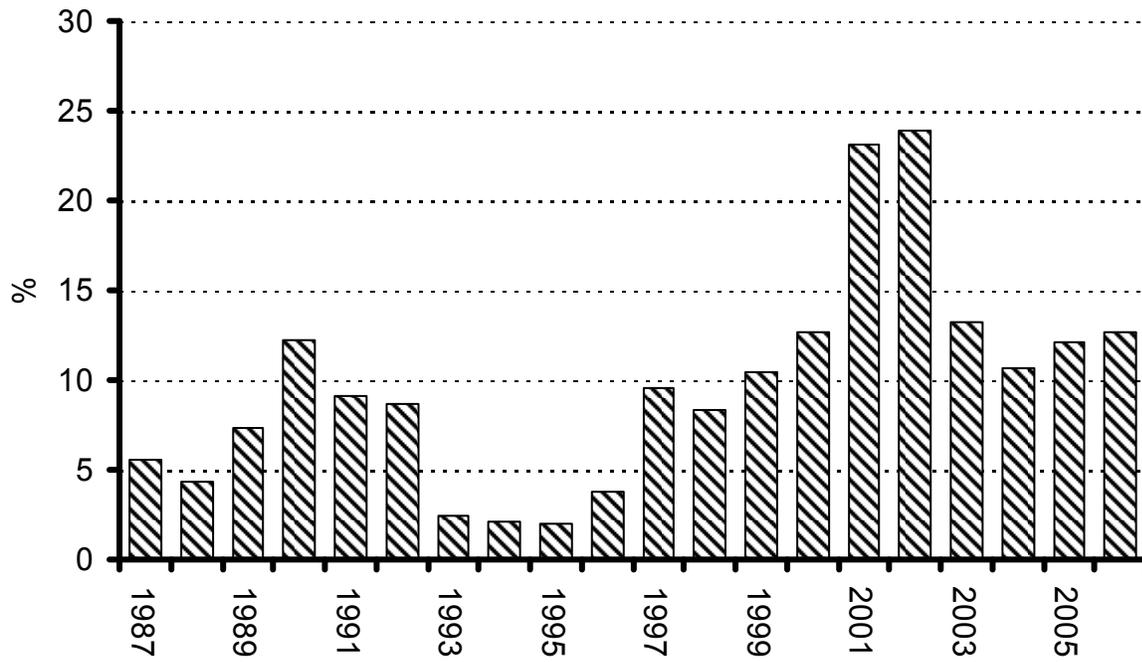
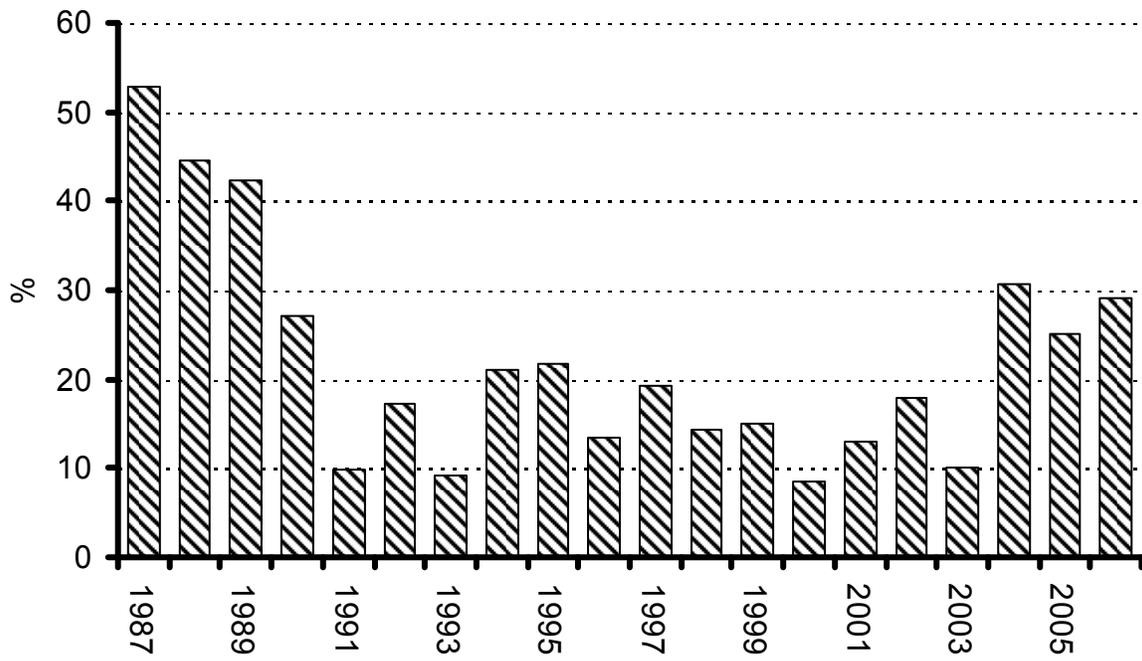


Fig. 5. Proportion of the adult female segment of the Denali Caribou Herd  $\geq 13$  years old on 1 May 1987-2006.





Appendix 1. Products of the Denali Caribou research program during 1986-2006.

Report – Adams, L.G., and G.H. Roffler. 2006. Dynamics of the Denali Caribou Herd, Denali National Park, Alaska: progress report (October 2004 – September 2005). USGS Alaska Science Center, Anchorage, AK. 15pp.

Publication - Adams, L.G., B.W. Dale, and G.H. Roffler. 2005. Extraordinary movements of the Denali Caribou Herd following the perfect storm. Rangifer Special Issue 16:19-25.

Publication - Adams, L.G. 2005. Effects of maternal characteristics and environmental variation on birth masses of Alaskan caribou. Journal of Mammalogy 86:506-513.

Report – Adams, L.G. 2005. Dynamics of the Denali Caribou Herd, Denali National Park, Alaska: progress report (October 2003 – September 2004). USGS Alaska Science Center, Anchorage, AK. 16pp.

Report – Adams, L.G. 2004. Dynamics of the Denali Caribou Herd, Denali National Park, Alaska: progress report (October 2002 – September 2003). USGS Alaska Science Center, Anchorage, AK. 11pp.

Publication - Adams, L.G. 2003. Marrow fat deposition and skeletal growth in caribou calves. Journal of Wildlife Management 67:20-24.

Report - Adams, L.G. 2002. Population dynamics of wolves and their prey in Denali National Park, Alaska: progress report (May 2000 - April 2001). USGS Alaska Biological Science Center, Anchorage, AK. 26pp. + appendices.

Publication - Ben-David, M., E. Shochat, and L.G. Adams. 2001. The utility of stable isotope analysis in studying foraging ecology of herbivores: examples from moose and caribou. Alces 37:421-434.

Report - Adams, L.G. 2001. Population dynamics of wolves and their prey in Denali National Park, Alaska: progress report (May 1998 - April 2000). USGS Alaska Biological Science Center, Anchorage, AK. 26pp. + appendices.

Report - Adams, L.G. 1999. Population dynamics of wolves and their prey in Denali National Park, Alaska: progress report. USGS Alaska Biological Science Center, Anchorage, AK. 17pp. + appendices.

Publication - Adams, L.G., and B.W. Dale. 1998. Reproductive performance of female

Alaskan caribou. *Journal of Wildlife Management* 62:1184-1195.

Book - Mech, L.D., L.G. Adams, T.J. Meier, J.W. Burch, and B.W. Dale. 1998. *The wolves of Denali*. University of Minnesota Press. 238pp.

Publication - Adams, L.G., and B.W. Dale. 1998. Timing and synchrony of parturition in Alaska caribou. *Journal of Mammalogy* 79:287-294.

Thesis - Adams, L.G. 1996. Calf production and survival in the Denali Caribou Herd, Alaska. Ph.D. Thesis. University of Minnesota, St. Paul. 152pp.

Publication - Adams, L.G., F.J. Singer, and B.W. Dale. 1995. Caribou calf mortality in Denali National Park, Alaska. *Journal of Wildlife Management* 59(3):584-594.

Publication - Adams, L.G., B.W. Dale, and L.D. Mech. 1995. Wolf predation on caribou calves in Denali National Park, Alaska. Pages 245-260 in L.N. Carbyn, S.H. Fritts, and D.R. Seip, eds. *Ecology and conservation of wolves in a changing world - proceedings of the second North American symposium on wolves*. Canadian Circumpolar Institute Occasional Paper 35. University of Alberta, Edmonton. 642pp.

Publication - Adams, L.G., and L.D. Mech. 1995. Population trends of wolves and caribou in Denali National Park, Alaska. Pages 347-348 in E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac, eds. *Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals and ecosystems*. U.S. Department of Interior, National Biological Service, Washington, DC. 530pp.

Popular article - Adams, L.G. 1992. Snowfall tips the balance of wolf-caribou relationships in Denali National Park. Pages 56-57 in *Highlights of natural resource management*. U.S. Department of Interior, National Park Service, Washington, DC. 67pp.

Publication - Davis, J.L., L.G. Adams, P. Valkenburg, and D.J. Reed. 1991. The relationship between caribou body weight and age and cohort specific reproduction. Pages 115-142 in Butler, C.E. and S.P. Mahoney (eds.). *Proceedings of the fourth North American caribou workshop*. Newfoundland and Labrador Wildlife Division, St. John's, Newfoundland. 529pp.

Report - Adams, L.G., B.W. Dale, and B. Shults. 1989. Population status and calf mortality of the Denali Caribou Herd, Denali National Park and Preserve, Alaska - 1984-1988. U.S. National Park Service Natural Resources Progress Report AR-89/13.

Anchorage, AK. 131pp.

Publication - Adams, L.G., B.W. Dale, and F.J. Singer. 1988. Neonatal mortality in the Denali Caribou Herd. Proceedings of the third North American caribou workshop. Alaska Department of Fish and Game Wildlife Technical Bulletin 8:33-34.

Publication - Adams, L.G., P. Valkenburg, and J.L. Davis. 1988. Efficacy of carfentanil citrate and naloxone for field immobilization of Alaskan caribou. Proceedings of the third North American caribou workshop. Alaska Department of Fish and Game Wildlife Technical Bulletin 8:167-168.

Popular article - Adams, L.G. 1987. Fate of caribou calves studied in Denali. Page 16 in Highlights of natural resource management. U.S. Department of Interior, National Park Service, Washington, DC. 53pp.

Report - Adams, L.G. 1986. Population status and neonatal mortality of the Denali Caribou Herd-progress report. U.S. National Park Service Natural Resources Progress Report AR-86/05. Anchorage, AK. 13pp.