Alaska Department of Fish and Game
Division of Wildlife Conservation
Research Progress Report

CAUSES OF LOW CALF RECRUITMENT IN THE SOUTHERN ALASKA PENINSULA CARIBOU HERD AND RECENT HERD HISTORY

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a cooperative project between the Alaska Department of Fish and Game, Wildlife Conservation and the U.S. Fish and Wildlife Service, Izembeck Wildlife Refuge.

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This is a progress report on continuing research. Information may be refined at a later date.

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BACKGROUND

The Southern Alaska Peninsula Caribou (*Rangifer tarandus*) Herd (SAPCH) ranges over about 4,900 km^2 from Port Moller to the tip of the Alaska Peninsula (Fig. 1). The area is of volcanic origin, and annual seismic and volcanic activity has occurred recently. Largely unvegetated habitats of glaciers, snowfields, or ash-flats dominate at elevations above 300 m. Lowlands are characterized by wet herbaceous meadows with numerous lakes and streams. Interspersed within lowlands are areas of ericaceous shrub tundra. This habitat type characterizes midland elevations from 50 to 300 m. Lowland and midland habitats compose essentially the entire range of the SAPCH.

Climatic conditions on the SAPCH range, as measured by the National Weather Service at Cold Bay, are characterized by mild winter and summer temperatures, incessant winds, cloudy skies, and frequent but not high precipitation. The average wind speed is 16.9 mph with frequent, sustained winds in excess of 50 mph. The average annual temperature is 37.9°F. The average February and August temperatures are 27.5°F and 51.2°F, respectively. Annual precipitation averages 35 inches. In 1989 measurable precipitation occurred on 232 days. Although it rains or snows often, large amounts seldom fall. Appreciable amounts of snow seldom accumulate because of warm temperatures and frequent rain and wind.

Few options for range expansion or dispersal are available to the SAPCH, making it a somewhat insular. Areas to both the northeast and southwest (Fig. 1), the only directions the herd could move to, are already inhabited by caribou.

From the mid-1970's to the early 1980's the SAPCH appeared to be increasing. In July 1975 Irvine (1976) estimated that the herd contained 2,627 caribou; 29% were calves. An additional 3,334 caribou were counted on Unimak Island. In 1981 U.S. Fish and Wildlife Service (USF&WS) personnel from Izembek National Wildlife Refuge began periodic surveys to monitor herd size and calf recruitment. In 1983 they obtained their highest count of 10,203 caribou. Calf recruitment was fairly low at that time; calves represented only 15% of the herd in October. Since that time the herd has declined; the 1989 herd estimate was about 4,000 caribou (Johnson 1989, USF&WS files). Calf recruitment has been as low as the July calf percentages, averaging only 13% from 1981 to 1989. Comparable calf percentages in the more productive Northern Alaska Peninsula Caribou Herd (NAPCH) have ranged from 25% to 30% in recent years (Johnson and Sellers 1989).

Poor nutrition may have been a factor in the chronically poor calf recruitment, resulting in low birth rates or low

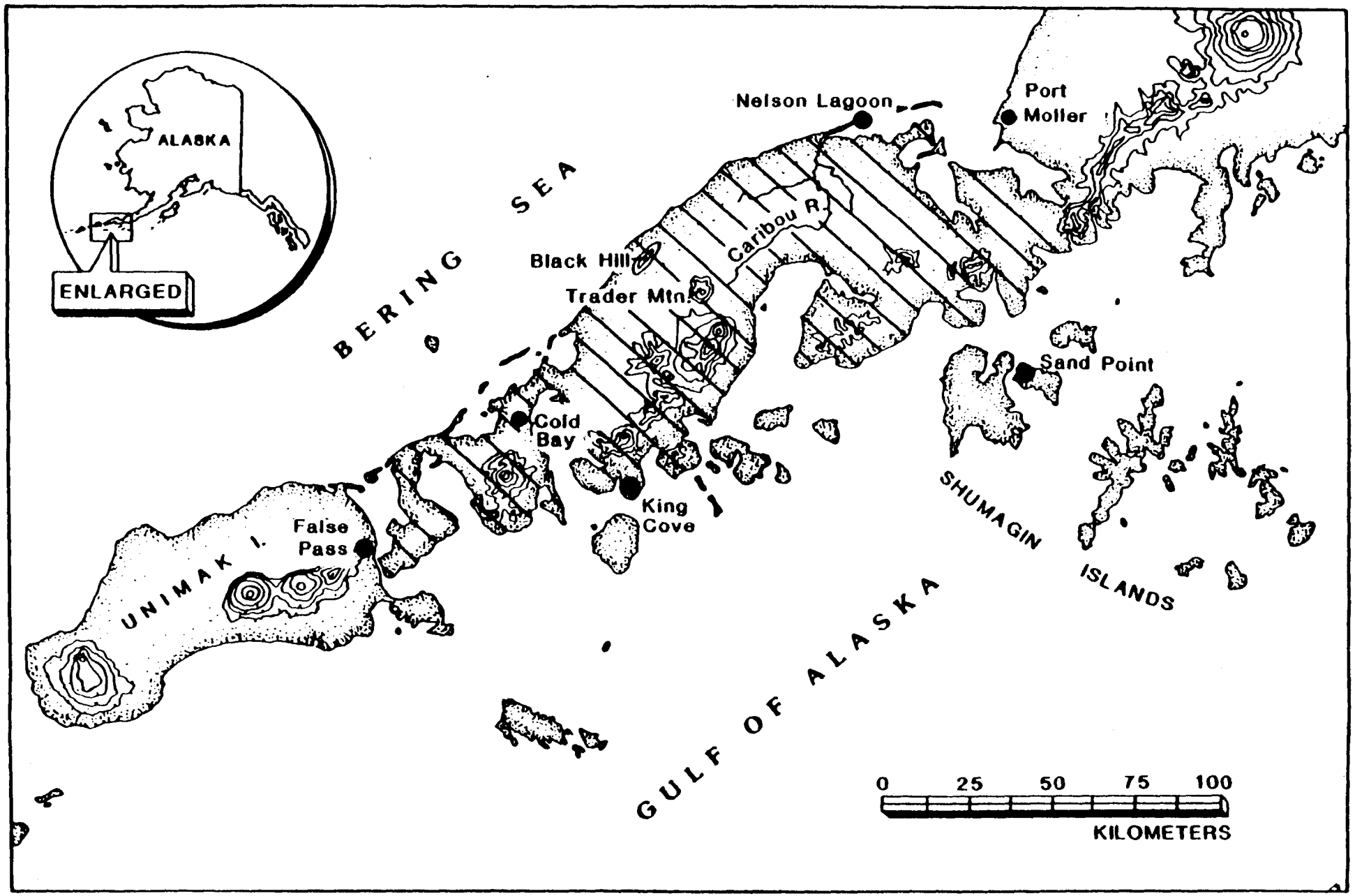

Figure 1. Range of the Southern Alaska Peninsula caribou herd.

viability of newly born calves. Sellers (1988) noted that cows captured during April were in poorer condition than those from the neighboring NAPCH and plant phenology in the spring lagged substantially behind that on the NAPCH range, placing additional nutritional stress on animals that were already in poor condition after a winter on substandard range. The SAPCH range is atypical of many caribou ranges because lichen abundance is low. It has not been determined whether the low lichen abundance is the result of prolonged high utilization by caribou or the habitat is unsuitable for extensive production.

Predation, perhaps exacerbated by undernutrition, is another possible cause of low calf recruitment. Little specific information is available; however, both wolves (*Canis lupis*) and brown bears (*Ursus arctos*) commonly occur on the SAPCH range, and both are known predators of adult and calf caribou. Golden eagles (*Aquila chrysaetos*), which are known to prey on caribou calves, are rare on the SAPCH range. Although bald eagles (*Haliaeetus leucocephalus*) are common there, they are not a known predator of caribou.

The purposes of this report are to review the past population dynamics of the herd and report on recent field investigations conducted on the range of the SAPCH, including those accomplished on the calving grounds from 29 May through 16 June 1989. This is a cooperative project between the Alaska Department of Fish and Game (ADF&G) and USF&WS. The general strategy of the field investigations was to determine if the apparent trend of poor calf recruitment was continuing and, if so, its likely causes. Findings of reduced birth rates and/or low birth weights would support the hypothesis that nutrition was a key factor in poor recruitment. Normal birth rates and weights, in conjunction with extensive evidence of predation on neonates, would discount the nutritional hypothesis.

OBJECTIVES

To collate and critically examine recent population dynamics data for the SAPCH.

To estimate the birth rate for females of the SAPCH.

To estimate birth weights for calves in the SAPCH.

To estimate short-term calf recruitment to the SAPCH.

To determine why calves are dying, if the birth rate is normal and recruitment is low.

To evaluate growth of SAPCH animals in relation to caribou from other Alaska herds.

To determine the timing of calving for the SAPCH and to compare it with calving dates for other southern Alaska herds.

To estimate the natural mortality rate for adult females in the SAPCH.

To estimate the composition of the winter and spring diet of the SAPCH.

PROCEDURES

Historical herd estimates and composition data were obtained from reports produced and files maintained by USF&WS and ADF&G. Linear regression of the natural logs of annual counts by year was used to determine if trends in caribou abundance existed and to estimate r, the observed mean annual exponential rate of change (i.e., rate of increase) (Caughley 1977). Linear regression of the percentage of calves in the herd by year was used to determine if trends in recruitment had occurred.

Estimates of birth rates were generated by 3 independent methods. A helicopter survey was conducted late in the calving period to determine the proportion of cows with distended udders (Bergerud 1964). Shortly before giving birth, pregnant cows develop distended udders. For cows that are nursing calves, the udder remains enlarged until fall when the calf is weaned. If a calf dies the mother's udder gradually shrinks, becoming unrecognizable within about 3 weeks. Therefore the proportion of cows with distended udders late in the calving period is a close approximation of the birth rate. Whitten (1989) found that only about 90% of females that gave birth developed large udders before parturition and some females no longer had visible udders within 2-11 days after losing their calves; therefore, the udder count technique may slightly underestimate birth rates. In 1989, 19 radio-collared cows were closely monitored from fixed-wing aircraft during the calving period to determine the proportion giving birth and the calving chronology. A small sample (8) of adult female reproductive tracts were collected after the breeding season from hunter-killed animals in 1987 and examined for the presence of fetuses and/or corpora lutea of pregnancy in order to estimate pregnancy rate.

Young calves (approximately zero to 3 days old) were captured by landing a helicopter nearby and chasing them on foot. They were weighed by suspending them from a hand-held scale using a broad leather belt. Disposable surgical gloves were worn during handling and changed after each capture.

Low level surveys were conducted from a Piper Supercub (PA 18) fixed-wing aircraft both early and late in the calving period and in mid-October, when caribou were classified as calves or adults for the calf recruitment estimate. Approximately 80 hours of low-level aerial surveys were flown in a Piper Supercub and in a

Hughes 500 helicopter over the calving grounds of the SAPCH during the calving period. Another 20 flight hours were spent relocating radio-collared animals through the fall and winter. Observations of dead caribou and potential predators were recorded.

Jaw length measurements were obtained from mandibles collected from hunter-killed caribou of known sex. Ages were estimated from eruption and wear of molariform teeth (Skoog 1968). Mandible lengths provide a good index of skeletal growth (Suttie and Mitchell 1983). Weights were obtained from adult females captured for radio-collaring.

Fecal samples were analyzed for dietary components using the microhistological technique (Sparks and Malechek 1968) at the Wildlife Habitat Management Laboratory at Washington State University. A listing of vascular and nonvascular species potentially occurring in the diet of caribou on the southern Alaska Peninsula was provided to the laboratory. Two fecal pellets each from 25 individual pellet groups were collected during 3 sampling periods: two in December 1988 and one in June 1989. Results are presented as the percentage of total occurrences of taxonomic groupings encountered in each composite sample. While this technique is known to have produced biased data, most major foods can be identified (Dearden et al. 1975, Boertje et al. 1985).

Estimates of mean annual survival rates and associated confidence intervals were made for radio-collared animals using the software program MICROMORT (Heisey and Fuller 1985). The procedure is based on the number of mortalities experienced by radio-collared animals and the period of time the radio-collared animals were monitored.

Differences in the proportions of calves in the Caribou River Flat (CRF) and Black Hill-Trader Mountain (BHTM) subgroups (areas) during late June and mid-October recruitment surveys (time) were evaluated using a logit loglinear model (Agresti 1984). Differences in weights of SAPCH animals from caribou in other Alaskan herds were tested using the Kruskal-Wallis one-way analysis of variance and Mann-Whitney U-test (Sokal and Rohlf 1969).

RESULTS AND DISCUSSION

Very few data are available regarding herd size and dynamics prior to 1975. In 1925 Murie estimated that 5,000 caribou inhabited the southern Alaska Peninsula and another 7,000 were on Unimak Island (Skoog 1968). In 1949 the USF&WS estimated 500 caribou in the SAPCH and less than that on Unimak Island. In 1975 ADF&G censused the SAPCH, counting 2,267 caribou and an additional 3,334 on Unimak Island (Irvine 1976). Irvine reported

29% calves for the SAPCH in July, indicating excellent early recruitment at that time.

Since 1981 USF&WS or ADF&G have obtained yearly estimates of herd size as well as indices of calf recruitment (Table 1). The population estimates do not appear to have always been accurate, because the interannual variation is unrealistically large. The data suggest an increasing population during the late 1970's and a general declining trend ($\underline{P} = 0.05$) during the 1980's (Fig. 2). This assessment is also supported by calf recruitment data that suggest high recruitment in the late 1970's and low recruitment with no trend ($\underline{P} = 0.98$) in the 1980's (Fig. 3).

Complicating our understanding of historical SAPCH population dynamics is the unknown magnitude of immigration of Unimak Island caribou to the SAPCH range. Skoog (1968) reported on historical movements of caribou between Unimak Island and the southern Alaska Peninsula. The winter of 1975-76 on Unimak Island was severe, and an ADF&G fisheries biologist flying in the area reported a winter mortality of 30-40 caribou. Fishermen reported seeing caribou crossing False Pass from Unimak Island to the mainland during the summer of 1976. The number of Unimak Island caribou declined from several thousand to several hundred in the mid-1970's, and it is conceivable that immigration could have played a role in the increase of the SAPCH between 1975 and the early 1980's.

The overall SAPCH range comprises an area of approximately 4,875 km^2. The current density, based on an estimated herd size of 4,000, is 0.8 caribou per km^2. This is a relatively high density, now exceeded in Alaska only by the Western Arctic, Nelchina, Mulchatna, and Adak herds. The density in 1983, when the herd was estimated at 10,203, was 2.1 caribou per km^2, which is over twice as high as any current Alaskan herd; however, insular Alaskan reindeer herds, in the absence of bears and wolves, have reached densities of about 18 caribou/km^2 before declining precipitously to near extinction (Scheffer 1951, Klein 1968).

Initial radio-tracking surveys flown on 29 and 30 May indicated the SAPCH was primarily located in the BHTM area, the CRF, and long the Bering Sea lowlands from Moffet Lagoon to the Cathedral River. Animals in the first 2 locations were primarily females, while the latter group was composed of mostly males. Based on the proportion of radio-collared animals found in each of the areas and the number seen during recruitment and udder counts, we estimated that roughly 20-30% of the female segment of the herd was in the CRF, while most of the remaining females were in the BHTM region. A few females were scattered between the 2 areas; the 2 concentrations of females were about 40 km apart.

Calving had begun by 29 May; 6 calves were observed during the first radio-tracking survey, including calves of 2 radio-collared females, in the CRF. No calves were seen in the BHTM vicinity

Table 1. Summary of population statistics for Southern Alaska Peninsula caribou herd (from ADF&G) S&I reports).

Year	Population estimate	Summer calf%	Bulls /100 cows
1975	2,627	29	
1977		27	
1981	6,000	12	
1982	7,000	13	
1983	10,203		
1984	7,500	17	
1985	4,044	6	
1986	4,543	17	32
1987	6,401	12	36
1988	4,000	16	41
1989	4,000	10	

Table 2. Calving success of radio-collared females from the SAPCH from 29 May through 16 June 1989.

Caribou no.	Calving area	Gave birth	Lost calf	Calving date
071	Black Hill	Yes	Yes	10 June
101	Black Hill	No		
170	Caribou R.	Yes	No	29 May
191	Black Hill	Yes	No	8 June
210	Black Hill	No		
221	Black Hill	Yes	No	11 June
300	Black Hill	Yes	Yes	12 June
410	Caribou R.	Yes	No	29 May
631	Black Hill	Yes	Yes	10 June
661	Black Hill	Yes	Yes	15 June
704	Black Hill	Yes	Yes	?
730	Black Hill	Yes	No	6 June
749	Caribou R.	Yes	Yes	6 June
130	Black Hill	Yes	No	5 June
140	Black Hill	Yes	Yes	10 June
300	Black Hill	Yes	Yes	10 June
330	Black Hill	Yes	Yes	11 June
370	Black Hill	Yes	Yes	8 June
420	Black Hill	No		

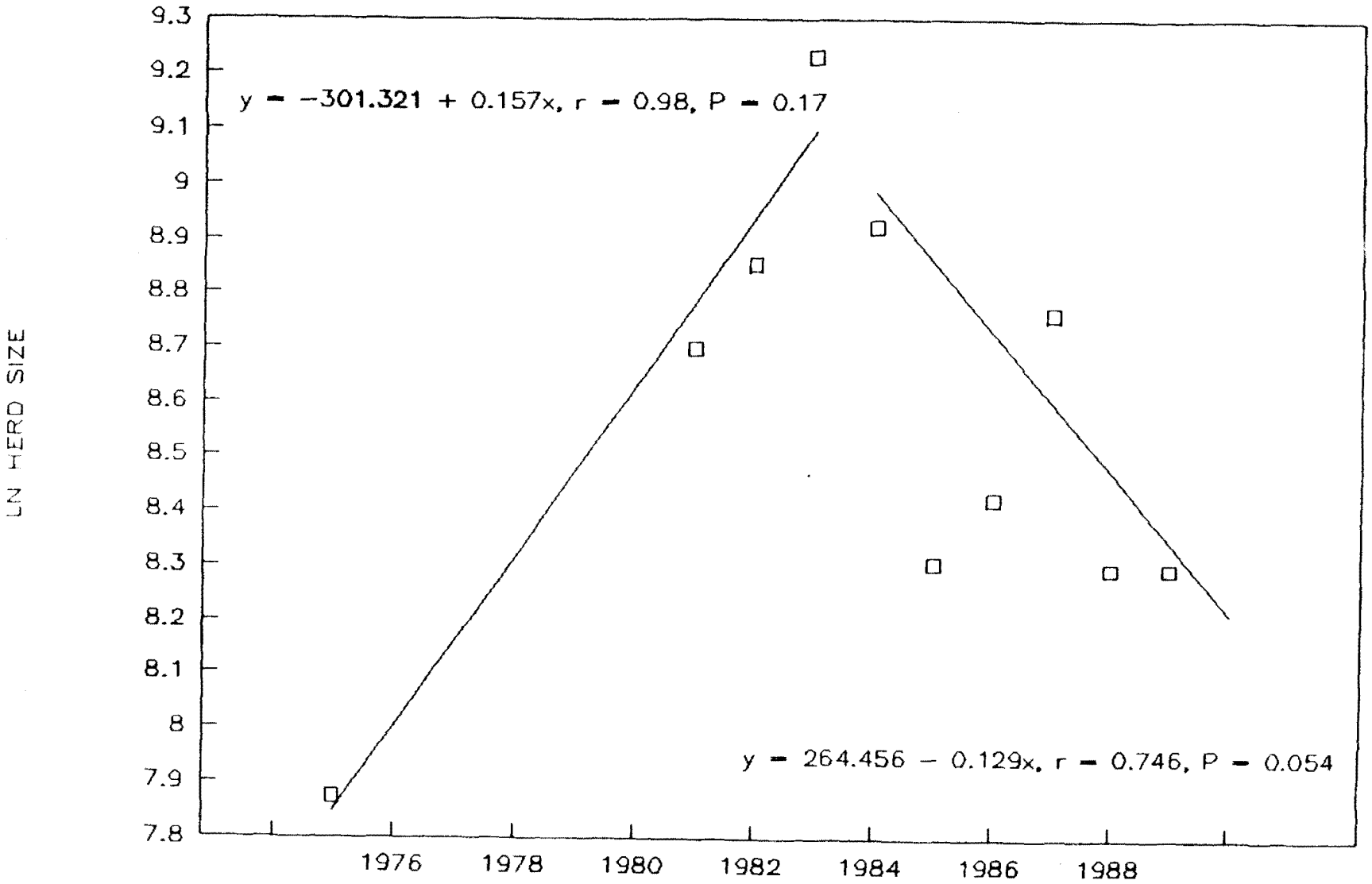

Figure 2. Linear regressions describing observed changes in numbers of the Southern Alaska Peninsula caribou herd, 1975-1989.

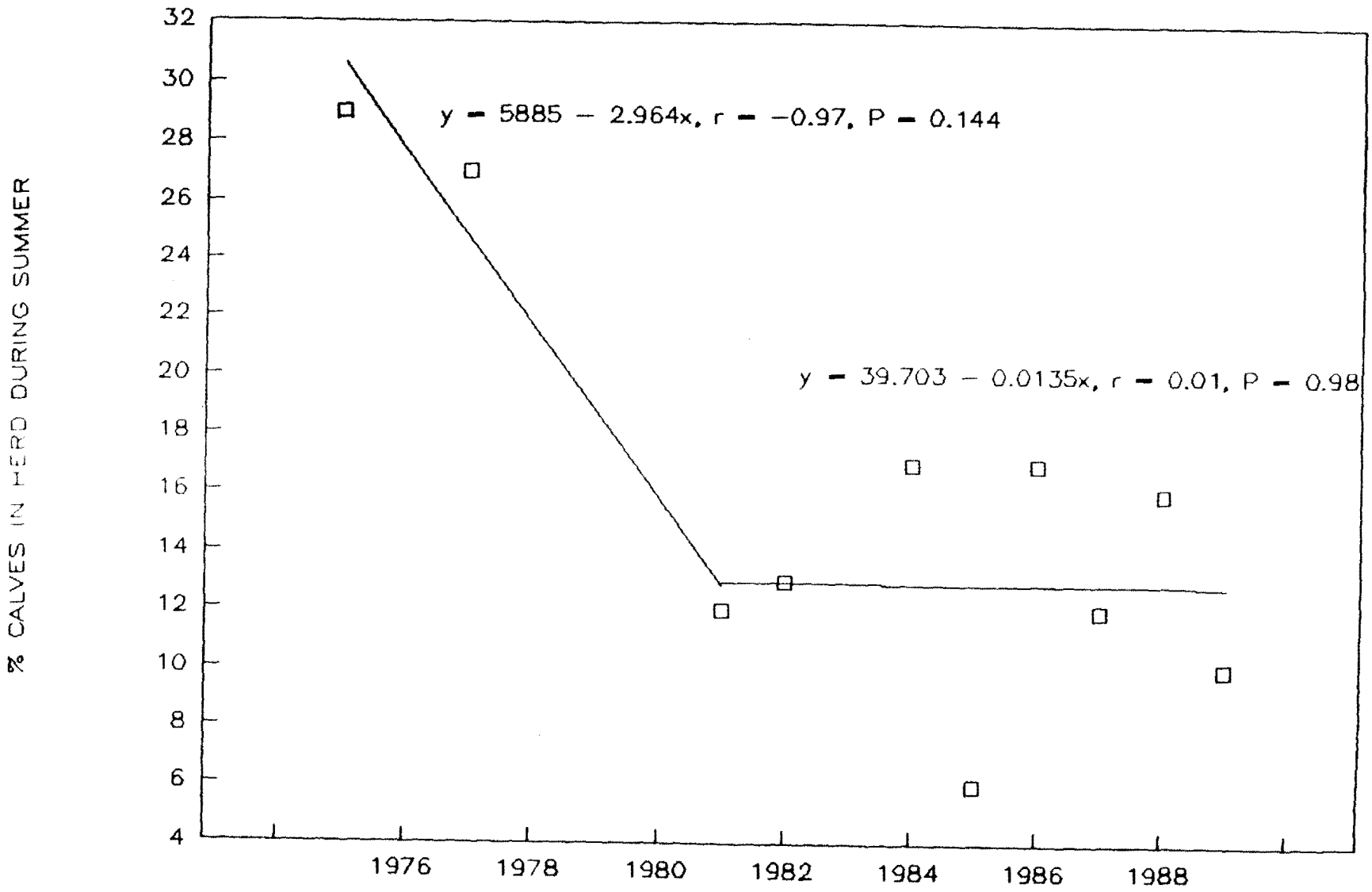

Figure 3. Linear regressions describing early calf recruitment to the Southern Alaska Peninsula caribou herd, 1975-1989.

until 4 June, at which time many calves were present on the CRF. It was apparent that calving occurred over 1 week earlier in the CRF than in the BHTM area. All 3 radio-collared females on the CRF had calved by 6 June (mean of 1 June), while calving by 13 radio-collared animals in the BHTM area ranged from 5 to 14 June (mean of 10 June) (Table 2). On 4 June, 166 (18%) of a sample of 939 caribou on the CRF were calves, while in the BHTM region only seven (0.7%) of the 1,070 caribou classified were calves. Calving by caribou in southern Alaska herds generally peaks in late May (Skoog 1968, Lieb et al. 1989), which is earlier than that for the SAPCH, particularly the BHTM group. Late calving has been suggested as indicative of undernutrition (Espmark 1980, Skogland 1984, Reimers et al. 1983.). Calving in the Denali Caribou Herd, which was not thought to be nutritionally stressed (Boertje 1985), peaked on 13 May in 1987 and 1988 (Adams et al. 1989), nearly a month earlier than that for the SAPCH. Calving in the adjoining and more productive NAPCH occurs about 1 week earlier than calving in the SAPCH.

The birth rate for adult females from the SAPCH, as estimated from the sample of radio-collared females, was 84%: 16 of 19 gave birth (Table 2). During an udder survey made about midway through the calving period, 73% of the 332 females classified had distended udders (Table 3), indicating recently past or imminent parturition. These estimates were not strictly comparable. All radio-collared females were mature animals, and the udder count sample contained some sexually immature animals, accounting for the lower estimate. Seven of 8 adult females (88%) harvested after the breeding season by hunters in the Cold Bay area in 1987 were pregnant. Skoog (1968) estimated that the fertility rate for females 1 year old and older in the Nelchina herd at 72%, nearly identical to the comparable estimate of 73% from udder counts in this study. He estimated the fertility rate of females 3 years old and older at 89%, similar to the 84% estimate obtained from the samples of mature radio-collared females and hunter-killed females from the SAPCH. Bergerud (1980) reported that the mean pregnancy rate for mature females from North American caribou herds was 82%, with only minor variation between herds. It appears that birth rate of mature females from the SAPCH falls within the normal range of values for other North American caribou herds.

On 13 June, when calving was thought to be nearly completed, surveys were conducted to estimate early calf recruitment (Table 4). Recruitment appeared high on the CRF, where calves composed 33% of the sample. In the BHTM region recruitment was much lower, because calves made up only 11% of the sample. Calves composed only 2% of 129 caribou classified in the Moffet Point area; however, animals in this area were primarily bulls. Overall calves composed 20% of the total sample. The dramatic difference observed in recruitment counts between the CRF and BHTM calving areas tended to be supported by production and survival of calves by radio-collared females in the 2 areas. All

Table 3. Helicopter survey of the SAPCH on 9 June 1989 to estimate proportion of parturient cows.

	Black Hill		Caribou R	
	no.	%	no.	%
Cows w/calves	32	13	38	48
Cows w/o calves & w/ distended udders	152	60	20	25
Total Parturient Cows	184	73	58	73
Cows w/o calves & w/o distended udders (nonparturient cows)	69	27	21	27

Table 4. Fixed-wing survey of SAPCH calving grounds on 13 June 1989 to estimate early calf recruitment.

Area	No. adults	No. calves	% Calves
Carbiou R.	476	237	33
Black Hill	1,326	151	11
Moffet Pt.	129	2	2
Totals	1,931	390	20

3 radio-collared females in the CRF produced calves and two of the three still had calves on 16 June when monitoring ceased. In the BHTM area 13 of 16 radio-collared females produced calves; however, only four of the 13 that produced calves still had them on 16 June.

Subsequent surveys indicated that substantial calf mortality occurred after the 13 June survey. During the ADF&G census conducted on 11 July, 10% of a sample of 686 caribou were classified as calves. None of the radio-collared females were accompanied by calves as of 30 August. A recruitment survey conducted on 14 October (Table 5) indicated that the percentage of calves in the herd had declined to 3%. The same geographical pattern of calf recruitment observed in June appeared to persist in October, because the calf percentage was 13% on the CRF, compared with 2% in the Black Hill to Cold Bay area. The best fitting logit loglinear model showed a significant interaction between area and time on proportion of calves (G^2 = 58.19, 1 df, P = 0.99).

It is unclear why such a large proportion of the calves died. Only 5 dead calves were observed; four of these were still being attended by females. Three of these calves (two that were examined from the ground) were intact and had not been killed by predators nor scavenged. The other two, which were seen only from the air did not appear to have been killed by predators, but were damaged in the umbilical area, probably the result of scavenging by birds (2 bald eagles were perched nearby in 1 instance).

We flew approximately 80 hours of low level surveys in the vicinity of the SAPCH calving grounds between 29 May and 16 June and observed no instances of predation on calves, although known caribou calf predators, including brown bears, wolves, and golden eagles, were seen in the area. Brown bears were relatively abundant in the area; we made a minimum of 112 sightings (not unique individuals). Each of these sightings was checked to see if it was associated with a kill. One bear was observed eating an adult caribou. Brown bears did not seem to be specifically associated with calving caribou until late in the calving period. On 16 June several bears were seen approaching groups of caribou containing calves in the BHTM area. Generally, brown bears seemed more abundant in the BHTM area than on the CRF. Although we made no observations of bears killing or eating calves, it was likely, based on bear abundance and distribution and caribou calf availability, that some calves were killed by bears.

A wolf den, attended by a least 3 adult wolves, was located mid-way between the 2 calving areas. Although no instances were noted of predation on caribou by wolves, some probably occurred because caribou are the only large mammalian prey consistently available to wolves on the SAPCH range. Golden eagles were seen on 2 occasions but are considered rare in the area. They are not significant predators of caribou calves in the SAPCH. Although

Table 5. Fixed-wing survey of SAPCH range on 14 October 1989 to estimate calf recruitment at 4 months of age.

Area	No. adults	No. calves	% Calves
Caribou R.	126	18	13
Black H.-Cold Bay	1,528	36	2
Totals	1,654	54	3

Table 6. Comparative mean weights and mandible measurements for caribou from selected Alaskan caribou herds.

Herd	Yerd	Female calf wt (kg)	Male calf wt (kg)	Female adult wt (kg)	Female adult mandible lgth (cm)
SAPCH	1987-88	5.4	6.7	90.1	263
Porcupine	1984-87	6.7	7.1	92.1	
C. Arctic	1987			89.3	
W. Arctic	1960'S				263
W. Arctic	1980's				270
Nelchina	1989				286
Mulchatna	1988				284
NAPCH	1988			103.0	266
Denali	1986-87	8.3	9.5	120.9	291
Adak	1966-86				289

predation undoubtedly occurs on caribou calves, it is likely that other factors (i.e., undernutrition?) also played a major role in the mortality of calves. Based on field observations, other biologists (J. Davis, R. Boertje, W. Gasaway pers. commun.) have discounted predation as a major cause of neonatal mortality in the Delta and Denali Caribou Herds, only to deduce from later studies that it was the predominant cause.

A survivorship estimate for adult female caribou from the SAPCH was based on the monitoring of 36 radio-collared females for varying intervals between April 1987 and June 1989. These caribou were monitored for a total of 468 months; 15 natural mortalities were recorded. Mean annual survivorship was estimated at 0.62 (95% confidence interval = 0.46 to 0.77). This level of mortality is exceedingly high. Estimates of survivorship for adult females from other herds in southern Alaska were 0.91 for the Nelchina herd (Pitcher 1987) and 0.92 for the Mulchatna herd (ADF&G files). Bergerud (1980) reported annual adult mortality rates of 7% to 13% if predators were common and 5% to 6% if predators were rare. We have no information on causes of death for the radio-collared sample. We visited nearly all death sites on 8 and 9 June 1989; however, there were few remains, and none were recent. Wolf scats were seen at 3 sites, and a brown bear had buried remains at another site; however, whether they were scavenged or killed is unknown.

We saw 3 dead adult caribou during our surveys. A bear was feeding on an adult caribou on 30 May; we were unable to tell whether it had killed or scavenged it. On 3 June the skeletal remains (intact rib cage) and hair from 1 adult was seen near Black Hill. On 10 June a fairly fresh adult carcass with intact rib cage and spinal column was seen on the CRF calving area.

Weights were obtained from 17 young calves from the SAPCH (Table 6). Mean weight of 9 female calves was 5.4 kg (SD = 1.7). For 9 male calves mean weight was 6.7 kg (SD = 2.0). Weights for both sexes were significantly less ($P = 0.0001$) than those for calves captured from the Denali caribou herd (Adams et al. 1989). Female calves from the SAPCH were smaller ($P = 0.027$) than those captured from the Porcupine Caribou Herd in northeastern Alaska (Whitten et al. 1985), while male calves were not ($P = 0.16$). Calves of undernourished females have reduced birth weights and survival (Skogland 1984). Low birth weights may be correlated with low calf survival (Haukioja and Salovaara 1978). Espmark (1980) found that calves of undernourished female reindeer had low birth weights and tended to be somewhat physically retarded at birth, reducing chances of survival. He also found that undernourished females tended to be more intolerant of their calves, increasing risks of desertion. Bergerud (1980) reported that small calves that he tried to raise invariably died.

Live weights of 12 adult female caribou captured in October of 1987 and 1988 averaged 90.1 kg (SD = 7.1) (Table 6). These weights were similar to those in the Central Arctic ($P = 0.90$)

and Porcupine herds ($P = 0.23$), but they were less than for the Denali herd ($P < 0.0001$) and the adjoining NAPCH ($P = 0.0002$). Mandible lengths of 40 adult females harvested in the Cold Bay area averaged 263 mm (SD = 8.2). A similar sample of 34 males averaged 283 mm (SD = 12.2). These weights and measurements (Table 6) are small for caribou from southern Alaska herds (with the exception of mandible length from the NAPCH) and are comparable in size to animals from the Western Arctic, Central Arctic, and Porcupine herds (Skoog 1968; Adams et al. 1989; Cameron et al. 1989; S. Fancy and K. Whitten pers. commun.).

There is some indication that body size may have declined in the SAPCH over the past 10 years. Clayton Brown, manager at the Russell Creek hatchery and longtime resident of Cold Bay, reported a substantial reduction in body and antler sizes since the early 1980's. Prior to that time an adult bull and cow provided about 52 kg and 34 kg of boned meat, respectively. In recent years only about 40 kg and 21 kg of boned meat have been obtained from mature bulls and cows, respectively. Dick Gunlogson, a registered big game guide who has hunted caribou on the SAPCH range since the 1960's, noted that antler development of bulls has declined since the late 1970's or early 1980's. John Sarvis, former Izembek refuge manager who lived in Cold Bay between 1974 and 1988, noted a reduction in the occurrence of large antlered bulls in the early 1980's, suspecting the intensive harvest of mature males that occurred in the late 1970's and early 1980's (i.e., when SAPCH caribou became available to hunters along the Cold Bay road system) as the cause.

Results of fecal dietary sampling are summarized in Table 7. The winter samples were composed of over 50% mosses, an unusually high occurrence, even considering the overrepresentation of mosses that occurs using this technique (Dearden et al. 1975, Boertje et al. 1985). This high proportion of mosses, which are of low digestibility and considered to be low-quality forage, has been rivaled only by herds on Arctic islands; e.g., Peary and Svalbard Islands (Thomas and Edmonds 1983, Reimers 1982). Boertje (1984) felt that relatively high uses of evergreen shrubs and mosses indicated poor range condition.

The winter samples also contained 16% lichens, which is probably an underestimate of their importance in the diet because of the high occurrence of mosses (Boertje et al. 1985); this is surprisingly high, considering their scarcity on the SAPCH range. Lichens compose over 50% of the winter diet of many herds (Scotter 1967, Skoog 1968, Thompson and McCourt 1981, Boertje 1984). Most surprising was the near absence of sedges (<1%) found in the SAPCH winter samples. Sedges with green tissues are considered an important winter food of caribou (Skoog 1968, Boertje 1984) and appear to be abundant on the SAPCH range.

Table 7. Percentage composition of plant fragments in caribou fecal samples collected on the SAPCH range during 3 sampling periods.

Species/group	(Sampling period) December 88	December 88	June 89
	Percentage of total composition		
Moss (Type 1)	21.8	14.1	7.5
Moss (Type 2)	31.3	20.9	3.4
Club Moss			0.3
Other Moss	4.7	17.7	2.1
Total Moss	57.8	52.7	13.3
Lichen (Alectoria)	9.4	8.0	2.9
Lichen (Fruticose)	4.6	6.5	1.8
Lichen (Foliose)	1.6	4.7	1.5
Total Lichen	15.6	19.2	6.2
Sedges	0.8	0.3	12.2
Festuca			5.8
Calamagrotis			12.3
Unk. Grasses	4.4	5.1	1.9
Total Grasses	4.4	5.1	20.0
Shrubs[1]	16.4	17.4	34.3
Forbs[2]	0.6	5.0	9.8
Unk. Leaf	4.4		
Hair		0.3	4.2

[1] Winter samples were primarily *Empetrum*, *Arctostaphylus*, *Vaccinium* and small amounts of *Salix* and *Cornus*. Spring sample mostly *Salix* and *Arctostaphylus* and small amounts of *Empetrum*, *Vaccinium*, *Rubus*, and *Equisetum*.

[2] Both winter and spring samples contained *Solidago*, *Trientalis*, and *Angelica*. The spring samples also contained *Artemisia* and *Epilobium*.

SUMMARY AND CONCLUSIONS

Findings of this study corroborated earlier findings and suspicions of low calf recruitment, high adult mortality, and resultant declining herd size. The SAPCH calved primarily in 2 areas; the CRF and the BHTM vicinities and could be reasonably considered 2 herds, according to traditional definition (Skoog 1968); however, this will be clarified by additional radio-collaring and radio-tracking. Birth rates appeared to be normal in both areas. Calving for the SAPCH was late, relative to other southern Alaska caribou herds. Calves were born at least 1 week earlier in the CRF than in the BHTM areas. Early calf survival was much lower in the BHTM than the CRF areas and this pattern appeared to persist into October. The combined findings of small adult body sizes, low calf birth weights, late calving dates, observations of dead calves that had not been killed by predators, and low-quality winter diet suggested that undernutrition may be an important factor in low recruitment in the SAPCH, particularly in the BHTM vicinity. Findings of early calving and higher early calf survival on the CRF suggested differences in the condition of females utilizing the 2 calving areas. Females calving in the CRF may spend the winter and spring in different areas than those that calve in the BHTM area (John Sarvis, pers. commun.) and therefore may have different nutritional regimens. Habitat is also substantially different at the 2 calving sites. The CRF is a wet, lowland area with abundant sedge meadows. Greenup appeared earlier at this site than at BHTM, which is generally higher elevation tussock and shrub tundra intersected by ridges and small drainages. Nutrition may be better near the CRF during late gestation and calving periods.

In the late 1970's much of the SAPCH began utilizing the new winter range in the vicinity of Cold Bay that they continue to use. In the early 1980's low calf recruitment and reduced growth were noted. It appears, based on radio-tracking flights and general observations, that animals utilizing the CRF also winter in that general area, while animals calving in the BHTM area winter in the Cold Bay area. These observations, combined with the differences in recruitment and calving dates between the CRF and BHTM calving areas, lead us to wonder whether the Cold Bay area is particularly poor winter range or animals utilizing it are in poorer condition than those from the CRF.

Late calving dates by the SAPCH corresponded with small body size. Late calving reduces the summer growth season during the first year (Klein et al. 1987) that, in turn, reduces growth potential.

While it appears that undernutrition may be impacting this herd, the presence of 2 known caribou predators, brown bears and wolves, cannot be discounted as mortality factors affecting the SAPCH. Brown bears are abundant throughout the range of the herd; R. Sellers, ADF&G area management biologist for the Alaska

Peninsula, estimates that there are roughly 500 bears on the SAPCH range. Brown bears are known to prey on both adult and calf caribou (Whitten et al. 1985, Reynolds and Garner 1987, Boertje et al. 1988, Adams et al. 1989). We have no quantitative information on wolf abundance in the area; however, according to a longtime guide in the area, they are currently abundant, perhaps numbering 60 during the fall of 1989 (R. Gunlogson, pers. commun.). Wolves are known to be effective predators of both calf and adult caribou (Eide and Ballard 1982, Miller et al. 1985, Ballard et al. 1987, Adams et al. 1989). Caribou are the only large mammalian prey available on a consistent basis to wolves in this area; therefore, wolves are likely to be highly dependent on them.

It is important to consider whether predation occurring on the herd is compensatory rather than additive. If somehow undernutrition is predisposing either and/or both calves and adults to predation and if many of them would have died regardless of predators, then predation is not a serious concern. However if many animals are dying as the direct result of undernutrition and then predators are killing many of the survivors, then the situation is compounded. A serious concern is the possibility that when the herd declines to a size or utilizes alternative range so that nutrition is no longer limiting, then predation will either cause the herd to continue to decline or prevent it from recovering. Gasaway et al.(1983) discussed the "loose" feedback mechanism between wolf numbers and declining prey populations. It may take a number of years and very low prey populations before wolf numbers decline substantially. Brown bears, not being obligatory predators, may not decline in response to lower caribou numbers. If and when nutritional status of the SAPCH improves, every effort should be made to limit human harvests and prevent the herd from declining further so that the impact of predation and the probability of long-term control of the herd by predators can be minimized.

RECOMMENDATIONS

Research on the SAPCH should continue to provide information useful in managing the herd, but perhaps more importantly, to obtain information on population regulation of caribou herds, particularly as undernutrition may be playing a role in the decline of the SAPCH. Annual estimates of herd size and indices of calf recruitment should be obtained. Future research should focus on seasonal condition, seasonal range use, and food habits of adult females utilizing both the CRF and BHTM calving areas. Consideration should be given to conducting a calf mortality study in which radio collars would be placed on young calves that would be intensively monitored for several weeks; however, the possibility exists that such a study would substantially underestimate perinatal mortality (K. Whitten, pers. commun.) from causes such as stillbirths, congenital defects, and abandonment, thereby overestimating neonatal mortality caused by

predation and accidents. A proposed study of the SAPCH range by a graduate student at the University of Alaska-Fairbanks (with support from USF&WS and ADF&G) should be pursued. This study could include work on forage availability, forage quality, and food habits on the ranges of the CRF and BHTM subgroups. Seasonal activity budget sampling might also provide insight into nutritional status (Boertje 1985) of this herd. This would nicely supplement work planned by ADF&G and USF&WS on nutritional status and seasonal range use of these subgroups.

It is difficult to make specific management recommendations for the SAPCH without knowing if the decline is a result of (1) range-wide density dependent food limitation, (2) a shift into inferior winter range, or (3) high predator abundance and past high harvests. Because of a lack of answers to these questions and extremely high natural mortality of both calves and adult females, we feel that hunting mortality should be reduced to the greatest extent possible, particularly for females. Unless we obtain information supporting a different approach, every effort should e made to prevent the herd from declining below 2,500 (i.e., a density of about 0.5 caribou/km^2), where food limitations should not be a concern. As previously mentioned, we have concerns that predators might prevent a small, low-density herd from recovering for an extended period, particularly in this case where caribou are the sole large mammalian prey. In this situation it may be difficult to manage the herd at a level between nutritional limitation and predator limitation.

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