

Population growth and status of the Nushagak Peninsula caribou herd in southwest Alaska following reintroduction, 1988 - 1993

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Abstract: Caribou were reintroduced to the Nushagak Peninsula, Alaska in February 1988, after an absence of over 100 years. The purpose was to reestablish caribou in the area and once again provide hunting to local residents. The Nushagak Peninsula caribou herd (NPCH) has grown rapidly from 146 reintroduced caribou to over 1 000 in 6 years at an exponential rate of increase of $r = 0.317$ or about 38%. The dramatic growth of the herd was attributed to the initial high percentage of females in the herd, high calf production and survival, pristine range, few predators and no hunting. Abundant high quality forage on the Nushagak Peninsula is the probable reason for the enhanced body condition and high natality even among 2-year-olds, and it has most likely contributed to the high calf survival and recruitment. Lack of predators and hunting has allowed calf and adult mortality to remain low. Although the size of the NPCH has grown steadily over the past 6 years, no significant dispersal from the peninsula has occurred. The population density of the NPCH was estimated to be 1.0/km² in 1993. We believe the herd will continue to grow, and could reach a density of 2.3/km² by 1998, even with a 10% harvest beginning in 1995. While the current growth of the NPCH makes the reintroduction a success, the increasing density, lack of dispersal and potential for over-grazing, presents managers with hard decisions.

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Introduction

Historically, a large caribou population roamed the coast of the Bering Sea from Bristol Bay to Norton Sound. Archaeological excavations near the village of Togiak in 1960 suggested that caribou were important to the native population (Kowta, 1963). Presumably, caribou once concentrated in the mountains up river from Togiak Bay and in the rocky headland towards Cape Newenham. Large caribou herds were also observed "roaming over the mountains of the Nushagak Peninsula" (Petrov, 1900). Petrov (1884) noted that caribou were virtually absent from the lower Yukon-Kuskokwim River area by 1880. While still numerous in the upper Kuskokwim drainage (Capps, 1929), caribou were absent in the Togiak and Goodnews drainages as early as 1900. Alaska Game Commission (1925-1935) noted only small scattered herds in the Kilbuck Mountains by the mid 1930s. Caribou disappeared during a period of human population growth, including an influx of caucasians and intense commercial trade.

Reindeer were introduced into the Bristol Bay area in the early 1900's to provide the native community an economic base and a reliable source of

red meat. Herds flourished from Togiak to the Nushagak River, north to the Seward Peninsula. The Togiak and Kulukuk River drainages had several active herders and the Nushagak Peninsula was reportedly an important grazing area. By the 1930s, the reindeer industry faltered and by the 1940s, reindeer were gone from the area.

The concept of reintroducing caribou to the Togiak area was first addressed in "Alaska Wildlife Management Plans, Southwestern Alaska" (Alaska Department of Fish and Game, 1976). The Togiak National Wildlife Refuge was established in 1980 by the Alaska National Interest Lands Conservation Act. One of its purposes was to allow restoration of populations to their historic levels. The nearest caribou herds to the Togiak Refuge are the Mulchatna caribou herd (MCH), Kilbuck caribou herd (KCH), and the North Alaska Peninsula herd (NAPH). Hunting pressure, natural barriers, and human settlements appeared sufficient to prevent any of these herds from expanding onto the Togiak Refuge in the near future.

Caribou were reintroduced to the Nushagak Peninsula in February 1988 under a cooperative

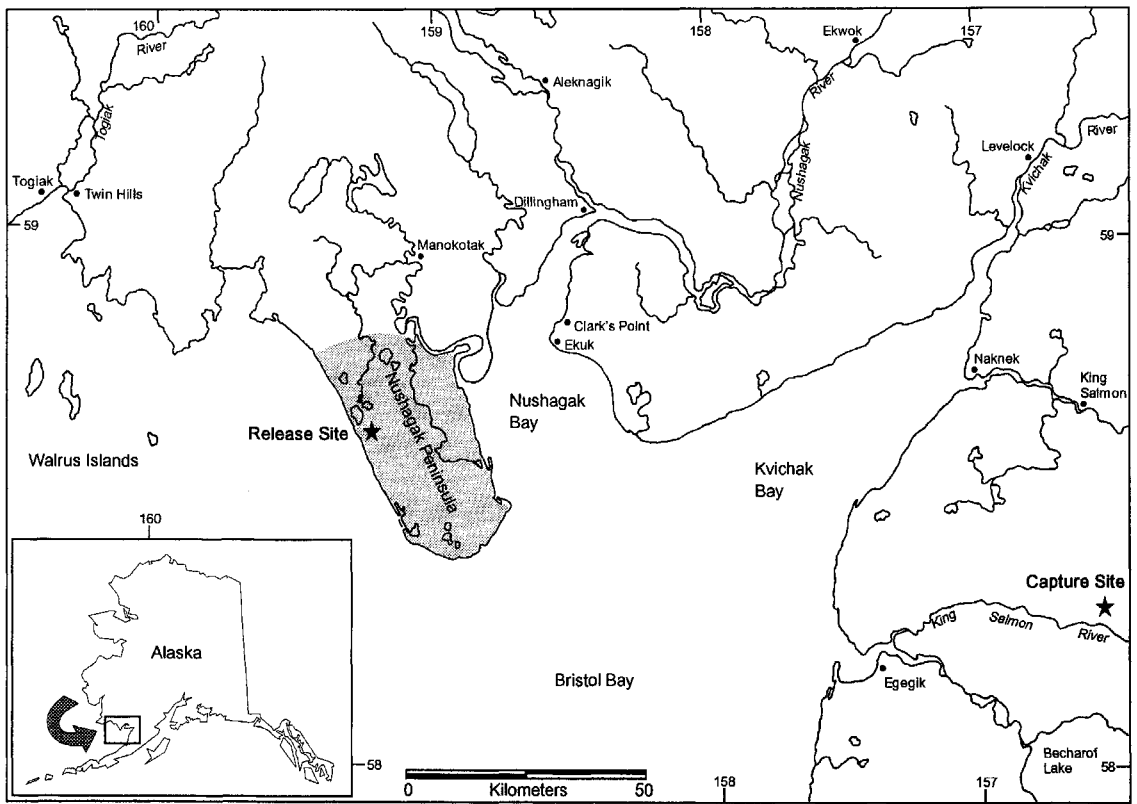


Fig. 1. Location of capture and release sites, and distribution (shaded area) for the reintroduced Nushagak Peninsula caribou herd, February 1988, southwest Alaska.

agreement between the U.S. Fish and Wildlife Service (USFWS), Alaska Department of Fish and Game (ADFG), and the residents of Togiak, Manokotak, Twin Hills and Dillingham. The reintroduction was intended to reestablish caribou in an area where local residents had been dependent on them for thousands of years. The principle goal was to establish a population large enough to sustain a subsistence hunt, while still allowing the herd to grow.

Methods

Reintroduction

Potential capture and release sites were evaluated to determine which would be most cost effective and would best support a caribou population during winter when forage is less available. Kikertalik Lake on the Nushagak Peninsula was chosen as the primary release site (Fig. 1). The NAPH was selected as the donor population for this transplant because it was the closest herd and there was less chance the animals would return to their original range because of direct separation by Bristol Bay.

At Kikertalik Lake, we constructed a 10 m diameter, 2.5 m high corral of 1/2" plywood, supported

by 2X4 braces. A smaller holding pen approximately 3 m diameter was constructed adjacent to the corral to hold caribou until they recovered from tranquilizer administered prior to or during transport.

The capture site was located 53 km SE of King Salmon, Alaska on a small unnamed lake 3 km north of the King Salmon River (Fig 1). Helicopter fuel, a four wheeler and sled, and 18 caribou transport crates were transported by Dehavilland Otter to the capture site. Twelve (3 sets of 4) individual holding pens 0.6 m X 1.2 m X 1.2 m with sliding doors at each end and numerous 2.5 cm diameter air holes were fabricated in Dillingham, disassembled and flown to the capture site where they were reassembled.

The capture effort began 4 February 1988 and was completed 16 February. Two USFWS Cessna 206 aircraft were used to transport field crews from King Salmon to the capture site daily. Field crews consisted of USFWS staff from Togiak and Becharof refuges, ADFG staff, and volunteers from the villages of Togiak and Manokotak. Selected students and teachers from Togiak, Manokotak, Naknek, Dillingham, and Egegik also participated in various stages of the project. A Hughes 500 heli-

copter with a skid-mounted net gun was used to capture caribou. The net gun was operated by the pilot and was capable of firing two 6 m X 6 m mesh nets a distance of approximately 10 m. Two capture teams of two biologists each sedated caribou after capture using either R51163 (an experimental drug supplied for testing by Wildlife Labs, Fort Collins, Colorado) or xylazine. Each animal was placed inside a canvas transport bag and a foam padded cloth hood was fitted over the head to protect the eyes. The neck was supported by a foam pad 7-10 cm to help keep the head upright during transport to the staging area. The canvas bag was then laced together and the sling rope was tied through the support loops at the end of the bag. A loop at the end of the rope was attached to the helicopter sling hook while it hovered over the caribou.

Transported caribou were lowered to the ground approximately 100 meters from the pens at the staging area to reduce disturbance to the animals already in the corral. They were loaded onto a sled pulled by 4-wheeler to the processing area where each was weighed, de-antlered, ear-tagged and fitted with a visual collar. Radio-collars were placed on 20 animals. Blood samples were taken to test for brucellosis, pack-cell volume and to add to the serum sample bank from the northern Alaska Peninsula herd. Each caribou was injected with 3 ml Ivermectin to reduce the possibility of the spread of parasites to new habitats. Temperature, heart rate, and respiration rate were monitored during the processing phase. After processing, caribou were either loaded individually in the holding pens, placed in transport crates or cargo nets and loaded onto the Otter for transport to the release area. Holding pens were generally used only for caribou held over-night before transporting them to the release site. Initially, either R51163 or xylazine was used to keep these animals sedated until transport. As the capture effort progressed however, all but the most active caribou were allowed to recover over-night from their initial sedation. Animals held over-night were sedated again prior to transport.

Caribou were transported in groups of 7-9 animals to the release site, a flight of 1.0 to 2.2 hours. Caribou were generally calm, although turbulence and engine noise caused them to struggle occasionally.

Weather conditions were generally poor at the release site during the operation. The snow drifted severely on the lake where the corral was constructed, and the lake surface inside the corral was very slippery. Efforts to increase traction (including covering the ice with straw and sawdust) were largely unsuccessful. Our intention was to hold transported caribou in the corral and release them in

groups of 50 to facilitate group cohesion. However, because of the slippery surface and the danger of trampling, all but the first group were released outside the corral immediately after unloading.

Radio-collaring

In April 1992, an additional 23 caribou were captured on the Nushagak Peninsula and 16 more radio-collars were deployed. The purpose of the recollaring was to supplement the original 20 caribou radio-collars. We again used a Hughes 500D helicopter equipped with a skid-mounted net gun to pursue and capture female caribou. When the caribou became entangled in the net, we restrained them and immobilized them with 1.3-1.4 cc xylazine. We collected standard measurements and blood samples and bioelectrical impedance measurements were taken as an indicator of body condition (Gerhart *et al.*, in press).

Population Monitoring

Monthly flights to track radio-collared animals began February 1988. Weekly flights during the calving period were initiated in 1991. When possible, direct observations were made of each radio-collared caribou to determine if a calf was present. However, during post-calving aggregation this was not possible without major disturbance to calves. Monitoring radio-collared caribou allowed us to evaluate seasonal movements, distribution, dispersal, home range, calf production and survival, calving chronology, recruitment, and adult mortality.

A fall sex and age composition count was completed in October 1992 using a Bell 206 Jet Ranger helicopter. Groups of caribou were located first with the Cessna 185 fixed-wing aircraft which directed the helicopter to caribou to be classified.

Population estimates for 1988-1989 were based on the highest count obtained during a tracking flight. A population census was conducted during late winter each year since 1990 using a total-count technique. Transects were flown over the entire peninsula at intervals of 1.0-1.5 km depending on conditions. An attempt was made to census after fresh snow, during bright light conditions, and when winds were less than 25 kph.

Results and discussion

Reintroduction

Biologists captured 167 caribou from the NAPH between 4-17 February, 1988. Three were released at the capture site due to shipping delays and one escaped at the capture site. Mortality during the course of the project was 17 caribou (10.2%). Six died of injuries directly related to capture technique (broken necks and legs), 1 died from suffocation

enroute to the holding pen, and 1 died in the holding pen. Of the 155 transported to the Nushagak Peninsula, 1 died enroute from suffocation, 6 died of capture myopathy at the release site, and 2, including 1 radio-collared animal, died within 24 hours of release. We successfully reintroduced 146 caribou to the Nushagak Peninsula. All were released at Kikertalik Lake except 1 group of 8 caribou which was released near Dillingham, approximately 40 km northeast of the release site, after poor weather conditions grounded the Otter in Dillingham.

Body measurements and condition

Nushagak Peninsula caribou captured in 1992 were larger and appeared to be in better condition than the caribou originally transplanted to the peninsula. The mean body weight of 2-yr-old caribou captured in 1992 was significantly ($P < 0.05$; two-tailed t -test) heavier ($\bar{x} = 100.5$ kg, $n = 5$) than the 2-yr-olds captured in 1988 ($\bar{x} = 87.7$ kg, $n = 18$). Adult caribou (> 4 yrs) captured in 1992 had somewhat greater mean mandible lengths (27.9 cm, $n = 5$) than caribou captured in the parent NAPH (27.3 cm, $n = 17$), however, these differences were not significant ($P > 0.10$). Enhanced body condition is likely a direct result of the abundant high quality forage on the Nushagak Peninsula. It is also the probable rea-

son for the preponderance of pregnant 2-yr-olds and contributing to the high calf survival we have seen in this herd.

Population size and growth

The NPCH has grown rapidly from 146 to over 1000 caribou in the 6 years since reintroduction (Fig. 2). The average growth was 38% (± 7.3 s.d., $n = 6$), or an exponential rate of increase $r = 0.317$. This growth rate exceeds the maximum theoretical potential of $r = 0.29-0.30$ or about 35% as described by Bergerud (1980), and Bergerud *et al.* (1983). Bergerud (1980) summarized that Alaska caribou herds without predators showed rapid growth approaching $r = 0.30$, while those with predators showed little or no growth. Davis *et al.*, (1991) however states that the growth of caribou herds seldom approach this level except in transplanted herds, and growth over 20% is uncommon even under optimum conditions. We attribute the impressive growth of the NPCH to the high percentage of females in the herd at reintroduction, in concert with high calf production and survival, pristine range conditions, few predators, and no hunting. When the current growth of the herd is modeled using average natality and mortality figures to reach the current population level, as expected,

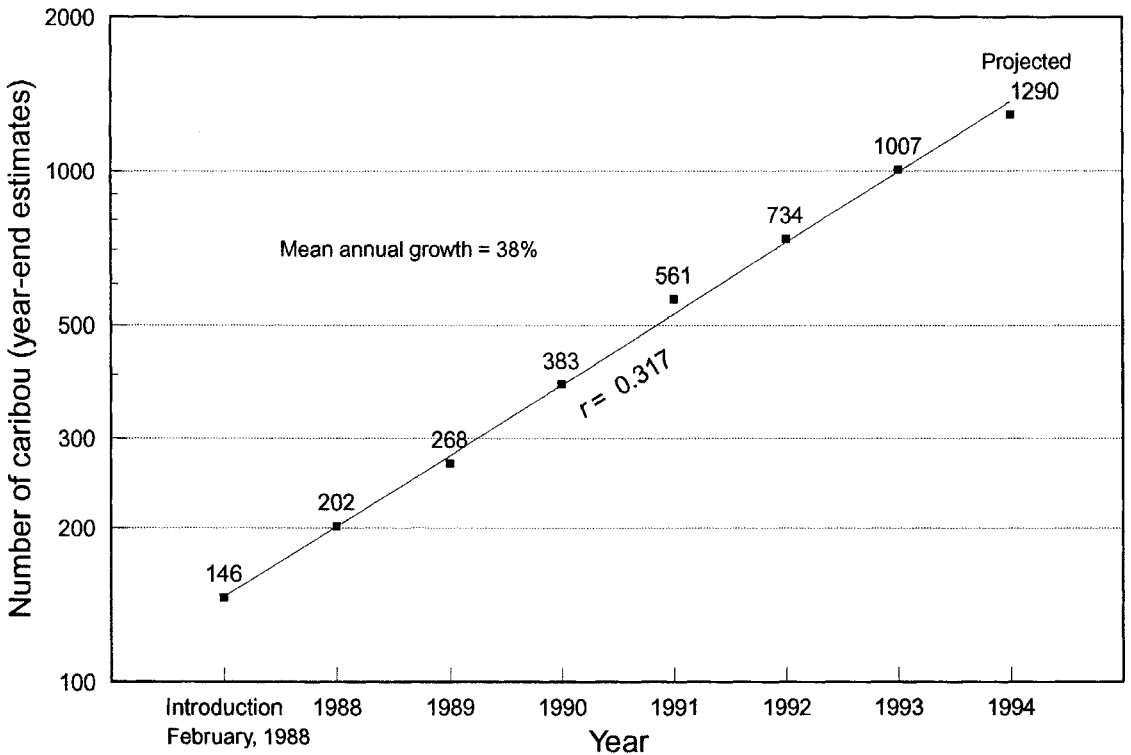


Fig. 2. Population growth of the Nushagak Peninsula caribou herd following reintroduction, southwest Alaska, 1988 - 1993.

the growth rate is highest at the time of reintroduction and steadily decreases.

The increase of the Nushagak herd is similar to that for reindeer when introduced into pristine range in the absence of other large herbivores and predators (Bergerud, 1980; Klein, 1987; Swanson and Barker, 1992). The average rate of increase on St. Matthew Island was possibly higher than 34% (Klein, 1968). Reintroduction of caribou in other areas of mainland Alaska has been less dramatic. Caribou transplanted to the Kenai Peninsula in 1965 and 1966 grew rapidly from 15 and 29 respectively to 335 in 1974 (Davis, 1978). An additional 80 caribou transplanted in 1985 and 1986, increased to 197 in 1990, 237 in 1991, and 272 in 1992; with annual rates of increase of 17% and 13% respectively (Spraker, 1992a; 1992b; 1993).

Sex and age composition

Sex and age composition at the time of reintroduction was skewed toward young females. Herd composition of the 146 caribou released and known to be alive at the end of the transplant operations was 111 adult females, 9 yearling females, 9 female calves, 6 adult males, 8 yearling males and 3 male calves. Estimated average age for the herd was around 5 years.

Herd composition changed dramatically in the first 4.5 years since reintroduction (Table 1). Although mortality rates in some Alaska herds have been found to be higher for males than females (Davis *et al.*, 1988, 1991), the percentage of males in the NPCH continued to grow.

The male component of the NPCH herd now exceeds those of most hunted Alaskan caribou herds which is generally less than 45 bulls:100 cows (Leib *et al.*, 1991; Van Daele, 1994) and even lower (27 bulls:100 cows) in herds with bull-only hunts (Davis *et al.*, 1990). Valkenburg *et al.* (1993) estimated a bull:cow ratio for the Western Arctic herd at 52 bulls:100 cows. Harvest of this herd is primarily by local subsistence users who usually do not select for bulls.

Calf production and survival

Natality estimates derived from radio-collared females were found to be similar to estimates from samples of the herd at large (Davis *et al.*, 1991). Natalty rates for radio-collared females from the Nushagak herd ≥ 2 -years-old have been high. In 1990, 1992 and 1993, all radio-collared females observed produced calves; 14 of 14, 27 of 27 and 28 of 28 respectively. No production data were collected in 1988, 1989 or 1991. Natalty rates for most caribou are generally lower than the rates we observed, i.e. 82% average pregnancy rate for 8 herds and 86% parous females for 7 herds (Bergerud, 1980).

Caribou generally do not come into estrus until they are 28 months old (Skoog, 1968; Bergerud, 1971), and sometimes not until they are 41 months with poor nutrition (Bergerud, 1971). With good nutrition, caribou can conceive at 17 months (Bergerud, 1980). Davis *et al.* (1991) state caribou generally have to be at least 3 years old to be successful at producing and raising calves due to lower fat reserves, continued growth during their second winter, or immaturity which may effect mother-young bonding. All 5 females estimated to be 2-years-old from the NPCH radio-collared in April 1992 produced calves. Another 2-year-old which died during capture operations was also pregnant. Nutrition and body condition seems to be the most important factors affecting the natalty rate of 2-year-olds. This agrees with Valkenburg (1991) who states "A small (relative to food supply) caribou herd within suitable habitat can be expected to be highly productive with most 24-month-old females producing calves."

Peak calving for radio-collared Nushagak caribou occurred in late May, similar to other caribou herds at similar latitudes in Alaska (Skoog, 1968; Hemming, 1971; Valkenburg *et al.*, 1991). Intensive monitoring of 27 radio-collared females in 1992 showed 4% had calved by May 17th, 32% by the 23rd, 66% by the 27th and 89% by June 4th. Eleven percent calved after June 4th. Results were similar

Table 1. Sex and age composition of the Nushagak Peninsula caribou herd, southwest Alaska.

Date	Bulls/ ^a 100 cows	Calves/ 100 cows	% calves	% cows ^b	% bulls	Sample size	Estimated herd size
Feb, 1988 ^c	12	10	8	82	10	146	146
Oct, 1992 ^d	60	72	31	43	26	611	750

^a Includes yearling males.

^b Includes yearling females.

^c Composition at time of reintroduction.

^d Aerial estimate using a Bell 206 helicopter.

in 1993 for 28 radio-collared females; 6% calved by May 15th, 42% by the 23rd, 87% by the 27th and 100% by June 10th.

Calf survival and recruitment for the Nushagak herd has been high. Percent calves observed in fall 1990-1993 from radio-collared females averaged 64.3% ($\pm 9.8\%$ s.d., $n=4$). If we use the ratio of 72 calves:100 cow estimated from a helicopter survey during fall 1992 composition count, the average would be even higher. Results are similar to the average ratio of 67 calves:100 cows when the herd is modeled to reach the current population level using observed mortality figures. Because all radio-collared females observed produced calves, these percentages represent actual calf (0-5 months) survival estimates. As with natality, fall calf:cow ratios for the Nushagak herd were higher than generally found in other caribou herds (Bergerud, 1980; Valkenburg *et al.*, 1991; 1993).

Studies of other caribou herds indicate that the greatest mortality occurs within the first few weeks of calving due primarily to predation (Skoog, 1968; Bergerud, 1971; 1980; Adams *et al.*, 1988; Leib *et al.*, 1991). Over-winter calf mortality can be high (Heard & Calef, 1986), however Bergerud (1971) found no evidence that calves died during winter at a higher rate than adults. Over-winter mortality of calves from the Delta herd was relatively low and no higher than cohorts ≥ 24 months (Davis *et al.*, 1988; 1991). Fall calf:cow ratios are often used by managers to evaluate population recruitment, and seems to provide a good index for the Nushagak herd.

Whitten (1991) suggested the survival rate of calves from 2-year-olds is lower than that of ≥ 3 -year-olds. However, 4 of the 5 2-year-olds were still accompanied by calves in the fall.

Adult mortality

Annual mortality of radio-collared animals with known fates ranged from 0-6.7%, with a mean of 4.1% ($n=6$). Only 2 of 36 radio-collared caribou were bulls, and both died within the first 4 years. Bergerud (1980) estimates that adult mortality varies between 7-13% where predators are common, and 5-6% where they are not. Two of the 6 radio-collared caribou that died were males, the only 2 radio-collared bulls in the herd. One died within 24 hours of release and is not considered in the above estimate, and the other died when it locked antlers with another bull. One had a broken neck while the other probably died of starvation. The cause of death for the remaining 4 females is unknown. Ages of these animals were 3, 4, 6-7, and two 9 years-olds, suggesting no age-specific mortality. The extent of predation on the Nushagak Peninsula is

unknown; however, we believe it is not a major factor. Brown bears are common on the peninsula and wolves are rare. The NPCH is currently closed to hunting, with only two caribou known to have been poached in March 1992, and possibly 1 in 1993.

Seasonal movements and distribution

Although the size of the NPCH has grown steadily over the past 6 years, no significant dispersal from its "core range" on the peninsula has occurred (Fig. 1). Of over 18 000 observations of caribou (1 486 radio-locations) during tracking flights and surveys, more than 99% were observed on the Nushagak Peninsula. The range of the herd on the peninsula as defined by a convex polygon that connected the outermost locations was 1 010 km². Two radio-collared females with several other individuals have been observed west of Kulukuk Bay and north of Twin Hills, an area of about 370 km². This movement began soon after reintroduction and has occurred primarily during the summer months, with the animals returning to the peninsula each time. Caribou observations have been plotted by month and season, with no detectable pattern of seasonal movements or distribution. Females were distributed throughout the peninsula during calving.

Caribou were observed in the upper Togiak River drainage in 1992 and 1993. These were probably members of the Kilbuck caribou herd which have been expanding southward onto the Refuge. However, no Kilbuck or Nushagak radio-collars were heard. Caribou observed near Dillingham during 1992 were believed to be members of the expanding Mulchatna herd. No overlap between these 2 herds and the Nushagak caribou is believed to have occurred at this time. As all 3 of these herds continue to grow and/or expand, overlap may occur.

Variations in mean group size were the only detectable seasonal changes for the NPCH. Group size was greatest in July during post-calving aggregation, and decreased through September. With the approach of rut, group size again increased and remained relatively stable throughout the winter months. As spring neared, pregnant females dispersed to calve, and group size again was at a low.

Home range

Mean home range for 32 radio-collared caribou was 447 km² (± 168 s.d.), ranging from 239 km² and 799 km². Not included in this average were the 2 radio-collared caribou with ranges beyond the Nushagak Peninsula (1301 km² and 1458 km²). These home ranges provide a rough estimate of the amount of habitat utilized. However, size of home range was

correlated with the number of locations. For radio-collared caribou with 64-74 locations (those caribou collared in 1988), mean home range was 606 km² (± 98 s.d., n=11), while those with 15-20 locations (collared in 1992) was 299 km² (± 59 s.d., n=15). Mean home ranges for the Kilbuck caribou herd calculated using the same technique was 5 900 km² for 14 caribou with 16-38 locations each (Hinkes, 1989).

Habitat assessment

Range inventory and monitoring studies have been initiated in the years following reintroduction. Preliminary evaluation indicates the range of the Nushagak Peninsula to be in excellent condition, with an abundance of forage, including lichen. The range shows little sign of grazing. Although there are caribou trails in some areas, the impact does not appear significant.

Population Dynamics

The population dynamics of the NPCH are similar to those experienced by other caribou and reindeer herds introduced into, or occupying range with an abundance of high quality forage and few predators. In summary, the dramatic growth of the herd over the past 6 years was attributed to enhanced body condition, an initial high proportion of young females, high natality even among 2-year-olds, high calf survival and recruitment, and low adult mortality. An abundant high quality forage was probably the greatest factor effecting natality, while the lack of predators and hunting has allowed calf and adult mortality to remain low. Dispersal has not been a factor affecting the population dynamics of the NPCH.

Dispersal has been considered a major factor in the population dynamics of caribou herds in North America (Skoog, 1968; Bergerud, 1980; 1983; Haber & Walters, 1980). Haber & Walters (1980) suggest that competition for food when herds approach a density of 2.0 caribou/km² will cause caribou to disperse. This concept is supported by the decline and dispersal of the George River herd when it reached a density of 1.9/km² (Couturier *et al.*, 1990). The Avalon herd dispersed when it reached a density of 2.1/km² (Mercer *et al.*, 1986). However, there are several examples of caribou and reindeer herds that have reached densities and not dispersed (Bergerud, 1983). The south Alaska Peninsula herd apparently exceeded 2.0/km², did not disperse and declined dramatically (Pitcher & Johnson, 1989). Bergerud (1983) suggests that "caribou have not evolved intrinsic density-dependent limitations to growth at extreme densities to avoid catastrophic crashes."

The population density of the NPCH was estimated to be 1.0/km² in 1993. We believe the herd

will continue to grow, and could reach a density 2.3/km² by 1998, even with a 10% harvest beginning in 1995. The NPCH provides an opportunity to examine the relationship of density to population growth and dispersal.

The NPCH is expected to exceed 2000 caribou by 1998. Whereas the current growth of the NPCH verifies the success of the reintroduction, the increasing density, lack of dispersal and potential for over-grazing, presents managers with hard decisions. Should the herd be allowed to continue to grow in hope that the herd will disperse into new range; alternately, should herd growth be limited through increased harvest to avoid range degradation?

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