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# Increases in body weight and nutritional status of transplanted Alaskan caribou

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*Abstract:* Body weight and natality rate in ungulates can be useful indices to nutririon, bur they may also be influenced by genetic and climatic factors. Because caribou (*Rangifer tarandus granti*) are distributed as discrete populations or metapopulations (i.e., herds) that are usually reproductively isolated from each other for unknown periods, it is difficult to separate the influence of genetics and nutrition on body weight, especially where historical data are lacking. To help elucidate the influence of nutrition on potential variation in body weight and natality of caribou in Alaska, we reviewed data for body weight and natality in 5 populations which resulted from transplants to previously ungrazed ranges, or to areas where reindeer and caribou had been absent for many decades. In 2 of 5 populations body weight increased significantly, and likely increased in the other 3 populations, but data were insufficient. Natality rate increased in all 5 populations, proportion of fecund yearlings was high and 3 of the 5 newly established herds increased ar about the maximum biological potential for the species ($\lambda \approx 1.35$). In the Adak transplant, a lactating yearling was documented. These 5 transplanted populations provide additional evidence that body weight and natality rate in Alaskan caribou are sensitive to changes in population density and relatively short-term (i.e., 10 years) increases in grazing pressure independenr of climate and genetics.

Key words: natality, *Rangifer tarandus granti.*

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## Introduction

Changes in body weight and natality can be useful indices of nutrition in ungulates (McEwan & Wood, 1966; Klein & Strandgaard, 1972; White *et al.*. 1981; Clutton-Brock *et al.*, 1982; Peters, 1983; Reimers, 1983; Reimers *et al.*, 1983; Skogland, 1983; 1984; Beninde 1988; Crete & Huot, 1993; Gaillard *et al.*, 1996; Reimers, 1997). However, body weight and natality can also be influenced by genetic and climatic factors that must be controlled when comparing disparate populations (c.f. Klein, 1965; Røed & Whitten, 1986; Beninde, 1988). Experimental transplants can sometimes provide such control and help biologists assess the influence of grazing history and population density on herd nutrition (Klein, 1968). In this paper we review 5 Alaskan caribou transplants and recent data on changes in body weight and natality in transplanted and parent herds, and make inferences about the importance of population density, previous grazing pressure, and climate on body weight and natality in Alaskan caribou. We consider the term "herd" to be synonymous with population or metapopulation because opportunities for interbreeding occur, but are uncommon, and dispersal seems to occur at very low levels (Valkenburg *et al.*, 1996; Valkenburg, 1997).

*Adak Island transplant*

In response to a request from the military, caribou were transplanted from the Nelchina herd (Fig. 1) to previously ungrazed Adak Island in 1958 and

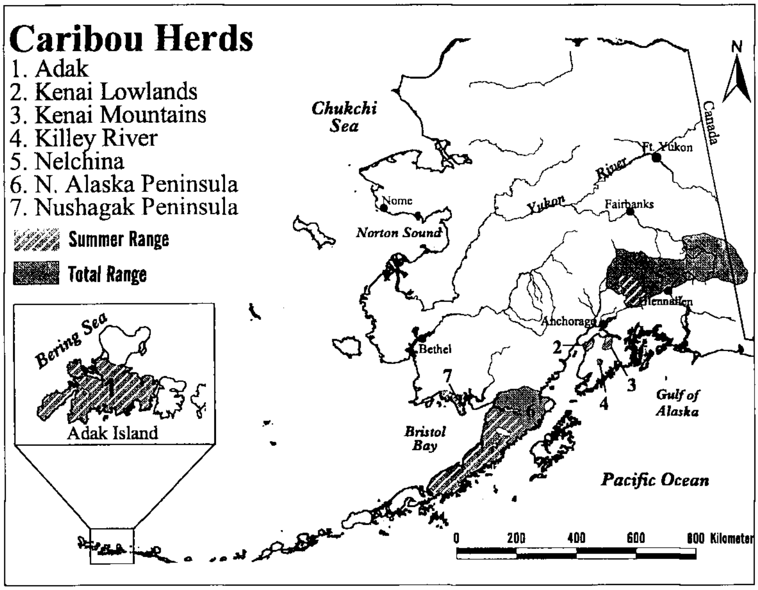


Fig. 1. Location of transplanted and parent herds.

1959 (Jones, 1966; Burris & McKnight, 1973). Caribou were captured as 1- or 2-day-old calves and held in captivity for 5 to 8 weeks before being released. Following release, calves from both transplants were bottle fed until 6 August and then left to fend for themselves. The Adak transplant was unique because caribou were removed from the parent herd as newborn calves, and thus had no opportunity to acquire parasitic oestrid larvae (*Hypoderma tarandi* and *Cephenemyia trompe*).

Data on body weight and nutrition of transplanted caribou are scant, but it appears that body weight and natality increased (Table 1). On Adak, mean weight of 5 "adult" bulls taken in August 1964-1968 was probably higher than in the parent Nelchina herd, but Skoog (1968) presented no estimate of variance, and a statistical test was not possible (Table 1). However, *most* (compared with 13% in the parent herd) yearling females were pregnant on Adak, and a lactating yearling (indicating the animal conceived as a calf) was killed in autumn 1966 (Glenn, 1967). In addition to increased production in young females, the Adak herd also exhibited maximal population growth (Table 1).

*Kenai Peninsula transplants*

The first Kenai Peninsula transplants took place in 1965 and 1966, and the caribou were again taken from the Nelchina herd. Release sites on the Kenai Peninsula had received no grazing by reindeer or caribou since about 1900 (Davis & Franzmann, 1979). At the time of the transplants the Nelchina herd was at the beginning of a population decline following a peak of about 70 000 in the early 1960s, and reduced nutrition was probably affecting body weight (Eberhardt & Pitcher, 1992). The Kenai Mountains herd formed from caribou released in 1965 (Spraker, 1992). Most caribou from the 1966 transplant moved southwest and formed the Kenai Lowlands herd, but some also went northeast and joined the Kenai Mountains herd (Spraker, 1992) (Fig. 1). Although there are no data on body weight or relative nutritional status in the years immediately following the transplant, a bull immobilized and measured in the early 1980s from the Kenai Lowlands herd had antlers unofficially scoring 476 2/8 Boone and Crockett points, more than any other caribou in the Boone and Crockett records (Boone & Crockett Club, 1993). The shed antlers of this animal were retrieved and mounted and are on display at the Anchorage Department of Fish and Game office. However, the Kenai Lowlands herd increased slowly, apparently because of predation (Spraker, 1992).

In contrast to Kenai Lowlands herd, the Kenai Mountains herd initially increased rapidly from 15 in 1965 to 339 by 1975 ($\lambda$=1.37) (Spraker, 1995). The herd then fluctuated in size with lows of about 200 and 300 in 1978 and 1988, respectively, and highs of 450 in 1986 and 500 in 1996. In April 1996, when the herd was at its peak of about 500, the mean weight of a sample of 11 female calves was similar to the heaviest cohorts of calves from the parent Nelchina herd during 1992-1997 (Table 1).

In 1985 and 1986 caribou were again relocated to the Kenai Peninsula from the Nelchina herd. At that time, the Nelchina herd was growing, from a herd size of about 27 000, and approaching a moderate density of about 0.5 caribou/km$^2$ (Van Ballenberghe, 1985). The 2 transplants resulted in formation of 3 additional herds, the largest of which became known as the Killey River herd (Fig. 1). This herd increased from about 70 caribou in summer 1987 to about 350 in 1997 ($\lambda$=1.18). In 1996,

Table 1. Population and range characteristics of 5 introduced caribou herds and their parent populations.

| Herd | Year of introduction | Elevation of summer range (m) | Approximate mean number of days in growing season[a] (dates) | Mean rate of population increase ($\lambda$)[b] | Maximum summer density achieved (caribou/km$^2$) | Mean weight (kg) of 10-month-old female calves, mean, $n$ (year of sample) | Mean weight (kg) of adult males, $\bar{x}$ (range, $n$) |
|---|---|---|---|---|---|---|---|
| Adak | 1958, 1959 | 0-500 | 165 (15 May-30 Oct) | 1.30[c] | 1.0 | | 280 (229-318, 5)[d] |
| Kenai Mountains | 1965, 1966 | 600-1500 | 135 (15 May-30 Sep) | 1.37[e] | 0.3 | 57.6, 11 (1996) | |
| Kenai Lowlands | 1966 | 20-100 | 150 (1 May-30 Sep) | <1.05 | 0.5 | | |
| Killey River | 1985, 1986 | 600-1500 | 135 (15 May-30 Sep) | >1.26[f] | 0.8 | 65.7, 10 (1996) | |
| Nelchina | n.a. | 1000-2000 | 105 (15 May-1 Sep) | approx 1.15[g], approx 0.9[i], 1.10[j] | 4.7 | range 47.6-57.0, 9-29 (1992-1997) | 255 (200-299, 9)[h] |
| Northern Peninsula | n.a. | 0-1200 | 135 (1 May-15 Sep) | 1.00[k] | 1.4 | 51.4, 19 (1995), 48.4, 14 (1997) | |
| Nushagak Peninsula | 1988 | 0-100 | 135 (1 May-15 Sep) | 1.38[l] | 0.8 | 57.1, 15 (1995), 50.9, 10 (1997) | |

[a] Growing season is defined as the time when new growth (usually *Eriophorum*) is available in spring to the time of the first killing frost in autumn.
[b] Population increase during the first 10 years after transplant in transplanted herds, or at the time of the transplant in parent herds.
[c] Calculated from 1959 to 1967. Ten 3-month-old calves were released in 1958 and 14 were released in 1959, so herd growth was delayed until these animals reached maturity (Burris & McKnight, 1973).
[d] Weights from Hemming (1971), Jones (1966), and unpublished data given to D. Klein from 2 bulls collected by J. Hemming. Standard deviation = 34.5.
[e] The herd increased from 15 in 1965 to 339 in 1975. Initial growth rate inflated by high proportion of females in the transplant.
[f] One year after the transplant there were 70 caribou, and they increased to at least 281 by 1993.
[g] Growth during the Adak transplant in 1958 and 1959 (Skoog, 1968).
[h] Data from Skoog (1968), no estimate of variance given.
[i] Probable growth during the transplants to Kenai Lowlands and Kenai Mountains herds in 1965 and 1966 (Van Ballenberghe, 1985).
[j] Growth rate at the time of the transplant that formed the Killey River herd in 1985 and 1986. Growth rate was reduced by harvest (Tobey, 1993).
[k] Growth rate at the time of the transplant to Nushagak Peninsula (late 1980s).
[l] Growth rate was initially elevated by the high proportion of females in the transplant (Hinkes & Van Daele, 1996). Growth rate was calculated from 1988 to 1996.

the mean weight of a sample of 10-month-old female calves exceeded previously recorded calf weights for all Alaskan herds (Valkenburg, 1997) (Table 1). These calves were significantly heavier ($P<0.001$, $t=4.84$) than calves weighed during the same period in the Kenai Mountains herd, despite similarities in elevation, growing season length, and physiographic characteristics of their ranges (Table 1).

*Nushagak Peninsula transplant*

In 1988, caribou were transplanted from the Northern Alaska Peninsula herd to a vacant range on the Nushagak Peninsula about 100 km to the west (Fig. 1). The transplanted caribou increased rapidly (Table 1), and all females aged 2 years or older were fecund during 1988-1993 (Hinkes & Van Daele, 1996). At the time of the transplant, the Northern Peninsula herd had been stable in size at a relatively high density (about 0.6/km$^2$). When body condition in both herds was assessed in April 1995, Nushagak calves were significantly heavier ($P=0.005$, $t=2.98$) than Northern Peninsula calves (Table 1), and 2-year-old females were commonly producing calves in the Nushagak herd. However, despite being transplanted to pristine range, Nushagak Peninsula caribou calves never became as large as calves in the Killey River herd or other low-density Interior herds (Table 1) (Valkenburg, 1997). In 1997, when population density had increased to 0.8/km$^2$ in the transplanted Nushagak herd, body weight of calves was not greater than in the Northern Alaska Peninsula herd ($P=0.28$, $t=1.11$) (Table 1).

## Discussion

The 5 transplanted herds reviewed here provide additional evidence that body weight and natality in many established Alaskan herds are significantly limited by density-dependent nutritional factors that are independent of climate and genetics. On Adak, the longer growing season, lack of parasitic insects, and potential availability of green forage in winter could have accounted for increased body weight and productivity compared with parent stock in the Nelchina herd (Jones, 1966; Thomas & Kiliaan, 1990). On the Nushagak Peninsula, however, body weight of calves was greater in the transplanted herd from 1992 to 1995 despite the similar summer climate and physiography (Hinkes & Van Daele, 1996) (Table 1).

The Kenai transplants also demonstrate the potential for increased body weight and fecundity on pristine ranges. Calves from the 1996 cohort in the Killey River herd were significantly larger than any of the Nelchina cohorts. In the Kenai Mountains herd initially, and in Killey River herd natality in 2-year olds must have been much higher than that reported for the Nelchina, because the Kenai Mountains herd grew at nearly the biological maximum (indicating virtually all yearlings were pregnant), but the highest reported pregnancy rate in Nelchina yearlings was only 13% (Skoog 1968; Bergerud 1980: 568).

Although changes in body weight and natality rate were not obviously related to crude summer density across herds (Table 1), declines in body weight and natality occurred after relatively short periods of grazing pressure as density within herds increased. Decreasing summer nutrition is the factor most likely to cause observed declines in natality and body weight (Skogland, 1984; 1985; Eloranta & Nieminen, 1986; Reimers, 1997). Reduced body weight and natality began to occur in the Kenai Mountains herd after only 10 years of grazing, and summer density increased only to about 0.3/km$^2$ before herd growth slowed. In 1995 crude density was still only about 0.5/km$^2$ when body weight of female calves was similar to the parent Nelchina herd where summer density was 4.7/km$^2$ (Table 1).

Inherent physiogeographic and climatic factors, rate of population growth, and opportunity for dispersal undoubtedly determine the summer density that herds can achieve. For example, on St. Matthew Island very high summer densities were achieved (18/km$^2$) because of the high quality and quantity of summer forage, the long growing season, lack of opportunity for dispersal, and high population growth rates due to the virtual absence of predators (Klein, 1968).

On mainland ranges where large predators are present, predation can have a profound dampening effect on population growth rate and density when functional and numerical responses occur and prey vulnerability increases as nutrition declines (Dale *et al*, 1994; Valkenburg *et al*, 1996). Population growth was apparently restrained immediately after introduction due to predation by wolves (*Canis lupus*), coyotes (*C. latrans*) and dogs (*C. familiaris*) in the Kenai Lowlands herd (Spraker, 1995). However, in the Kenai Mountains herd and the Killey River herd, although both wolves and grizzly bears (*Ursus arctos*) were present and lightly hunted, near maximum caribou population growth continued for 10 years after introduction. This could either be due to a lag in predator hunting behavior, the low vulnerability of caribou on a very high plane of nutrition, or both. In the Nushagak herd large predators are scarce and particularly vulnerable to hunting.

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