Wolf predation in the Burwash caribou herd, southwest Yukon

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Abstract: The role of wolf predation as a proximate mortality factor influencing caribou herd growth was assessed in the Burwash herd (400 animals) in the southwest Yukon between 1980 - 1982. Ten to 14 wolves in two packs preyed primarily on caribou (*Rangifer tarandus caribou*) and moose (*Alces alces*) with disproportionate consumption of caribou (relative to available biomass) in the rut and winter periods. Wolf predation was responsible for 72% of total annual mortality in 1980 - 1981 and 46% in 1981 - 1982. Losses due to human harvest varied between 7 to 13%. Additional limited data on climatic factors and winter forage indicated forage-climate were not major proximate mortality factors in 1980 - 1981, but that early-calving climate may have been a factor in increased calf mortality in 1982.

Key words: wolves, caribou, predation, forage-climate

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Introduction

There is general agreement among researchers that the population growth of many mainland caribou (*Rangifer tarandus*) herds is primarily limited by low recruitment to breeding age due to mortality (Bergerud, 1980; Kelsall and Klein, 1979). Wolf predation has been identified as an important source of mortality in a number of caribou studies (Davis, *et al.*, 1980; Kuyt, 1972; Miller and Broughton, 1974) with some researchers arguing that predation alone can limit population growth (Bergerud, 1980). However, numerous researchers have pointed out the potential complexity of interactions of predation-forage-climate, among other factors, which can confound interpretation of the identity and degree of factors primarily responsible for changes in numbers (Connolly, 1981; Keith, 1974).

The study of a caribou (*R. t. caribou*) herd in southwest Yukon known as the Burwash herd examined the likely contribution of wolf predation as a proximate mortality factor in the limitation of herd growth. We reasoned that the likelihood that predation was a major proximate mortality factor would be strong if changes in herd numbers were not related to natality, ingress or egress and human harvest. Earlier reports on the abundance (Gauthier and Theberge, 1985) and distribution (Gauthier *et al.*, 1985) of the Burwash herd provided data on these factors. In addition, studies of wolf food habits should show that the number of caribou eaten was significant in relation to caribou productivity. The significance of predation as a limiting factor depends upon the likelihood that the prey population is not at or near a range carrying capacity. If it were, any decrease in predation would theoretically be compensated for by increased starvation (Theberge and Gauthier, 1985). In this paper we report data on wolf food habits and the general contribution of some key range components.

Study area

The study area was located on the northeastern flank of the St. Elias Mountains (Fig. 1). It included a 160 km^2 western subregion of rolling tundra plateau between 1200 and 2000 m known as the Burwash Uplands, a 60 km^2 eastern subregion of largely tundra plateaux between 1100 and 1900 m known as the Brooks Arm plateau, and a central forested lowland subregion of 1450 km^2 (the Shakwak Trench) bisecting the two upland plateaux subregions. The remaining areas of the Burwash and Brooks Arm subregions consist of mountain peaks rising to 2350 m and ridges and river valleys covered by boreal forest generally below 1220 m.

The study area lies on the rain shadow of the St. Elias Mountains and is characterized by a dry cold-continental climate. Major vegetation cover types include boreal forest (largely *Picea glauca*, *Populus balsamifera* and *Populus tremuloides*), mainly below 1220 m, and subalpine and alpine habitat (principally *Salix* spp., *Betula* spp., and sedges and grasses) above 1220 m.

Three other species of ungulates inhabit the region: Dall's sheep (*Ovis dalli*), moose (*Alces alces*), and mountain goat (*Oreamnos americanus*). Large predatory mammals are wolves (*Canis lupus*), grizzly (*Ursus arctos*) and black bears (*Ursus americanus*), coyotes (*Canis latrans*), fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), and lynx (*Lynx lynx*).

Gauthier and Theberge (1985) reported demographic data on the Burwash herd. All evidence indicated stable or slowly increasing numbers from the fall of 1978 until winter 1982 when a decline in numbers was attributed to movement of short duration (1-month) from the study area. Ingress did not appear to be a significant factor influencing herd size. Since there was no evidence of variations in productivity among years and movements from the study area were accounted for in changes in numbers, the results suggested that mortality factors were important in limiting growth of the herd over time.

Methods

Wolf predation

Information on wolf numbers, sex and age composition were collected from aerial and ground observations of wolves, telemetric monitoring data of radio-collared wolves and information provided by local trappers and residents. Three wolves were equipped with radio collars: two by aerial capture from a helicopter with CapChur equipment using M99 and rompun, and a third by live- trapping using modified Victor No. 4 leg-hold traps. Aerial radio relocations of the collared wolves were made on 137 separate occasions, with an additional 43 sightings of uncollared wolves.

To assess wolf food habits, a total of 388 wolf scats were collected from September 1978 to June 1982 on transects and at one wolf denning site (during the spring of 1980 and 1981) within the area of wolf distribution. Techniques of aging, laboratory cleansing of scats and the method of sample selection of hairs have been described in Gauthier (1984). Caribou and moose calf hair could be distinguished from adult-subadult-yearling hair only for the calving season (15 May - 30 June), the only season for which caribou and moose were separated into age classes. Identification keys for calf versus older-aged caribou hair were developed from calf hair taken from Burwash animals during the calving period and older-aged caribou during the summer. The proportion of prey hair in scats for the calving (May - June), rut (September - October) and winter (November - April) periods was used to predict the number of prey animals consumed by wolves in each of those seasons.

Floyd *et al.* (1978) proposed a regression method to estimate the amount of prey biomass consumed by wolves based on knowledge of individual prey weights. We derived seasonal estimates of weight for caribou from live-capture data and for moose from literature sources (see Gauthier, 1984 for complete description). These weight data were used in the regression method to estimate the biomass of each prey type consumed by wolves seasonally (for example, scat analysis showed that adult caribou accounted for approximately 70 kg of prey consumed by wolves in calving 1980, or 17% of total prey biomass). Numbers of caribou and moose (Gauthier, 1984; Gauthier and Theberge, 1985) derived from censuses were converted to biomass values and compared to estimated biomass values derived from scat data (representing amount of prey consumed by wolves). Contingency table analysis was used to assess whether the prey biomass ratio of caribou:moose derived from scat analysis was significantly different from the

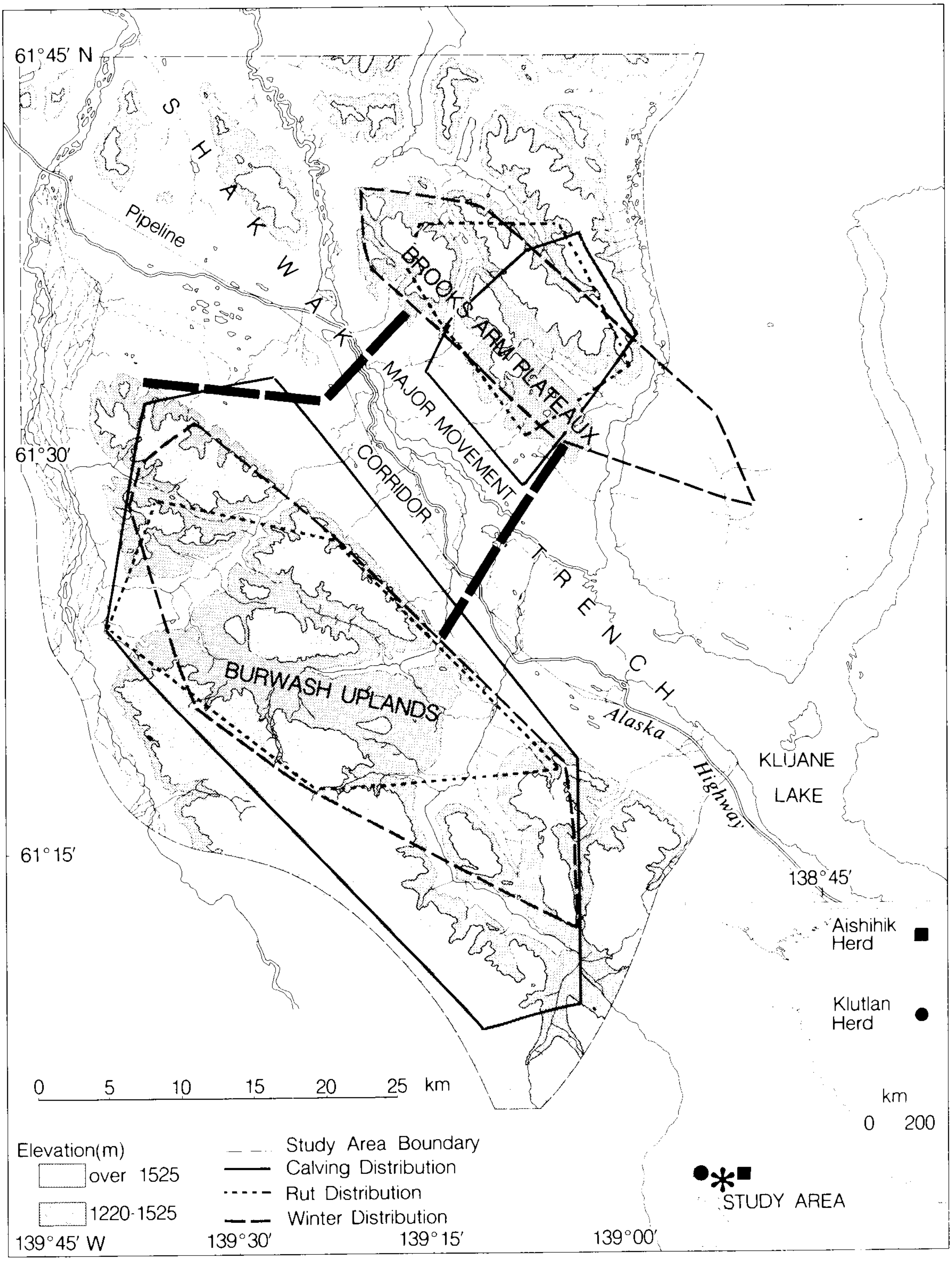

Fig. 1. Burwash caribou herd study area.

total prey biomass ratio for each of the three seasons.

Based on the number of wolves in the region, wolf seasonal food requirements were calculated; approximately 2.0 kg of food per day for adult wolves and 2.5 to 3.8 kg of food per day for wolf pups (Mech, 1970; Haber, 1977). For example, in the 123 day calving/post-calving period of 1980, we estimated approximately 2500 kg of food would be required by the 10 adult wolves in the region. We recognize that wolves may not meet their requirements and these figures are therefore relatively crude estimates. Each of the seasonal estimates was apportioned to prey type based on the estimated proportion of that prey type derived from scat analyses (for example, wolf scat analyses showed that adult caribou accounted for 17% of prey biomass consumed in the 1980 calving period or 425 kg of the 2500 kg estimated wolf food requirement). Each estimate of prey species biomass was divided by the estimated individual prey weight to give the number of prey consumed (for example, the estimate of 425 kg of adult caribou consumed in calving 1980 was divided by an estimated weight value of 84 kg to give five adult caribou consumed by wolves in calving 1980). In all of the foregoing calculations, estimates of scavenging activity and the amount of carcasses consumed were included. Complete details of methods and calculations are given in Gauthier (1984).

Forage and climate

Vegetative cover types were classified through Landsat satellite image analysis (Gauthier, 1984). The number of caribou observed in each habitat type was compared with the area size of each habitat type for each of the three seasons.

Caribou food habits were assessed through analyses of fecal pellet samples, a recognized technique for ungulates (Sparks and Malechek, 1968). Twenty-nine samples of pellets were collected: 4 during calving, 5 during rut and 20 during winter. The microhistological analytical techniques used were the same as those described by Hansen *et al.* (1982), using 100 samples or readings of plant fragments per pellet group. Seasonal differences in the proportion of five vegetation classes present in caribou feces were assessed by contingency table analyses.

Based on analyses of food habits, emphasis was placed on assessing lichen biomass. One 100 m straight-line transect was sampled in each of six sedge-grass-lichen communities using a 25 x 25 cm square at 32 randomly selected points along each transect from which to collect lichen samples. Samples were sorted and identified in the laboratory, oven-dried and weighed. Total lichen biomass estimates per transect were correlated (using Pearson's product-moment correlation test) with the cumulative total number of caribou observed in each transect area on all winter aerial surveys.

Possible effects of weather were assessed from climatic information: total snowfall and precipitation from 1967 to June 1982 (monthly records of Atmospheric Environment Service); snow thickness and hardness were recorded on transects (rammsonde penetrometer; Skogland, 1978) with 10 sample points per transect, conducted during the winters of 1979 - 1980 (n=73) and 1980 - 1981 (n=87) in caribou feeding areas, caribou movement pathways and areas of no caribou activity, as determined from aerial and ground surveys. Insufficient data were collected in the winter of 1978 - 1979 to allow analysis and the ground study ended in December 1981. Daily minimum temperatures and mean windspeeds (during daylight hours) were recorded in upland tundra and mountainous locations during the calving periods of 1979, 1980 and 1981.

Results and discussion

Ten to 14 wolves in two packs occupied the herd's range. The Burwash pack occupied non-caribou range in the Shakwak Trench and caribou range in the eastern section of the Burwash Uplands. Pack numbers varied between a low of 5 wolves (adult-subadults) from 1978 to 1980 to a high of 9 wolves (5 adult-subadults, 4 pups) in 1981 when the pack denned. Based on telemetry information, this pack had not denned in 1980 nor did it den again in 1982. The 1981 den site was located within caribou calving range and wolf pack movements during calving 1981 corresponded to primary calving areas within and surrounding the Burwash Uplands. The fate of the pups between May 1981 and May 1982 was unknown and we assumed a maximum of 5 adults and 4 pups for that period. An additional group of 5 wolves of unknown sex occupied caribou range in the Brooks Arm subregion. It is unknown if the pack denned during the study although no pups were observed in that subregion. The estimated densities during 1979 and 1980 were 1 wolf/297 km^2 and 1 wolf/212 km^2 in 1981. Since the survival status of the pups past August 1981 was unknown, we estimated 10 to 14 wolves (1 wolf/212 to 297 km^2) in the study area between September 1981 and June 1982.

Wolf fecal analysis revealed the average number of prey per scat was 1.7. The biomass method of estimation showed that ungulates comprised two-thirds of food items for wolves over the study period, with small mammals comprising the remainder (Table 1). No significant difference in the proportion of ungulates and small mammals was found among seasons (P=0.646). Caribou were the dominant ungulate prey item followed by moose, and hares were the dominant small mammal prey item. Results suggest that wolves were eating caribou and moose in proportion to their available biomass during the calving period and were disproportionately eating caribou during the rut and winter periods (Table 2).

We estimate that wolves consumed 66 caribou from calving 1980 through winter 1981, 47% during calving, 21% during rut and 32% during winter (Table 3). From calving 1981 through winter 1982, wolves consumed between 80 to 111 caribou, approximately one-half during calving and one-quarter of the total for the year during each of the rut and winter periods. Thirty to 50 caribou were consumed by wolves in calving 1982. The total annual mortality rate for adult

Table 1. Percentages of individual prey species biomass found in wolf scats according to season.

Prey species	Calving	Rut	Winter	All seasons
Caribou[1]	30	55	40	35
Moose[2]	36	6	25	30
Hare	20	22	27	21
Ground squirrel	8	11	6	8
Other small mammal spp.	6	6	2	6

[1] comprised of 17% adults/subadults and 13% calves.
[2] comprised of 29% adults/subadults and 7% calves.

Table 2. Comparison of the proportion of prey biomass from wolf scats with total prey biomass derived from censuses.

Season and prey species	Scat estimate[1] (%)	Total ungulate biomass (%)	Probability
Calving			
Caribou	35	40	ns[2]
Moose	42	60	
Rut			
Caribou	66	34	s[3]
Moose	8	66	
Winter			
Caribou	43	30	s
Moose	28	70	

[1] Small mammals (hares, cricetids, microtines) comprise remaining percentages in each season.
[2] ns=not significantly different, P=0.05.
[3] s=significantly different, P=0.05.

Table 3. Summary of sources of losses in caribou numbers, Burwash herd, 1980 - 1982.

	1980-1981	1981-1982
Difference between number of caribou in calving period and the number by next calving period (excluding new calves).	92	286
Estimated gain due to ingress	negligible	negligible
Estimated loss due to egress	negligible	85
Subtotal (mortality losses)	92	201
Estimated loss due to wolf predation	66	95
(% of total mortality)	(72%)	(47%)
Estimated loss due to human harvest	12	14
(% of total mortality)	(13%)	(7%)
Other sources of mortality	14	92
(% of total mortality)	(15%)	(46%)
Percentage of total annual calf mortality between the calving and rut periods.	58%	53%
Percentage of calf mortality between the calving and rut periods due to wolf predation.	22%	23%

and subadult caribou varied from 6 - 7% (1980 - 1981) to 8 - 9% (1981 - 1982) and for calves from 58% (1980 - 1981) to 69% (1981 - 1982) (Gauthier and Theberge, 1985).

A decrease in the proportion of caribou mortality between 1980 - 1981 and 1981 - 1982 as a result of wolf predation (72% to 47%) was not due to a decrease in wolf consumption rates (6 caribou/wolf in 1980 - 1981 versus approximately 8 caribou/wolf in 1981 - 1982). Other mortality factors assumed importance in 1981 - 1982. Our data indicate that increases in caribou losses over the previous year occurred in the winter and early calving periods of 1982.

The rate of wolf predation on caribou neonates was relatively low. In 1980 and 1982, 58% and 53%, respectively, of total annual calf mortality occurred between the calving and rut periods. Wolf predation accounted for 22% and 23%, respectively, of that seasonal mortality. These data suggest that wolf predation was an important mortality factor on caribou, not through its effect on neonates, but principally on older-aged animals during the rut and winter periods.

Caribou food habits, forage availability, and weather

We observed a shift in caribou distribution from shrub habitats in calving to sedge-grass-lichen units in the rut and winter, indicating that caribou food habits would also show a shift. Shrub species (principally *Salix* spp.) were the dominant food item in caribou diet over all seasons (46%) followed by lichen species (33%). This pattern was repeated seasonally. Shrubs were the dominant forage item during calving (81%), rut (47%) and winter (39%), while lichens were secondary in each of the three seasons at 12%, 25% and 39%, respectively. Lichen proportion differed significantly among seasons ($P>0.014$), doubling from calving to rut and tripling from calving to winter.

Caribou occupied predominantly sedge-grass-lichen (42%) and shrub (26%) environments over all seasons, i.e. mainly alpine and subalpine habitats. Tests of nonsignificant interactions in contingency table analysis showed that the major difference between the calving and the rut/winter periods was the decrease in occupancy of shrub habitat (from 37% to 26%) and increase in sedge-grass-lichen habitat (from 32% to 43%). Comparisons of the ratio of the number of caribou observed in each landform category to the amount of area in each category showed that caribou distribution was proportional to the amount of area of life-form classes during calving periods but disproportionate in the rut and winter periods when caribou had shifted to sedge-grass-lichen habitats. We suspected that winter sightings of caribou in sedge-grass-lichen environments were probably a function of their use of those habitats to obtain terrestrial lichens and possible prostrate shrubs. This observation was enhanced by the results of the food habits analyses that showed a predominance of lichen and shrubs in winter feces.

We examined only the availability of lichens as partial indicator of the forage available to wintering caribou. Lichens were relatively abundant in the sedge-grass community, one of nine communities described by Gauthier (1984), averaging 189 kg/ha based on six transects. Lichen biomass values and numbers of wintering caribou were significantly correlated ($P<0.01$).

The portion of the major home range of the Burwash herd classified as sedge-grass community from Landsat analysis was 542 km^2 and the total estimated lichen biomass for this community was 10 234 350 kg (Gauthier, 1984). Assuming caribou of the Burwash herd consumed the highest lichen biomass reported (5 kg/caribou/day; Hanson *et al.*, 1975), and that the herd size was 402 animals (the largest number estimated from winter censuses), the herd would require 2010 kg/day of lichen or 331 650 kg over the winter period (165 days), or 3% of the estimated total biomass in sedge-grass-lichen communities. We have no information on the relationship between annual growth and lichen biomass in the study area, the extent of loss of lichen biomass through scraping and trampling by animals, or the long-term ability of the range to support animals. Given these deficiencies and our crude estimate of total available biomass, we can only infer that the large difference between the dryweight lichen intake required for the herd and that estimated as existing in the main community type within which they forage suggests little absolute shortage of lichen to affect the nutritional status of animals.

Lichen availability to caribou was not likely influenced by snow conditions. Burwash caribou do not have to contend with large snowfalls. The average yearly total snowfall as measured at a snow station in forested habitat (area of greatest snow accumulation) in the Burwash area from 1967 to 1978 was 127.7 cm. In the first 3 years of this study, total snowfalls were less than the average, ranging from 70 to 83 cm. In 1981 - 1982, total snowfall of 135 cm exceeded the long-term average, however, no significant difference in snowfall levels among years was found ($F=1.80$; $P=0.149$). Snow depth averaged 28.3 cm in 1979 - 1980 and 18.0 cm in 1980 - 1981, while snow hardness values averaged 10.1 kg and 8.3 kg, respectively. Average snow thickness and rammsonde hardness values were well below many reported levels (for example, LaPerriere and Lent, 1977; Stardom, 1975).

Neonate mortality rates in the Burwash herd were 40% in the first 3½ weeks of calving in 1980, 13% in the first 2½ weeks in 1981 and 49% in the first 2½ weeks in 1982 (Gauthier and Theberge, 1985). No differences in mean minimum temperatures, total precipitation rates or mean windspeeds were found between the calving periods of 1980 and 1981 (Gauthier, 1984), suggesting that variations in neonate mortality rates between the 2 years were not related to microclimatic conditions. However, for 1982, Downes (1984) reported periods of cold, wet weather in the Burwash Uplands region during the calving period. An explanation for the high neonate mortality in 1982 may have been short but severe periods of low temperatures and wet conditions. We note that, regardless of year, the influence of climatic conditions as indirect factors influencing susceptibility of calves to more proximate mortality factors is unknown.

With range and weather implicated in caribou mortality to the minor degree discussed, other factors must have been proximal causes of the non-wolf related mortality (15% of total mortality in 1980 - 1981 and 46% in 1981 - 1982). We noted that human harvest amounted to 13% and 7% of total mortality in the 2 years. As well, we documented predation by grizzly bears through incidental observations. Grizzly bears have been shown to be important mortality agents in wolf-ungulate systems, principally through their effect on neonates (Ballard and Larsen, 1985). The neonatal caribou losses documented in this study which could not be accounted for by wolf predation, may have been at least partially a result of predation by other predators.

Conclusion

Wolf predation was numerically the largest proximal cause of mortality in the Burwash herd. Its significance relative to other causes of mortality may be variable as shown in 1982 when it appeared that weather or other predators may have been an important cause of calf loss. We view our analysis of range carrying capacity as only partial, for reasons discussed. As well, the degree of compensation that may exist among the three main predatory species (wolf, bear and man) is not known. Therefore, while our data document an important role for wolf predation on the herd further work is necessary to assess its limiting effect.

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