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RESPONSES OF DALL SHEEP POPULATIONS TO WOLF CONTROL IN INTERIOR ALASKA

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ABSTRACT

Severe winters in the early 1970's and overharvest of moose by humans coupled with very high wolf populations necessitated a wolf control program in the Tanana Flats south of Fairbanks. This area is adjacent to a low quality sheep population which has been extensively studied for 12 years. The sheep populations had been declining since a high was reached in 1970. Wolf control began in 1976, the population of sheep stabilized at that time, and numbers began a gradual upswing. Aerial surveys in 1980 indicated that sheep populations closest to the foci of wolf reductions benefited most. Expansion of these local population responses to the entire area affected by wolf control indicates wolf predation may have been largely responsible for declines in sheep numbers observed in the early 1970's.

INTRODUCTION

Severe winters in the late 1960's and the early 1970's initiated a moose (Alces alces) decline in the Tanana Flats south of Fairbanks. Excessive sport hunting and wolf (Canis lupus) predation sustained the moose population decline. Other ungulate species, particularly caribou (Rangifer tarandus), were also declining. The gravity of moose and caribou population declines prompted the Alaska Department of Fish and Game to initiate a wolf control, program to reduce mortalities on the ungulate species involved. This program had immediate beneficial effects on moose and caribou numbers which have increased to levels that can safely support reasonable levels of both human harvest and predation. Wolf numbers are also increasing again (Gasaway et al., submitted 1982).

Sheep numbers also responded to reduced wolf numbers but to a smaller degree than moose or caribou populations. The purpose of this paper is to describe changes in the sheep population prior to and following wolf control and to discuss, in general, the effects wolves may have on Dall sheep abundance in Interior Alaska.

METHODS

Wolves

The abundance and distribution of wolves in the study area were determined primarily by extensive aerial surveys (Stephenson 1978). Population estimates for the 17,060-km^2 area were made annually between 1972 and 1979 with the most accurate estimate resulting from 324 hours of fixed-wing flying prior to and during initial wolf control efforts in winter 1975-76. Wolves were removed by shooting from a helicopter after tracking and locating wolf packs with fixed-wing aircraft. A mandatory sealing program provided accurate harvest data on wolves taken by the public. The carcasses of 162 wolves killed in the study area from 1976 through 1979 were necropsied in the laboratory. Data on sex and age, nutritional and reproductive condition, and food habits were collected.

Sheep Population Size

Lamb production and yearling recruitment were determined from composition counts at the major mineral lick in the study area. Sheep were classified using spotting scopes at distances of less than 200 m. The mineral lick was observed daily from 19 June through 30 June from 1972 through 1981 from 0430 to 1200 hours.

Population estimates were made from collared sheep resighting data, aerial censuses and intensity of mineral lick use recorded for the observation period. Aerial censuses of 1970, 1975 and 1980 were used to determine population sizes for those years. The number of incoming sheep during the observation period in those years was then plotted as a function of population size. This plot revealed a linear relationship, and population sizes were then estimated from data on mineral lick use going back to 1970. One further data point where intensity of mineral lick use and population size were known was derived from collared sheep return frequency observed in 1972.

During 1972 the mineral lick was observed for 24 hours/day for 6 weeks. The return frequency for 200 collared sheep of all age and sex classes was then used to estimate the total sheep population size. The estimate of 1,473 sheep total minus the lambs present (which were not collared) based on a collared sheep number of 200 indicated about one sheep in eight was marked when this estimate was made. All 4 known population sizes and mineral lick use intensities fell on the same straight line, and subsequent population estimates are thought to have an accuracy of about plus or minus 3%. Obviously these estimates are of insufficient validity to place much confidence in any individual value, but we believe they are adequate for determining population trend in the range of population sizes observed.

During aerial counts, data were divided into census units which correspond to the home ranges of ewes determined from movement studies (Heimer 1973). A map detailing census blocks is shown in Fig. 1.

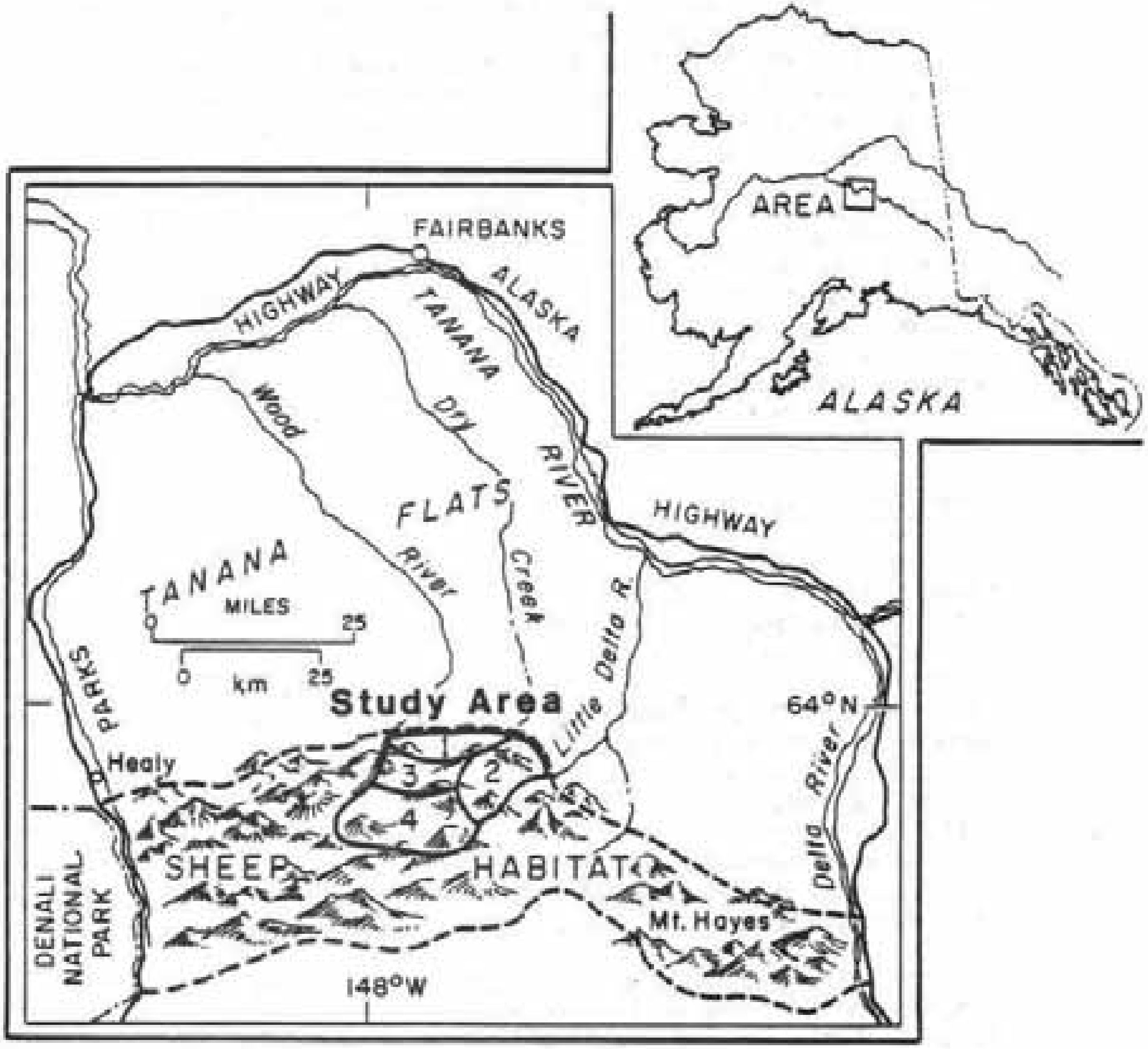

Fig. 1. Map of the Tanana Flats and the sheep habitat lying along the southern edge. The count blocks in the Dry Creek study area are numbered 1-4.

RESULTS

Wolves

The Tanana Flats wolf population was estimated at 239 prior to the initiation of control efforts in winter 1975-76. Less extensive surveys indicated at least 200 wolves were present during early winter from 1972 through 1974. The 1975 population included 23 packs with an average size of 9.3 wolves, distributed fairly uniformly on the Tanana Flats. This population was reduced by about 60% during winter 1975-76 when 145 wolves were taken. Wolf numbers were maintained near this level through 1979. This program was primarily designed to benefit moose and caribou populations, and control efforts were emphasized in areas used by these species. Moose and caribou habitat overlapped considerably with sheep between 1976 and 1979.

Data reflecting winter food habits were obtained from the stomachs of 156 wolves killed between 1976 and 1979. Fifty-five percent of the stomachs contained moose remains, 12% contained caribou, 2% sheep, 3% snowshoe hares, and 26% were empty. Of the 99 wolves killed near sheep habitat, only 3% had sheep remains in their stomachs. Although both successful and unsuccessful attempts by wolves to prey on sheep have been observed during summer and winter fieldwork, neither of these observations nor the occurrence of food remains in stomachs suggests that wolves preyed on sheep as regularly as on moose and caribou.

Sheep Population Size and Trend

Sheep populations adjacent to the wolf control area showed immediate trend reversals. Those that were in decline began increasing when wolves were removed from their home ranges. Where wolves were not removed, sheep populations continued to decline at the same rate observed before wolf control. Fig. 1 shows the sheep study area divided into count blocks corresponding to discrete ewe subpopulations (Heimer 1973). These subpopulations were used for comparative analyses of the aerial censuses in 1970, 1975, and 1980. Table 1 gives flight times and total sheep seen during the census flights in these years. Since lamb production is variable from year to year, it is best to use the number of adults for year-to-year comparisons. We have gone further, using only adult "ewes" from censuses of 1975 and 1980, those years immediately prior to and following sustained wolf control (Table 2).

Postlambing sheep population size estimates and sex and age compositions for the entire study area before and after wolf control are given in Table 3. The 4 estimates of prelambing population size prior to initiation of wolf control show a downward trend. This trend is described by the equation $y = 1{,}254 - 85X$. After wolf control, the population trend is described by the equation $y = 1{,}010 + 0.5X$. It should be noted that these slope coefficients have units of "sheep lost or gained" per year in the prelambing population. Before wolf control, the overall population trend was downward at a rate of 85 sheep/year. Following wolf control, the population trend changed, indicating a gain of about 1 sheep annually.

That is, the number of sheep lost/year was reduced by 86 sheep/year following wolf control. However, during the pre-wolf control period, research-associated mortalities (Heimer 1982) accounted for an average of 6 sheep/year. These mortalities were not wolf related and should be subtracted. Hence, differences in population trend indicate about 80 sheep/year were not lost to the prelambing population of sheep following wolf reduction. The total overall prelambing population size has stabilizied near the 1975 level with count blocks 1 and 2 15.5% higher and blocks 3 and 4 17.5% lower than 1975 levels.

DISCUSSION

Impact of Wolf Reduction on Dry Creek Population

It is clear that sheep numbers and population trend in blocks 1 and 2 changed noticeably at the time wolf control began. Shepherd, Lentsch, and Haggland (pers. commun.), continuous participants in wolf reductions since 1975, report wolves continue to frequent count blocks 3 and 4 but are virtually absent from blocks 1 and 2. This suggests that wolves were, in large measure, responsible for the decline in sheep numbers seen in the 1st half of the 1970's. These findings tend to corroborate Murie's (1944) conclusion that wolf predation was the primary force controlling sheep numbers in Mt. McKinley National Park, adjacent to the Tanana Flats. Data given in Tables 2 and 3 suggest the various sheep subpopulations in the study area did not respond uniformly to wolf control. Populations in areas 1 and 2 increased to 1970 levels after declining by about 20% by 1975, while populations in areas 3 and 4 have apparently continued to decline from 1975 levels. These differences could be due to survey irregularities but may indicate that subpopulations closest to the focus of wolf removal (the Tanana Flats) showed the greatest response in terms of population trajectory. However, the low frequency of sheep hair in wolf stomachs during late winter suggests sheep were not a major food source for wolves during this time. This raises the question of how wolves could have depressed sheep numbers.

Changes in lamb production, survival, and yearling recruitment in the Dry Creek study area are strikingly similar to those in Denali National Park, about 70 km to the west, where no wolf control occurred and where moose and caribou populations are still low or declining. Therefore, the pattern of lamb survival does not appear to be related to wolf density. That is, wolves do not appear to exert their primary influence on Dall sheep populations through selective predation on lambs and yearlings. Because wolves did not appear to take large numbers of sheep in the study area during winter when caribou and moose are most vulnerable, 1 remaining hypothesis is that most wolf predation selects the various sex and age classes of sheep in the same proportions in which they occur in the populations during summer. It is also possible that no packs specializing in sheep hunting were collected during the wolf control effort on the alpine fringe of the Tanana Flats, and that some wolves relied more on sheep during winter than our food habits data indicate.

Table 1. Total Dall sheep counts from 1970, 1975, and 1980 for Dry Creek, Alaska Range.

Area surveyed	1970		1975		1980	
	Count	Time	Count	Time	Count	Time
1	315	*	250	3.0hrs	407	3.5hrs
2	485	*	347	2.4hrs	454	4.0hrs
3	332	*	341	3.0hrs	327	4.0hrs
4			294	5.9hrs	220	7.8hrs

*Specific time not available by area; total times 11 hrs.

Table 2. "Ewe"[1] numbers for survey areas within the Dry Creek vicinity in 1975 and 1980.

Area	1975	1980	Direction and magnitude of change
1	183	197	+8%
2	240[2]	294	+23%
3	186[2]	166	-11%
4	152[2]	116	-24%

[1] Definition of "ewe": sheep not identifiable as lambs or rams during aerial surveys. This class includes yearlings and young rams which can't be reliably distinguished from adult ewes in July.

[2] Number of lambs not classified in these areas for 1975. The number of ewes is back-calculated using aerial counts, mineral lick data for 1975 for lambs and yearlings, and lick data from 1974 to give a number of 2-year-old rams likely to be present with ewes and classified as such from the air.

Impact of Wolf Reduction on the Entire Game Management Unit (GMU) 20A Sheep Population

During an aerial survey in July 1970, 4,142 sheep were observed in GMU 20A; 25% were lambs. Assuming a sightability factor of 0.8 (Heimer 1982), the total population would have included 5,178. Subtracting the estimated number of lambs results in an adult population estimate of 3,882. Prior to wolf control, the prelambing population (Table 3) in the Dry Creek study area averaged 1,150 sheep and was declining by about 80 sheep/year. Use of data from Dry Creek to estimate prewolf control losses for the entire sheep population influenced by wolf control indicates the total population declined by about 280 sheep annually. This decline ceased following wolf control, suggesting the annual loss of sheep to wolves had exceeded recruitment by about 280.

During winter 1975-76, 39 wolves were taken in or near sheep habitat. During the 3 subsequent winters, an additional 11, 39, and 10 wolves, respectively, were taken. Because sheep numbers responded immediately following the reduction in wolf numbers in 1976-76 and because subsequent removal of wolves probably maintained the population near the level initially reached, it appears the removal of about 39 wolves resulted in 280 additional sheep surviving annually. Although this does not tell us the total number of sheep killed by wolves annually, it does indicate the amount by which the loss of sheep (to net wolves removed) exceeded recruitment.

These figures appear to be reasonable when the following calculations are considered. The composition of the sheep population averaged 22% lambs and yearlings with a mean weight of 16 kg, 58% ewes with a mean weight of 50 kg, and 20% rams with a mean weight of 77 kg. Assuming the average weight for sheep in this area is 48 kg (Heimer 1973) and that wolves preyed on the various sex and age classes of sheep in the proportion at which they occur in the population the total weight of sheep taken annually by wolves (above recruitment) would have been 13,440 kg. Since wolves consume about 80% of a sheep carcass, the total weight of sheep actually consumed was nearly 11,000 kg. Based on a study of radiocesium concentrations in wolves and their prey in the Tanana Flats, Holleman and Stephenson (1981) calculated that wolves preying primarily on moose consumed at least 2.8 kg/day/wolf. This estimate compares favorably with estimates of the amount of prey consumed in various field studies of free-ranging wolves (Mech and Frenzel 1971, Kolenosky 1972, Mech 1977, Peterson 1977, Fuller and Keith 1980) which range from 1.7 to 10 kg/day/wolf. If wolves occupying sheep habitat also consumed 2.8 kg daily, 11,000 kg of sheep would support about 11 wolves for 1 year.

These conservative calculations suggest the equivalent of 11 wolves relying on sheep for all of their diet would be sufficient to make the difference between stability and the observed decline in sheep numbers prior to wolf control. If wolves maintained a higher consumption rate, the number of wolves required to cause a decline of the magnitude observed would be even less.

Table 3. Estimated prelambing population, postlambing population, percent adult ewes observed, calculated number of ewes, lambs, percent survival to yearling age, and number of yearlings recruited in Dry Creek study population from 1972 through 1981.

Year	Estimated prelambing population	Estimated postlambing population	% breeding ewes	Number breeding ewes	Number lambs produced	Number yearlings produced	% survival
1972	1300	1473	55.9	823	123	132	--
1973	1110	1423	57.9	823	313	91	74
1974	1070	1280	58.6	750	210	187	60
1975	1031	1230	57.7	709	199	163	78
wolf control begun							
1976	1050	1310	55.2	723	260	116	58
1977	936	1350	52.9	714	414	121	47
1978	1094	1390	51.9	721	296	180	43
1979	942	1340	45.7	612	398	116	39
1980	1003	1425	44.2	630	422	227	57
1981	1044	1450	46.6	646	387	277	66

Other Factors

Lamb production and/or survival in the study area were variable between 1969 and 1981. The decline in dall sheep numbers from 1970 to 1975 coincided with low lamb production and yearling recruitment (Table 3). This was during a period of what are considered "normal" winter in interior Alaska except for winter 1971-72 which was particularly severe for sheep. Only 123 lambs were produced the following spring, and 91 survived to yearling age. Generally higher lamb production after wolf control probably resulted from milder winter weather after 1975. Winters have been noticeably mild since the mid-1970's. We believe factors other than weather must be included to produce different population responses in the differing count areas.

It is possible that overall increased lamb production and subsequent recruitment could be a result of decreased numbers of breeding ewes mediated by a density-dependent mechanism. However, Table 1 shows that in 1975, 709 ewes produced 199 lambs. In 1977, 714 ewes produced 414 lambs. This number of lambs in 1977 more than doubled the number produced by nearly the same number of ewes 2 years earlier. We think the increases in lamb production are more likely related to mild winters than to decreased density. It is interesting to note that survival to yearling age decreased following wolf control.

In summary, it appears reduced wolf numbers in the Tanana Flats had a noticeable effect on the area's sheep numbers. Our calculations of wolf numbers and the amount of wolf predation necessary to account for the observed response are approximate. However, they clearly show how relatively small increases or decreases in wolf predation can significantly influence sheep population dynamics.

In recent years, the varying effects of predation on moose and caribou populations in Alaska have been brought into perspective (Gasaway et al., submitted 1982). The data from our study indicate that in areas where large predators exist at normal levels of abundance in the presence of moose and caribou, predation may still have a significant controlling effect on sheep. However, there is little evidence suggesting that over large areas wolves rely on Dall sheep to the extent they do on moose or caribou since the decline we observed in sheep numbers during the early 1970's was less precipitous. Nevertheless, our data showing changes in sheep population trends where wolves are absent and continuing sheep declines where wolves are present suggest wolves may have depressed sheep numbers and were probably a major cause of mortality. The occurrence of wolves and other predators and other general ecological conditions in this area are to a large degree representative of most Dall sheep habitat in interior Alaska. These specific considerations suggest that increases in the human harvest of sheep must be approached cautiously in areas, such as Alaska, where large predators are still abundant. Furthermore, areas with less stable weather patterns should receive an even more cautious appraisal when increased human harvest is considered.

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