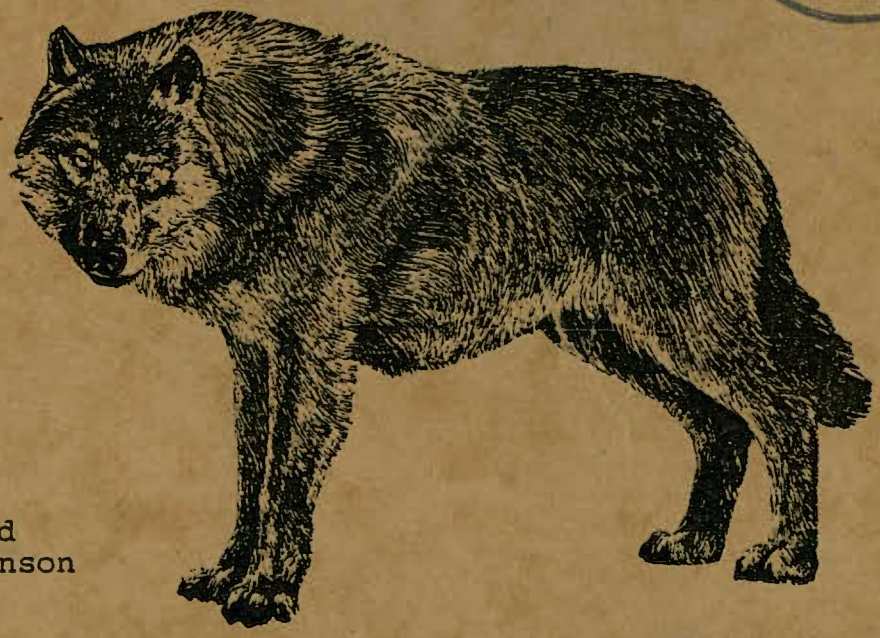
ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

NELCHINA BASIN WOLF STUDIES



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FINAL REPORT
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FINAL REPORT (RESEARCH)

State: Alaska

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Project Nos.: W-17-7, W-17-8, W-17-9, W-17-10 and W-17-11

Project Title: Big Game Investigations

Job No.: 14.8R

Job Title: Wolf Populations and Movements in Relation to Those of Prey Species

Job No.: 14.9R

Job Title: Wolf Food Habits

Job No.: 14.10R

Job Title: Impact of Wolf Predation Upon Ungulate Populations

Period Covered: April 1, 1975 to June 30, 1980

SUMMARY

Between 1 April 1975 and 30 June 1980, 103 individual timber wolves representing up to 22 different wolf packs were captured and radio-collared in Game Management Unit 13 (Nelchina Basin) of southcentral Alaska. Cost and problems associated with helicopter darting are discussed.

The 103 radio-collared wolves were individually located on 3,525 separate occasions resulting in 6,927 wolf sightings. Pack and individual wolf histories are presented and discussed.

Wolf territories were, for the most part, nonoverlapping. Overlaps which did occur were seasonal in nature or due to the method by which territories were plotted. There appeared to be changes in territory boundaries from year to year. Territory sizes for 14 intensively studied packs ranged from 268 to 864 mi^2 (691 to 2738 km^2), averaging 537 mi^2 (1390 km^2). Territory size appeared to be larger for larger packs and for those packs in areas of low moose density.

Wolf den and rendezvous site usage is described. The earliest that radio-collared wolves were observed at a natal den was 13 April. Most wolves began visiting den sites in late April and early May. Parturition appeared to occur throughout

the month of May. Natal dens were abandoned between 4 June and 1 August. Pups were observed first traveling with adults from late August to mid-September of each year.

Radio-collared wolf packs were observed on 360 individual prey kills, 38 (10.6%) of which were also occupied by one or more brown bears. Moose of varying ages comprised 72 percent of the observed kills. Calf and short yearling moose comprised 20 percent of the total kill. Wolves were preying upon short and long yearling age classes from January through July disproportionately to their presence in the moose population. Moose calves 0-6 months of age comprised only 6 percent of the kills observed.

Four thousand two hundred and ninety food items were identified in 3,624 wolf scats collected at den and rendezvous sites during this 5-year period. Overall, calf moose was the most frequently identified food item (44%). Percent occurrence of various prey items in wolf scats was generally related to prey abundance. Occurrence of calf moose in scats was correlated with subsequent fall calf:cow ratios, suggesting that wolves were preying upon calf moose in proportion to their abundance. Scat data were converted to numbers of individual prey eaten which was then extrapolated to GMU 13 spring wolf population estimates. This analysis suggested that wolves in GMU 13 were preying upon from 434 to 1,013 moose calves annually from mid-May through mid-July.

One hundred and twenty-five moose and 25 caribou kills were examined *in situ* to determine both cause of death and age and physical condition of prey taken by wolves. One instance of surplus killing of caribou by wolves was reported. Percent marrow fat of calf and short yearling moose killed by wolves was significantly higher than that of calves dying from both accidental causes and winter kill. We concluded that wolves were preying upon relatively healthy calf and short yearling moose.

Age and condition of wolf-killed adult moose examined from 1970-1972 were combined with data collected during this study. Overall, ages of adult moose killed by wolves were significantly ($P<0.05$) different from those tagged moose, winter-killed moose, and moose dying from accidental causes.

Age and condition of wolf-killed adult moose were compared with those of moose tagged during the same year predation occurred. We concluded that during severe winters wolves preyed upon adult moose in proportion to their occurrence in the moose population, while during average or mild winters relatively older adult moose were being preyed upon.

Marrow fat percent of wolf-killed adults was significantly ($P<0.05$) higher than that of winter-killed moose, but not significantly ($P>0.05$) different from those dying of accidental causes. We concluded that wolves were preying upon relatively healthy adult moose during winter.

Overall, 17 wolf packs averaged a kill every 4.9 days with a range of 3.1 to 12.7 days per kill. Differences between packs and problems associated with methods of calculating predation rates are discussed.

During winters 1978-79 and 1979-80, five wolf packs were intensively monitored to determine rates of kill according to pack size. Ungulate kill rates varied from one kill/8.3 days for a pack of two to one kill/3.6 days for a pack of nine wolves. Large wolf packs generally appeared to have a higher kill rate than smaller wolf packs.

During summers 1977 and 1978, activity patterns of two denning wolf packs were studied and are discussed. It was determined that adult males (presumed to be alpha males) were nearly always present when ungulate kills were made.

Wolf densities in GMU 13, excluding the wolf removal area, varied from 1 wolf/37.6 mi^2 (97.3 km^2) in fall 1975 to 1 wolf/121.7 mi^2 (315.2 km^2) in spring 1978. Wolf numbers in GMU 13 have declined since 1975. Hunting, trapping and dispersal were identified as the main reasons for the decline. GMU 13 wolf densities were compared with those reported elsewhere in North America.

Annual GMU 13 wolf harvests are presented and discussed. Rates of harvest from individual radio-collared wolf packs were examined in relation to productivity and ability of packs to replace losses. Losses in excess of 41 percent of the fall population resulted in pack population declines the following fall. It was suggested that a post hunting-trapping wolf density of 1 wolf/100 mi^2 might be suitable to keep wolf predation on moose to a minimum yet maintain a reasonable wolf population.

Of 103 wolves radio-collared during this study, 14 (14%) were known to be alive on 30 June 1980. Twenty-five percent were also known to have dispersed during the 5 years of study. The largest source of wolf mortality was human induced (77%). Ground shooting and suspected illegal aerial hunting, accounted for 76 and 11 percent, respectively, of the man-caused mortality. Natural forms of mortality accounted for 23 percent of the mortalities.

During this study at least 26 radio-collared wolves were known to have dispersed from their original pack area. Sixty-eight percent of the dispersals were males. Approximate average age of dispersed males was 35 months, while females averaged 37 months. Dispersal was most prevalent from April through June. Average distance dispersed was at least 67.7 miles (106 km). The longest documented movement was 460 miles (736 km), constituting a record movement for this species.

The effect of wolf predation on moose calf survival was studied in two areas of GMU 13. In one area, referred to as the Susitna River Study Area, wolf densities were lowered by Department personnel. In the other area of GMU 13 (remainder of the Unit generally east of Talkeetna Mountains), wolves were intensively studied to enumerate population densities and food habits.

From January 1976 through July 1978, 60 wolves were killed by Department personnel in an effort to test the hypothesis that lowered wolf densities would improve moose calf survival. Wolf densities in the Susitna River study area were estimated at 1 wolf/98 mi^2 of habitat in spring 1975 to 1 wolf/232 mi of habitat in spring 1978. By spring 1980 wolf densities had increased to within at least 89 percent of the spring 1975 estimate due to reproduction and immigration.

Fall moose sex and age composition count data and annual harvests were compared between the wolf removal area and other comparative count areas in GMU 13 where Department wolf removals had not been conducted. Statistical analyses revealed no significant ($P>0.05$) differences in either calf-cow ratios, moose observed per hour of survey, nor in ratios of harvested moose. Had wolf control increased moose calf survival we would have anticipated some significant differences in these ratios. Results of wolf food habits, moose calf mortality, and bear food habits studies indicated that the rates of predation on moose calves by wolves were far less than by brown bears. This tended to explain the lack of response by the moose population to reductions in wolf densities. Results of the bear transplant on moose survival are compared and discussed with this study.

CONTENTS

Summary i
Background 1
Objectives 2
Procedures 2
Results and Discussion 6
Wolf Pack and Individual Histories. 9
Wolf Territories. 36
Den and Rendezvous Site Usage 39
Food Habits in Relation to Availability of Prey . . 41
Food Habits Summary 82
Age and Condition of Prey 98
Wolf Predation Rates. 99
Summer Activity Patterns. 120
GMU Unit 13 Wolf Densities. 126
Trapping and Hunting Mortality. 128
Wolf Dispersal. 149
Experimental Wolf Removal 152
Wolf Repopulation of Removal Area 157
Evaluation of Wolf Removal on Moose 157
Recommendations. 171
Acknowledgements 171
Literature Cited 173

BACKGROUND

Rausch (1969) summarized the status of wolves (*Canis lupus*) in the Nelchina Basin (Game Management Unit 13) for the period 1957 through 1968. From 1948 to 1953 extensive poisoning by the Federal Government reduced populations of predators to low levels. In 1953 only 12 wolves were believed to remain in the Nelchina Basin. Rausch believed the wolf population gradually increased after 1953 and reached a peak of 400 to 450 in 1965. Although no formal wolf studies were conducted from 1969 through 1974, McIlroy (1976) speculated that a second peak occurred in 1970 after a low of 300 animals in 1968.

Rausch (1969), Bishop and Rausch, (1974), and McIlroy (1974) described the history of the Game Management Unit 13 moose (*Alces alces*) population. All pointed to an apparent inverse relationship between numbers of predators and numbers of ungulates. Moose apparently began declining after the severe winter of 1961-62. This decline continued and was hastened by severe winters in 1965-66, 1970-1971 and 1971-72. Fall calf:cow ratios declined sharply and reached a record low for the Basin in 1975. Although wolf predation was not suggested as the main reason for the population decline, it was thought to have at least amplified the decline and, more importantly, prevented recovery during mild winters (Rausch et al. 1975). This concern coupled with the findings of Stephenson and Johnson (1972, 1973), which revealed a high percentage of calf moose in wolf scats, suggested that wolf predation on calves was preventing the moose population from recovering. Consequently a series of

studies was initiated to obtain information on wolf-moose relationships in the Nelchina Basin. Preliminary results of this study were presented by Stephenson (1978) and by Ballard and Spraker (1979).

OBJECTIVES

To delineate wolf pack territories and determine wolf densities in an experimental area and a control area in Unit 13.

To compare seasonal wolf movements with seasonal movements and abundance of major prey species and environmental parameters.

To assess wolf food habits in the experimental and control areas of Unit 13.

To quantitatively assess the impact of wolf predation upon ungulate populations in Unit 13.

PROCEDURES

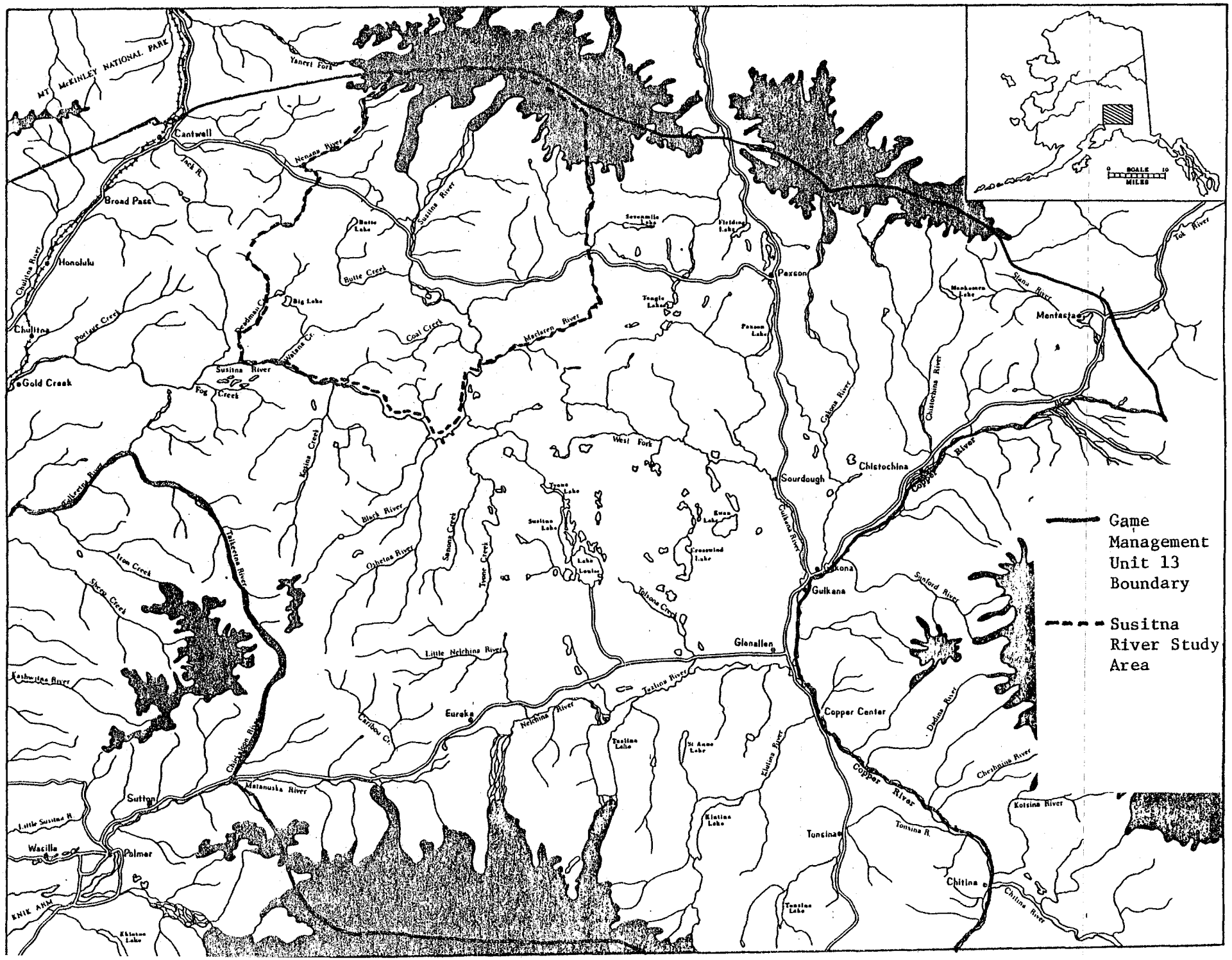
Wolves were studied in two different portions of Game Management Unit 13. In the Susitna River Study Area (Fig. 1) wolf numbers were experimentally reduced with the aid of helicopter and fixed-wing aircraft to assess the effects of wolf predation on moose calf survival. Moose calf survival there was to be compared to survival in the Nelchina Study Area, where wolf numbers had not been reduced.

Game Management Unit 13, an area of approximately 23,782 mi^2, has 7,258 mi^2 over 4,000 foot elevation. Detailed descriptions of its vegetation, climate and geography were provided by Skoog (1968).

The Susitna River Study Area is located in the northern portion of the Unit (Fig. 1). Its boundaries are as follows: the Alaska Range on the north; the Maclaren River on the east; the Maclaren and Susitna Rivers on the south; the confluence of Deadman Creek with the Susitna River northward to headwaters of Brushkana Creek, downstream to Brushkana Creek's confluence with the Nenana River and then northwest upstream to the Alaska range on the west. The Nelchina study area generally comprised those portions of Game Management Unit 13 lying east and south of the Susitna River study area.

Wolves were captured for radio-telemetry studies with a Cap-Chur gun and dart (Palmer Chemical Co.) fired from a Jet Ranger 206B helicopter using methods similar to those described by Baer et al. (1978). Our capture technique differed from theirs in that we darted in all types of vegetative cover and also while the animal was moving. Initially, a drug mixture of 0.7 ml, 100 mg/cc of phencyclidine hydrochloride (Sernylan, Parke-Davis Co.) with 1.0 ml, 100 mg/cc of promazine

Figure 1. Map of Game Management Unit 13 and Susitna River Study Area.



hydrochloride (Sparine, Wyeth Laboratories) was used to immobilize wolves. Later, the dosage of Sernylan was increased to 1.0 ml (100 mg/cc) to decrease the the latent period and obtain more complete immobilization. Twelve wolves were also immobilized with 2 mg of etorphine (M-99, D-M Pharmaceuticals, Inc., Rockville, MD). After being processed and radio-collared these wolves received an equivalent cc dosage (2 mg/ml) of the antagonist diprenorphine (M-50-50, D-M Pharmaceuticals, Inc., Rockville, MD) injected into the radial vein. Four live wolves were purchased from trappers and radio-collared.

Captured wolves were initially equipped with an adjustable machine belt radio collar manufactured by AVM Instrument Company (Champaign, IL) and later with an adjustable collar made of fiberglass and urethane manufactured by Telonics (Mesa, AZ).

Hair and blood samples were taken from each wolf using methods similar to those described for calf moose (Ballard et al. 1979). All hair samples were sent to Dr. Arthur Flynn, Case Western Reserve University, Cleveland, Ohio, for mineral element analysis. When practical, the following body measurements were recorded: weight, total length, heart girth, chest height, neck circumference, shoulder height, tail length, and length of canines. Preliminary analyses of hair and blood data were presented in Ballard and Spraker (1979). Results of these studies will be combined with those obtained from the Kenai Peninsula wolf study (Peterson 1978) and prepared for publication. Data reflecting blood and hair parameters not yet analyzed, are presented in Appendices I and II, respectively.

Initially we used a portable radiotelemetry receiver manufactured by AVM Instrument Company. The receiver contained four bands with 12 channels per band and covered frequencies in the 150.000 to 152.000 MHz range. Later, we began using a programmable scanning receiver manufactured by Telonics (Mesa, AZ).

Radio-collared wolves were tracked and, when possible, visually observed from fixed-wing aircraft using the methods described by Mech (1974). Monitoring intensity varied from pack to pack but consisted of at least bi-monthly monitoring during winter months.

Approximate ages of captured wolves were determined on the basis of tooth eruption and wear. Wild wolf age estimates were based upon their relative size and by criteria described by Jordon et al. (cited by Mech 1970). In some cases, age and sex structures of certain packs were not ascertained until the animals had been killed by hunters or trappers. We encouraged hunters and trappers to provide us with wolf carcasses taken in Units 11 and 13 by offering $10.00 per carcass. Ages of harvested wolves were determined by tooth eruption and wear, and by examining epiphyseal cartilage of the long bone according to methods described by Rausch (1967).

The sex and age of moose and caribou (*Rangifer tarandus*), killed by wolves were often determined from fixed-wing aircraft based on size, pelage and antler growth. Moose kills were categorized as calves, yearlings or adults. Both calves and yearlings were aged to the nearest month using an assumed birthdate of 1 June.

Size of wolf territories was determined by plotting all radio locations for individual packs and then connecting the outermost observations (Mohr 1947). Locations for individual radio-collared wolves which had dispersed were not included. Sizes of wolf territories and study areas were determined with a compensating polar planimeter. All study areas and wolf territories were planimetered at least three times and then averaged to compute mi^2 (km^2).

Active wolf dens located through observations of radio-marked wolves, or during associated flying, were inspected on the ground after they were vacated by wolves. The vicinity of each den was searched and all scats collected and food remains identified. Scats were placed in individual paper bags, then autoclaved and analyzed using previously described techniques (Stephenson and Johnson 1972), except that hair scale impressions (Adorjan and Kolenosky 1969) were used to confirm identification of prey remains when identification was uncertain. Comparisons of hair scale impressions were made with known samples by imprinting them on a slide containing clear fingernail polish.

When practical, we examined wolf kills on the ground. We determined the cause of death according to methods described by Stephenson and Johnson (1973) and Ballard et. al. (1979). A femur or metatarsal and the mandible were collected from each kill to aid in establishing the animals' physical condition on the basis of percent marrow fat using methods described by Neiland (1970). Ages of moose killed were determined on the basis of tooth eruption and cementum annuli, using methods described by Sergeant and Pimlott (1959). Caribou were aged on the basis of tooth eruption and wear (Skoog 1968).

During winters 1978-79 and 1979-80 an attempt was made to locate and examine all kills made by selected radio-collared wolf packs during a 2-3 month period. These selected packs were radio-tracked at least every other day and were backtracked to their previous location. In an effort to maintain study packs at stable numbers portions of GMU-13 were periodically closed to hunting and trapping of wolves. Boundaries and season lengths of closed areas were described by Eide (1979) and Tobey (1980).

The effects of reductions in wolf density on calf and adult moose survival in the Susitna River study area were determined by several methods. Fall moose sex and age composition counts were used to compare calf:cow ratios in areas of high and low wolf densities. If wolf reductions had increased moose

survival, it was anticipated that the increase would also be reflected by increases in the sport harvest of bull moose. Moose harvests were determined by tabulating the numbers of successful hunters as determined from "mandatory" harvest reports. Statistical differences between annual calf:cow and harvest ratios involved arcsine transformation of observed ratios in calculations of the statistics (Sokal and Rohlf 1969:607). Comparisons of trends in calf:cow ratios within and between areas involved analysis of residuals (Everith 1977:46) to determine which cells of a chi-square table were significant in rejection of the null hypothesis. The latter analysis was conducted using BMDP canned programs (University of California, Los Angeles, Dept. of Biomathematics, School of Medicine). Statistical differences in means and deviations in ratio data were tested with t-tests and chi-square analyses (Snedecor and Cochran 1973), respectively.

Carcasses of wolves removed from the experimental area were necropsied and aged, and nutritional condition and reproductive status were assessed. Preliminary results of laboratory examinations of these and other wolves, including those taken during 1976 and 1977 in control programs in GMU-20A and in northwestern Alaska, have been presented by Nielson (1977). Additional results from these studies are being analyzed and will be presented in future publications. Stomach and intestinal tracts were submitted to John C. Schlotthaver, University of Minnesota, for parasite investigations. Results of this study are currently being prepared for publication (Averbeck, et al. In Prep.). Tissue samples from the above-mentioned wolves have also been radio-assayed for radiocesium (cesium-137) by Dan Holleman, Institute of Arctic Biology, University of Alaska, Fairbanks, in an effort to elucidate the relative importance of moose and caribou in the diet of wolves. Results of portions of these analyses are also being prepared for publication (Holleman and Stephenson In Press).

RESULTS AND DISCUSSION

One hundred and three different wolves were captured and radio-collared in GMU-13 from April 1975 through June 1980. Sixteen wolves were recaptured on one or more occasions. All wolves, with the exception of two mortalities (wolf #122062 and one unlisted), appeared to recover from the drugs within several hours and most returned to the pack within 12 hours of initial immobilization. One collaring mortality resulted from drowning which apparently occurred as the animal was recovering from the drug in deep snow, while the other resulted from hitting the animal between the vertebrae with the dart. Wolves immobilized with etorphine recovered within 60 seconds after the antagonist was administered.

Costs associated with radio-collaring wolves in GMU 13 were discussed in Ballard and Spraker (1979). Costs consisted of

charter charges for helicopter and fixed-wing aircraft and darting equipment but did not include manpower nor the price of the radio collars. Based on 1978 prices, an average of $578 was expended to radio-collar each wolf. Wolves from packs that did not already have at least one radio-collared member were more costly ($\bar{x}$ = $624.00 per animal) than those which did ($\bar{x}$ = $511.00 per wolf). This difference was reflected in increased search time with fixed-wing aircraft. Four trapped wolves were purchased from trappers and radio-collared for approximately $350.00 each. Two of these animals had been injured by the traps and appeared to have difficulty keeping up with other pack members. Nevertheless, trapped animals were useful in establishing contact with a pack so additional members could be subsequently radio-collared from a helicopter.

Our helicopter darting technique was most efficient in moderate to sparse spruce habitat and when the depth of powdered snow exceeded 1 foot. These conditions usually slowed the animal and allowed the helicopter to get within easy shooting range. We experienced difficulty capturing wolves in dense spruce habitat and on open tundra with hard snow pack. Dense spruce often allowed an animal to evade the helicopter and required many shots for each successful hit. Open tundra allowed a wolf considerable maneuverability at high speeds and although we were always successful, it was usually necessary to tire the animal by running it.

From April 1975 through June 1978 the 103 radio-collared wolves representing up to 22 individual packs (a pack is defined as two or more wolves) were located on 3,525 separate occasions resulting in 6,927 sightings (Table 1). These observations represent 1,805 wolf pack days (pack day is defined as any day on which a pack was located one or more times). Monitoring intensity was variable from pack to pack, being dependent upon proximity to the field station, short-term objectives of the project (i.e., predation rates study), reliability of radio-transmitters, and loss of radio-collared wolves to hunting and trapping.

Observability of individual packs was also variable, ranging from 14 to 95 percent and averaging 84 percent. Pack observability appeared to be primarily a function of different habitat types and individual wolf behavior. Wolves occupying thick spruce habitats were less frequently observed than those occupying open areas. Some wolves seemed to be evasive when we attempted to observe them from aircraft. Also, small packs (2-3 individuals) were harder to observe than relatively large packs (5 or more individuals). Observability was also influenced by the experience of the pilot and observer.

We had a disproportionate number of visual sightings of certain wolves. Most evident was our inability to make visual contact with both black and white wolves, especially black

Table 1. Summary of location observations of radio-collared wolf packs in the Susitna and Nelchina River Basins of southcentral Alaska from April 1975 through June 1980.

Pack	Combined number radio-collared wolves	Combined number individual radio location	Number wolf sightings	Number different pack radio location	Number pack days
Brushkana	1	31	109	31	34
Butte Lake	1	23	41	23	31
Coal Creek	1	19	18	16	17
Deadman	2	63	67	47	38
Deep Lake	6	210	343	183	145
Delta	4	27	43	24	20
Ewan	5	181	354	164	151
Gakona	3	11	13	8	8
Hogan Hill	5	306	746	225	176
Jay Creek	1	47	49	41	43
Keg Creek	8	568	958	287	240
Maclaren	1	51	119	51	52
Mendeltna	4	391	913	151	128
Middle Fork	5	49	60	35	27
Saint Anne	11	181	353	97	76
Sinona	7	304	844	186	170
Stephan Lake	1	24	16	24	24
Susitna	11	452	700	129	135
Tolsona	5	153	542	98	89
Tsusena	4	16	7	1	1
Tyone	14	359	568	185	170
Watana	5	57	64	29	30
Totals	105[1/]	3,525	6,927	2,035	1,805

[1/] Does not correspond with total number of wolves radio-collared because some wolves became members of other packs.

wolves during snow-free periods and white wolves during periods of snow cover. This suggests that the numbers of wolves of these color phases could be underestimated during aerial surveys.

Histories of individual radio-collared wolves and their respective packs are described in the following section. Individual radio-collared wolves are identified in the text by the last three digits of their assigned accession number.

Wolf Pack and Individual Histories

Butte Lake Pack - The Butte Lake pack included one collared wolf (#984) captured while traveling alone near Butte Lake in late April 1975. An adult female (#983), member of the Brushkana pack, was collared the same day 3 miles (5 km) from wolf 984, and tracks suggested that both wolves had been feeding on an old moose kill in the area. Subsequently, wolf 984 was accompanied by three black wolves and later by one black and one gray wolf and inhabited an area of 1,188 mi^2 (3,077 km^2) almost totally separate from the range of the Brushkana female. The associates of the Butte Lake male did not include female wolves, and a den was not located. The summer movements of this group were much more extensive than those of denning packs. No scats representing the summer diet were collected, but the small number of carcasses located suggested that both moose and caribou were used by the pack. Relatively few radio locations were obtained during early summer 1975 due to poor weather and the mountainous terrain inhabited by the pack during part of the study period. Three males were removed from this pack in January 1976 as part of the wolf removal experiment.

Brushkana Creek Pack - The Brushkana pack included only one radio-collared member, an adult female (#983). At least three and possibly four adults were associated with this pack, and six pups were reared in 1975. An adult male was shot within the territory of the pack by a local trapper in October 1975, constituting the only known mortality prior to the pack's removal in connection with the wolf reduction experiment in January 1976 . Based on the movements of the collared female, the pack inhabited an area of at least 468 mi^2 (1,212 km^2).

Coal Creek Pack - This pack consisted of an uncollared yearling gray male and wolf 002 which was originally radio-collared as a member of the Keg Creek Pack in April 1975. The origin of the yearling male is unknown. Shortly after being radio-collared, wolf 002 exhibited a tendency to travel independently of the other Keg Creek pack members during late winter and summer 1976.

In mid-January 1976 wolf 002 was often found alone but stayed for the most part within the Keg Creek boundaries. On 8 March 1976 wolf 002 was located near the center of the Hogan

Hill wolf territory (Figs. 2 and 3) and was accompanied by the radio-marked Hogan Hill male (#988). On 9 March these two wolves were observed traveling within a few miles of each other in the northern portion of the area where the Hogan Hill and Keg Creek territories overlapped. On this date, wolf 988 was accompanied by another wolf, presumably also a Hogan Hill pack member. On the morning of 12 March 1976, wolf 002 and wolf 988 were again found traveling together in the area. Observations during the remainder of March showed that these wolves subsequently returned to their respective packs and territories. However, wolf 002 tended to remain some distance from the four remaining Keg Creek pack members during late March and April. On 22 April 1976 she was located in the southern portion of the Ewan pack territory, 49 miles (80 km) south of the Keg Creek den. She returned to the territory by 28 April but showed a tendency to remain apart from other pack members and in late May again left the Keg Creek territory. On 29 and 30 May, the wolf was located in the Susitna River study area north of the Maclaren River, 24 miles (39 km) north of the 1975 den. Extensive aerial searches during the next 2 weeks failed to locate the wolf, but on 13 June 1976 she had moved west across the Susitna River to the vicinity of Coal Creek. It is probable that during this time, wolf 002 was either in the Watana or Clearwater Mountains (which could not be adequately searched due to inclement weather).

On 26 June wolf 002 and an uncollared gray male were observed 8 miles (13 km) east of the 13 June 1976 location, east of the Susitna River on Clearwater Creek. By 28 June the pair had moved 29 miles (47 km) west to the Jay Creek area where they were observed to detect and pursue the radio-marked Tsusena female (#199) which in mid-June had also entered the experimental area. Details of this encounter are provided in the section on the Jay Creek Pack. On 30 June the pair was located in the Watana Creek drainage, 8 miles (13 km) east of the den used in 1975 by the previously removed Deadman pack, and on 2 July they were found on the south side of the Susitna River near Kosina Creek.

Our observations of these wolves during June and July 1976 indicated that they maintained a territory of 315 mi^2 (816 km^2). They were not associated with a den during this period. During July 1976 they were only observed on two kills; one of unknown species and one beaver (*Castor canadensis*). Both wolves were killed in late July as part of the experimental wolf removal program.

Deadman Lake Pack - This pack inhabited a relatively small area in the vicinity of Deadman and Watana Creeks north of the Susitna River. An adult male (#981) and female (#982) were collared in April 1975 and three pups were reared that year. Although radio locations suggested the presence of a den on a brushy hillside, none was located despite an extensive ground search. Two rendezvous sites were located, and scats were

Figure 2. Boundaries of radio-marked pack territories in the control and experimental areas in Unit 13, 1975-76.

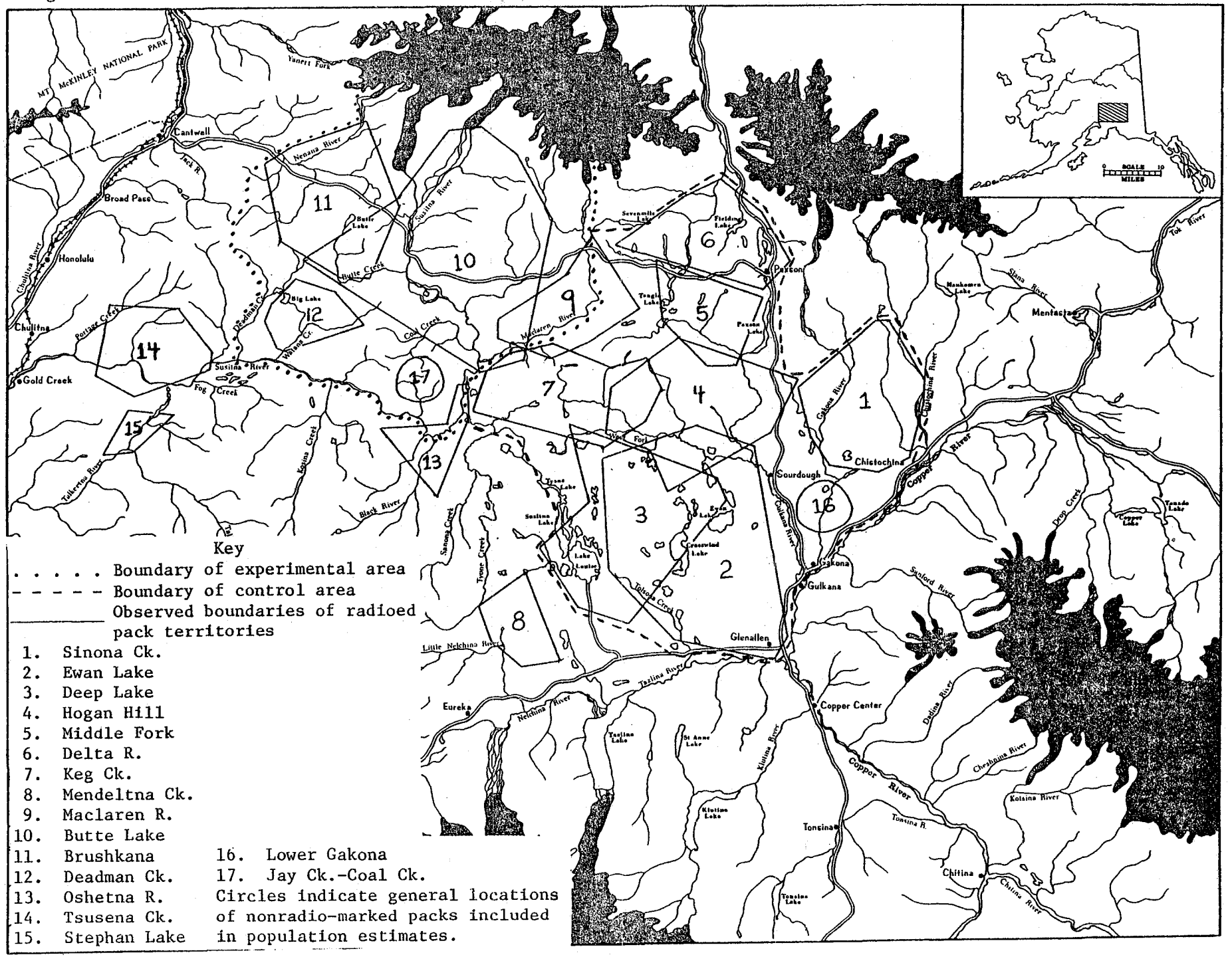
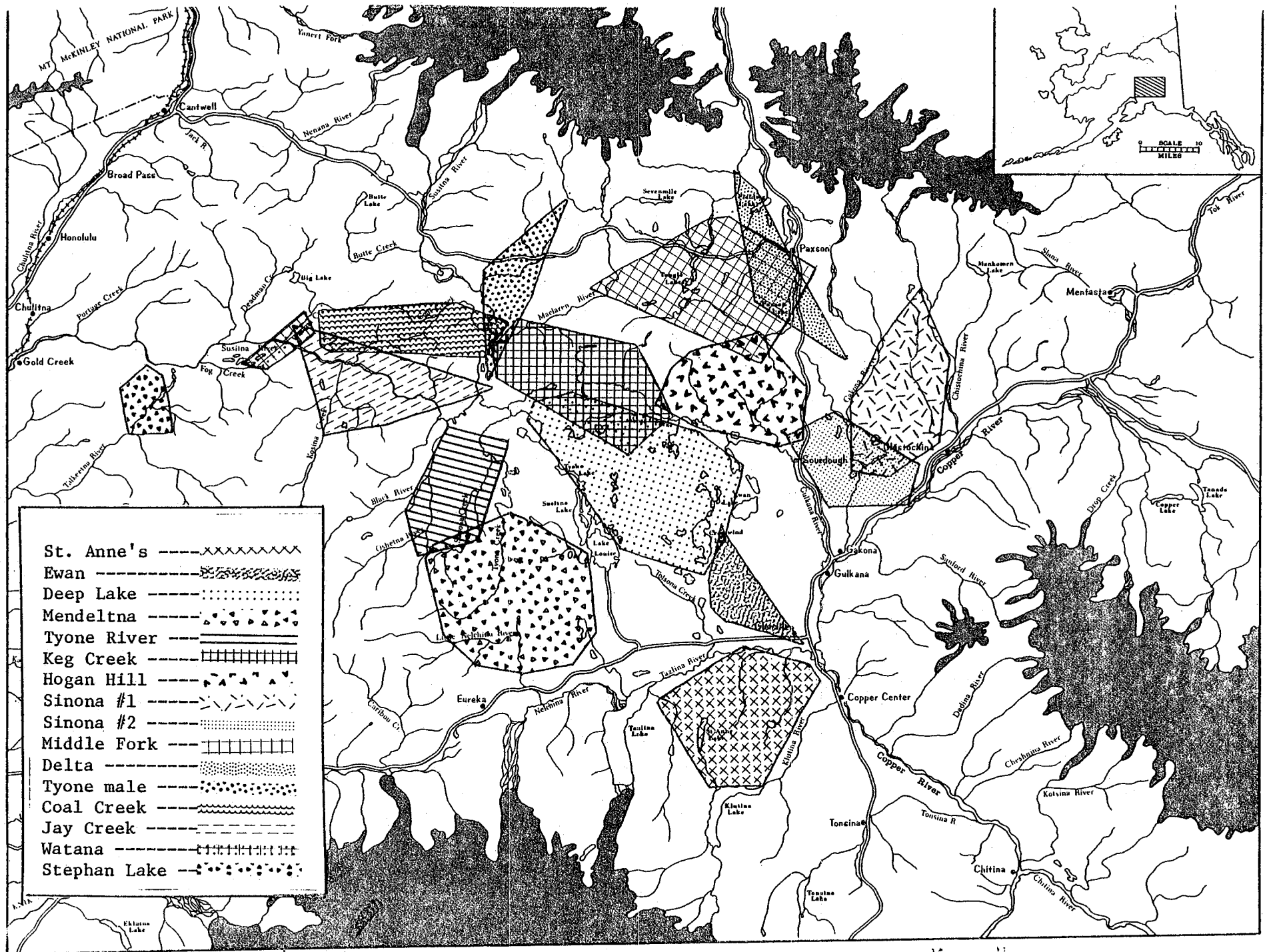


Figure 3. Wolf pack territories derived from monitoring radio-collared animals in Game Management Unit 13 of Southcentral Alaska from 1 July 1976 through June 1978.



collected at one of these. The three pups were removed in January and the two adults in March 1976 in connection with the wolf removal experiment. The home range suggested by radio locations, included only 108 mi^2 (280 km^2). The small home range may be the result of the small number of radio locations obtained. However, the pack was small in number and inhabited an area with relatively abundant and varied food resources.

Deep Lake Pack - Information on the numbers and movements of the Deep Lake pack was not obtained until March 1976 when two adult wolves (#'s 067 and 993) were radio-collared. An active den, at which an unknown number of pups were reared, was located in the area in June 1975 however, and signs indicated the presence of the pack in the area during early and mid-winter 1974-75. For unknown reasons wolf 993, collared at the same place as wolf 067 in March, subsequently inhabited an area southeast of the observed home range of the other seven members of the Deep Lake pack, remaining in the southern one-third of the adjacent Ewan pack territory. Wolf 993 was never observed with other wolves. We lost radio contact with her in late September 1976 at her most southerly radio location along the Trans-Alaska Pipeline, 2 mi south of the Tazlina River. We suspect she moved south along the Trans-Alaska Pipeline into the Chugach Mountain range where her transmitter eventually failed.

In July 1976 the Deep Lake pack consisted of at least four and probably five wolves. We suspected there was a den site approximately 2 mi southeast of Swan Lake but were unable to find it. Subsequent sightings and examination of carcasses turned in by trappers indicated that the pack probably did reproduce in 1976.

In late July 1976 wolf 067 began traveling alone near the northeast edge of the pack's territory. He was last observed in mid-August 1976, 2 mi south of Lone Butte, approximately 18 mi west of the Deep Lake pack territory. In March 1977 he was killed with members of the Keg Creek pack, having become a member of that pack.

Contact with the Deep Lake pack was reestablished in October 1976 when one wolf was captured and radio-collared (009). Five wolves, including two judged to be pups on the basis of size, were present. During winter 1976-77 ground shooting, and perhaps one dispersal, reduced the pack to two by spring 1977.

After February 1977 we had no contact with the pack except for track sightings and public observations until November 1977. At that time the pack numbered eight (three adults and five pups) indicating they had reproduced. Wolf 009 was recaptured and one additional male (#095) was radio-collared. The location of the den site was unknown, however, the 1975 site described by Stephenson (1978) was not used. During winter 1977-78 ground shooting reduced the pack to one adult and two pups. The pack

did not den in 1978. In June, wolf 204 began periodically leaving the Deep Lake Territory and was last observed with the pack in November 1978.

The two remaining members (wolves #009 and 1 uncollared yearling) of the Deep Lake Pack continued to occupy the traditional pack territory through fall 1978 and early winter 1979. In late October, one black wolf, which was subsequently radio-collared (#212), began periodicaly traveling with the pack, but he also demonstrated an affinity for traveling with three other wolves which we suspected were members of the original Ewan pack. These latter wolves were regularly seen on the Copper River near Gulkana during winter 1978-79.

In late February 1979, wolf 009 was killed by the Susitna wolves in the eastern portion of the Deep Lake territory. The Susitna wolves returned to their territory shortly after this incident and, thus, were probably trespassing. At the time, wolf 212 was with the Ewan wolves. The fate of the uncollared yearling which accompanied wolf 009 is unknown.

During March 1979, radio contact with wolf 212 was lost due to radio failure and we subsequently lost contact with the Deep Lake pack until winter 1979-80. Sign and reports from trappers indicated that very few wolves remained in the Deep Lake territory. In March 1980, wolf 212 and a young gray female, suspected to have been the wolf accompanying wolf 009 the previous year, were both ground shot at Minnesota Lake, within the Deep Lake territory. We suspect that by early spring 1980 the Deep Lake territory was vacant.

Annually from 1975 through early 1979, the Deep Lake pack occupied a territory of from 392 mi^2 (1,015 km^2) to 701 mi^2 (2,214 km^2). The largest territory occurred from 1975 through early 1978. Following the death of wolf 009 in February 1979, examination of location sightings of the neighboring wolf pack suggests that this territory was considerably smaller (392 mi^2) in 1979-80. If the pack was indeed only comprised of two wolves, then it seems probable that a smaller hunting area would be necessary.

The den site occupied by this pack in 1975 was not used from 1976 through the denning season in 1980.

Delta River Pack - The Delta pack included only one collared wolf, an adult male (#997), during 1975-76. The pack inhabited an area of about 288 mi^2 (746 km^2) in the Delta River-Tangle Lakes area and its range appeared to partially overlap the range of the Middle Fork wolves to the south. As many as six adults may have been present in early summer 1975. In June 1975, an adult lactating female was killed by an automobile near Summit Lake and a yearling male wolf was shot in defense of life and property at the same location in early July 1975. These two wolves and another had often been seen near a

lodge on Summit Lake during a period of 3 weeks, and the two that eventually died were described as being in very poor nutritional condition, lacking caution toward humans and appearing sick. The description of the adult female matched that of a wolf seen at the Delta River den in early June 1975, but which subsequently disappeared. Four pups were successfully reared at the den, however, and four adults were seen with the pups in early winter 1975. In mid-November, wolf 997 was found dead, apparently from natural causes, on Phelan Creek. Necropsy revealed no signs of physical injury and, although in poor nutritional condition, the wolf was not totally emaciated. At least two pups, both in poor nutritional condition, were trapped in early winter 1975. Little is known about subsequent movements of the remainder of the pack, and no signs of activity were found at the den or in the surrounding area in late winter or early summer 1976.

The Delta pack inhabited an area which had a very low year-round density of big game prey species which may account for the poor physical condition of pack members. For example, the four 1975 pups appeared small throughout summer, and examination of two pups trapped in early winter showed that they were small for their age and in very poor nutritional condition, weighing 50 and 55 pounds (23 and 25 kg), respectively. It appears that most of the 1975 pack members died or dispersed during winter 1975-76, leaving the territory without a denning pack.

From spring 1975 through June 1980, very little additional information was collected on this area except for public sightings and track counts. Radio contact with wolves in this area was maintained only between 21 March 1977 and 5 May 1977 through eight locations of two adult radio-collared wolves (#063 and 064). Both radio-collared wolves were observed together on three occasions, but neither was observed with other wolves. Contact with these animals was lost in May 1977 and at the time we suspected radio failure. However, we never saw additional sign of wolf activity in the Delta pack's area during several hours of surveying from fixed-wing aircraft under ideal snow conditions, and after several checks at the old den site. It was unknown whether these wolves were members of the original Delta pack or if they represented new wolves attempting to colonize an area.

In March 1979, wolf 064 was located on the Wood River in GMU 20A and shot by Department personnel as part of a wolf control program. At the time, wolf 064 was accompanied by an uncollared gray male. Comparison of color and weight indicated that it was not wolf 063. Further discussion of this wolf's movements is provided in the dispersal section of this report.

Two wolves were reportedly harvested from this area in 1976-77, but none were reported during the 1977-78 season. Two wolves were observed on the Denali Highway at Mile 10 by a

member of the public in March 1978. We suspect that the terrain, sparseness of vegetation, low density of available prey and snow conditions make wolves occupying the Delta area highly susceptible to trapping and ground shooting. Therefore, post-winter wolf densities have probably been consistently low in this area during recent years.

Ewan Lake Pack - Radio contact with this pack was established in April 1975 when one adult female (#990) was captured and radio-collared. Two additional wolves, an adult gray male (#991) and a male pup (#992), were radio-collared in November 1975. The pack denned in 1975 and included at least seven adults and four pups during most of the summer, however, one pup was apparently lost to unknown causes in August.

There were indications of relatively poor nutrition in this pack; thoughout summer 1975 the Ewan pups appeared smaller than those observed in other litters with the exception of the Delta litter. Also the male pup (#992), collared in November, was small and thin while the old adult male (#991) was in fair nutritional condition.

During winter, wolf 990 tended to remain apart from the remainder of the pack but was usually accompanied by one and sometimes two associates. This wolf was regularly found with the pack only during November. During December and January, it was accompanied by one and during February 1976 by two wolves. They were last observed in the Ewan territory on 25 February 1976 after which contact was lost until 30 April when wolf 990 was discovered in a new pack (Mendeltna pack) in an area 40 miles (64 km) west of the 1975 Ewan den. This pack, which contained at least two wolves never before seen with the Ewan wolves (and was later determined to include at least 5 adults), raised six pups at a den in the area during 1976. Wolf 990 and possibly two other Ewan pack members had successfully integrated into another breeding pack during March or April 1976 and subsequently remained in that association.

Following the dispersal of the radio-collared female the remainder of the Ewan pack could not be located. Extensive reconnaissance in late winter revealed no indications of more than a single wolf in the area previously used by the pack, and frequent aerial checks of the 1975 den showed no sign of activity. Although the loss of three, and possibly four, pack members from the original pack (2 mortalities and 1 or 2 dispersals) was suspected, the remaining members of the pack were unaccounted for and may have disappeared through dispersal and/or mortality, or were not detected by our survey methods.

After wolf 990 had dispersed in April 1976 we did not reestablish radio contact with the pack until March 1978. This pack's territory contained dense spruce stands which made tracking from a Super Cub difficult.

We were, however, able to maintain records on the numbers of wolves in the pack from track counts and public sightings. On the basis of track counts and public sightings this pack probably included five wolves in fall 1976. If public observations were correct, the five wolves present in fall 1976 either represented immigration or indicated the pack had reproduced in 1976. We suspect the latter. No wolves were reported taken from this area during the 1976-77 hunting-trapping season, although public sightings and track counts indicated only three wolves remained by spring 1977.

Trappers reported taking two pups in this area during winter 1977-78, indicating denning and successful reproduction in 1977. Radio contact was established with this pack in February 1978 when a gray female pup (#151) was radio-collared. The pack numbered four at the beginning of spring 1978 season. We again lost radio contact with this pack in March 1978 when wolf 151 died, apparently from wounds inflicted by an adult moose. Radio contact was not reestablished until fall 1978. Numbers present in this pack according to public observations are presented in the Wolf Density section.

On 17 November 1978 we captured and radio-collared a gray male pup (#219) which, on the basis of tracks, may have been accompanied by one or two associates. Following its capture the wolf was observed alone in the vicinity of Crosswind Lake. Contact with the animal was lost by late November, and at that time we suspected the animal had been harvested. However, in March 1979 wolf 219 was trapped north of Butte Lake, 80 miles (128 km) from its November 1978 location. From tracks, the trapper suspected wolf 219 was associated with two or three other wolves and, therefore, we suspected this wolf had become associated with a new pack.

The Ewan pack territory encompassed approximately 864 m^2 (2,238 km^2). The den site occupied by the Ewan pack in 1975 was not used from 1976 through the denning season in 1980.

Hogan Hill Pack - Radio contact with this pack was established in June 1975 when a yearling female (#987) was captured and radio-collared. The pack included seven adults (2 additional adults were observed on 1 occasion). In 1975 the pack denned 2 miles (3.2 km) west of the Trans-Alaska Pipeline. We could only confirm that two pups were raised from the 1975 litter. Reasons for the small litter size were unknown, but canine distemper may have had an influence (Stevenson, et al. In Prep). In November 1975, a young male (#988) was captured and radio-collared.

Information on this pack's activity between June 1976 and April 1978 was limited because wolf 987 was relocated only once due to a faulty radio transmitter. We do not know if the pack denned in 1976 but the 1975 den site, located about 2 mi (3.2 km) west of the Trans-Alaska pipeline, was not used. No

increase in pack size was evident between spring and fall 1976 according to public reports and Department track counts.

Wolf 988 remained in the eastern half of the pack's territory during most of fall 1976. However, he traveled at least once to the east fork of the Chistochina River, about 30 mi (48 km) east of the normal territory boundary. In December 1976 he was again observed in the Hogan Hill territory accompanied by two gray wolves. Shortly after the first of the year he apparently dispersed from the Hogan Hill pack, since radio contact was lost until March 1977 when he was relocated with one other gray wolf north of Mankomen Lake, about 36 mi (58 km) from the Hogan Hill territory. Radio contact with this wolf was lost shortly after it was observed in this area.

Track counts and observations made by Department personnel and the public indicated that at least four or five wolves remained in the Hogan Hill territory after wolf 988 left the pack. When radio contact with the pack was reestablished in April 1978 it contained eight wolves. Two (#205 and #206) of three wolves that were subsequently radio-collared were 11-month-old pups, indicating the pack had denned in 1977. They did not use the 1975 den site again during this reporting period.

On 9 May 1978, members of the Hogan Hill pack were observed at a new den site located about 10 mi (17 km) NNE of Fish Lake. Pups were first observed on 30 May with the largest number (5) observed on 20 June. The pups were moved to the first rendezvous site, located about 1 mi (1.6 km) north of the den, on 18 June. The pups had moved to a second rendezvous site, located 5 mi (8 km) north of the den, by 6 July.

By late fall 1978 the pack numbered 12: 7 adults and 5 pups. Radio contact with wolf 206 was lost in late September 1978. Eleven or 12 members of the pack, including both radio-collared males, were ground shot in January 1979 and thus radio contact with this pack was terminated.

The year-round home range of the Hogan Hill pack overlapped to various degrees, the ranges of the Ewan, Deep Lake, Keg Creek and the Middle Fork wolves. Territory size varied from 345 mi^2 (894 km^2) to 567 mi^2 (1,469 km^2) from 1975 through early 1978. Overall, from 1975 through 1978, the territory encompassed 597 mi^2 (1,546 km^2).

Jay Creek Pack - The Tsusena gray female (#199) moved from the Tsusena pack's territory shortly after being radio-collared in 1976 (a young adult male was also radio-collared at the same time but was never relocated). On 28 June 1976, wolf 199 was located in the Susitna River Study Area where she was observed bedded down just east of Jay Creek. Wolf 002 and her associate, a yearling gray male, both from a different pack, were observed within 1/2 mi (0.8 km) of and heading towards the Tsusena female.

The Tsusena female appeared to become excited, running in short tight circles, then attempted to hide in nearby brush. She hid for a few minutes, then burst out at a full run with the Coal Creek wolves chasing some distance behind. This chase lasted for 20 minutes and covered a distance of approximately 4 mi (6 km). During most of the chase the wolves did not appear to be in visual contact and the pursuing wolves stopped often to pick up the scent. At one point the pursuing wolves were within 1/4 mi (0.4 km) of the Tsusena wolf but for the most part they were easily outdistanced. Following the chase the Coal Creek wolves rested at a creek while the Tsusena female continued at a slower pace toward the Susitna River.

After this chase by Coal Creek wolves, wolf 199's movements became more widespread in a southerly direction. She was observed 14 mi (22 km) up Kosina Creek late in June 1976 and then moved back to the mouth of Watana Creek. She remained along the Susitna River until the end of July, then moved 40 mi (64 km) southeast to the head of Joe Creek. She stayed in that area and the vicinity of upper Daisy Creek, which comprised the summer territory of the Mendeltna pack, until 21 August 1976 when she was observed 5 mi (8 km) southeast of Clarence Lake.

During the remainder of summer, fall and winter of 1976-77 this wolf's movements were restricted primarily to the Susitna River lowlands. She was observed alone until 29 September 1976 when she was seen with a large, dark gray wolf which, on the basis of size, was judged to be an adult male. She was observed with this male on seven different occasions and it became apparent that a social bond had been formed.

We lost contact with wolf 199 after 19 March 1977 due to radio failure and, therefore, have no location sightings until she was recollared in March 1978.

During winter 1977-78, tracks of three or four wolves were common along the Susitna River in the same locale where the Tsusena female (199) had been observed in 1976. That winter 13 moose kills were observed on the river. We attributed these kills to this pack on the basis of tracks. In March 1978, when wolf 199 was recollared just east of Clarence Lake, she was pregnant and accompanied by three wolves, an adult dark gray male and two female pups. All but wolf 199 were killed by Department personnel as part of the experimental wolf removal study.

Wolf 199 was observed only three times during May and June 1978 because of dense vegetation which prohibited visual observation. She was tracked, however, to an aspen vegetated knoll at Jay Creek on several occasions indicating that she was denning in that area. On 28 June, she was observed there accompanied by at least three pups.

Radio contact with wolf 199 ended in July 1978, probably due to radio failure. During winter 1978-79, tracks of four to five wolves, in the same area occupied by the pack earlier, indicated that wolf 199 successfully raised pups in 1978.

During winter 1979-80 aerial trappers reported 10 to 11 wolves within the Jay Creek pack area. Six wolves were ground shot at that time. At least four wolves were observed on the Susitna River near Jay Creek during a moose survey in March 1980, indicating that the pack area was still occupied, probably by descendants of wolf 199 which we suspect survived through 1980.

Keg Creek Pack - Three adult wolves, two adult males (#986 and #083) and one adult female (#002) were captured and radio-collared in April 1975. Two additional wolves, an adult female (#068) and a female pup (#201) were radio-collared in March 1976.

During winter 1975-76, mortality within this pack was high; four wolves were taken with the aid of aircraft in December 1975 and we suspect that three to five wolves were illegally shot from aircraft in mid-March 1976.

Wolf 068 was suspected of being the dam of the 1975 litter and was the dam of the 1976 litter. Dense vegetation prevented observation of pups until 21 August, but radio locations of female 068 indicated that by 9 July the pups had been moved to a rendezvous site about 3 mi (4.8 km) north of the den site. By 29 August the pups began regularly traveling with the adults.

Between late August 1976, when pups were first observed, and March 1977 the size and composition of the pack remained stable at three adults and five pups. No mortality was observed during this period.

Studies of moose movements indicated that some moose from the Susitna River Study Area wintered and calved in the territory of the Keg Creek pack (Ballard and Taylor 1978). The decision was made to expand the study area to include the year-round range of these moose. Therefore, in late March 1977, Department personnel removed seven of eight Keg Creek pack members. The wolf which escaped was the gray adult female (#201) collared in 1976, with which we lost contact because of a faulty transmitter. One of the grays which we had observed with the pack for the previous several months was the radio-collared adult gray male (067) which had dispersed from the Deep Lake pack in August 1976.

Wolf 201 apparently did not breed during 1977, because we never found any indication of more than one set of wolf tracks until late March 1978 when she was recollared with an adult gray male (#203). When collared, wolf 203 was blind in one eye, had one foot missing and was judged to be 8-9 years old. From what area this wolf originated is not known.

Wolf 201 was pregnant when recaptured in 1978. She was first observed at the den site previously used by the pack in 1975 and 1976 on 9 May 1978. Pups were first observed at the site on 29 May 1978. The largest number of pups observed was five (on 12 June). By 25 August the pack moved to a rendevous site approximately 34 miles (54 km) to the west. On 30 September 1978 a total of 8 wolves were observed: 7 grays and 1 black, 6 of which were pups (5 grays and 1 black).

This pack remained stable in number until February 1979 when at least three to four members of this pack were ground shot. Examination of the carcasses indicated that at least two wolves had been illegally shot from aircraft. Contact with the remaining two pack members was lost in late February 1979 due to unknown causes. No public or Department wolf observations were recorded for this pack area during 1979-80. Therefore, this pack area was considered to be vacant or occupied by only one pair of wolves. The den site used in 1975, 1976 and 1978 was not used in 1979 or 1980.

During the reporting period the Keg Creek pack occupied a territory ranging from 106 mi^2 (275 km^2) to 432 mi^2 (1,119 km^2) annually. Overall, the year-round territory was 506 mi^2 (1,310 km^2).

Maclaren Pack - The Maclaren pack included one collared adult female (#985) which was captured in April 1975. Other pack members included an adult male and four pups reared in 1975. This pack inhabited an area of 279 mi^2 (723 km^2) encompassing the upper portion of the Maclaren River. On one occasion the Maclaren wolves were found within the Keg Creek pack territory where they killed a yearling bull moose. Although radio locations suggested the presence of a den in 1975, none was observed from the air nor during ground searches after the area was vacated. However, a rendezvous site 1 mile (1.6 km) from the probable den area was located. Despite the presence of only two adult wolves, the pack was able to regularly kill adult moose during winter. One pup was lost (possibly trapped) in mid-November prior to the removal of the pack in January as part of the experimental removal program.

Mendeltna Pack - Contact with this pack was established in April 1976 when the adult gray female (#990) from the Ewan Pack became integrated into a new pack. The new pack was comprised of wolf 990, a light gray thought to be a female, 1 dark gray, 1 slate black, and 1 black wolf.

The pack denned in 1976 at a site located 1.5 mi (2.4 km) SE of Marie Lake. At least six pups, three grays and three blacks, were raised. Pups were moved to a rendezvous site, located approximately 1 mi (1.6 km) south of the den, between 28 June and 2 July. The pups remained here until 2 August when they moved approximately 14 mi (22 km) northwest to the head of Daisy Creek. Between 1 and 8 September the pups began

accompanying the adults on a regular basis. On 8 September we observed wolf 990 with three gray and two black pups. The third black pup was observed alone at the Daisy Creek rendezvous site. Following this observation, our counts of the entire pack were short one black pup. We suspect the pup observed at Daisy Creek either dispersed, which seems unlikely, or died.

In October 1976, radio contact with wolf 990, originally from the Ewan pack, was lost. We never again observed this wolf with the pack nor was she reported in the harvest records. We speculate that she dispersed or died of natural causes.

Wolf 083, an adult gray male originally tagged in April 1975 as a member of the Keg Creek pack, was discovered with the Mendeltna wolves in April 1977. We thought that wolf 083 had been killed by illegal aerial hunting in the Keg Creek territory. Wolf 083 may have had contact with wolf 990 from the Ewan pack in October 1975 when both radio signals were located close to a moose kill. Radio contact with wolf 990 was lost in February 1976 and consequently reestablished in the Mendeltna pack in April 1976, while radio contact with Keg Creek wolf 083 was lost in mid-March 1976. This sequence of events suggests that both wolves may have emigrated to the Mendeltna area about the same time. Our contact with the Mendeltna pack in late June 1976 indicated wolf 083 was probably present at that time.

The Mendeltna pack contained seven wolves at the beginning of the 1977 denning season. By 21 April they began visiting the old den site utilized in 1976. After this date, observations at the den became more frequent. During the 1977 season this pack maintained two den sites and raised two litters of pups. Adult wolves were first observed at a second den site, located at Nickolson Lake approximately 5 mi (8 km) northwest of the main den, on 20 May. Wolf 007 was the dam of this second litter.

Pups were first observed at the main den on 1 June 1977 but not at the second den until 12 June 1977. At least seven pups were raised at the main den while at least two were reared at the second den. It was possible, however, that 10 or more pups were born because we made one sighting of three pups at the Nickolson den and perhaps eight at the main den. However, these observations occurred during a period when pups may have been transferred between den and rendezvous sites.

Nickolson Lake pups were first moved to a rendezvous site approximately 1 mi (1.6 km) east of the den on 22 June. At the main den we saw two adult wolves begin to move five pups to the Kelly Lake rendezvous site in the morning of 23 June, arriving at the site over 4 mi (6 km) straight line distance away, at least 12 hours later. We noted that as the pack moved from the den, the light gray wolf which we believed to be the dam kept returning to the den site. Because we were certain that at least seven pups were being raised at this den we speculate that two pups died. Our observations in the fall, when snow

conditions were optimum for observing wolves, could only confirm the presence of eight pups in the entire pack. Therefore, at least one or maybe two or more pups were lost during the summer. The circumstances surrounding these losses are unknown.

By 25 July the Nickolson Lake rendezvous site was abandoned and the pups were moved to the Kelly Lake site. Between 8 and 17 August all the pups were moved to a third rendezvous site at White Sand Creek located approximately 9 mi (14 km) northwest of the Kelly Lake site. By 13 September, the pups began traveling with adults on a regular basis.

By early fall 1977, the pack numbered seven adults and eight pups. In early November wolf 008 was discovered dead at the northern edge of the pack's territory west of Moose Lake on Tyone Creek. Examination of the kill site indicated that he had been killed by several other wolves. Tracks of four or five wolves were followed down Tyone Creek, indicating they were members of the Tyone Creek pack. The dead wolf had been fed upon and a portion of the rib cage and most of the viscera were gone. Most of this appeared to be the result of scavenging activity by ravens (*Corvus corax*) and gray jays (*Perisoreus canadensis*). Necropsy revealed several punctures on the neck and considerable subcutaneous hemorrhaging in both the neck area and on the upper left portion of the cranium. We surmise that this wolf was killed by another pack, apparently while trespassing in the Tyone Creek territory.

During winter 1977-78, the Mendeltna pack slowly suffered attrition from ground shooting and illegal aerial hunting until early February when the pack numbered eight. Heavy snowfall during February followed by clear sunny weather provided excellent wolf tracking conditions. On 9 February 1978 the remaining eight known members of the Mendeltna pack were harvested by ground shooting. Members of this pack were accounted for by wolf hide sealing documents with the possible exception of three, a radio-collared gray male pup and two black yearlings. The carcass of the radio-collared pup was found buried in snow, where it had been shot with buckshot and not retrieved. The two blacks, one a crippled yearling male, still remain unaccounted for; either their presence has been undetected after several hours of census, or they actually were harvested and their harvest location falsely recorded.

From June 1976 to February 1978, this pack occupied a territory of 559 mi^2 (1,448 km) (Fig. 2). Summer territory was 515 mi^2 (1,334 km^2) while winter territory was 266 mi^2 (689 km^2). Members of this pack traveled to the extreme edges of the eastern, western and southern portions of their territory during summer while the northern extreme was frequented primarily during winter.

No wolves were known to occupy this area until late in 1978 when at least one member of the Tolsona pack began traveling

through the area. Repopulation of this area is described in the Tolsona pack section.

Middle Fork Pack - Radio contact with this pack was established in March 1976 when wolves 062, 078 and 996 were captured and radio-collared. Unfortunately the collars were chewed off within 2 weeks and only seven radio locations were obtained. At that time the pack contained nine animals.

Our only contact with the Middle Fork pack during fall 1976 was a track sighting by a member of the public which indicated the pack still numbered nine. During winter 1976-77 two wolves were reportedly shot, one was wolf 078 which had been collared in March 1976.

We reestablished radio contact with the pack in March 1977 when it numbered four. Two wolves were captured. Wolf 062 was again recaptured along with a 10-month-old pup (#061) both of which were radio-collared. Wolf 062 drowned while still partially immobilized. An additional pup (#085) was radio-collared in April 1977. We believed the remaining pack member was also a pup, were unable to account for three other wolves which should have been present in the pack.

During summer 1977, the Middle Fork wolves did not den and were rarely observed together. They were never observed on any kills and we believe that they were preying on small game.

In early September, these wolves began associating with each other once again and did so through winter 1977-78. During January 1978 both radio-collared wolves, and probably the third unmarked member of the pack were shot, leaving the Middle Fork pack territory vacant. An aerial census in late April supported this conclusion.

The Middle Fork pack occupied an area of approximately 514 mi^2 (1,331 km^2). Their territory appeared to have considerable overlap with that of the old Delta pack's area. Like the Delta area, the somewhat open nature of the terrain and vegetation would probably make members of this pack highly susceptible to winter aircraft activities. We suspect that late winter wolf densities in this area have always been and will remain low.

St. Anne Pack - Data pertaining to this pack during 1976 consisted of track counts, public locations and harvest records. Although the pack denned in 1976 it was not known how many pups were produced; however, by fall the pack numbered eight.

In April 1977, three wolves (#086, #087 and #088) were radio-collared from a pack of eight. The pack denned in 1977 at the same site used in 1976. Pups were first observed on 11 May. By fall 1977 the pack numbered 14.

The rate of loss of radio-collared wolves from this pack was high. Some of the losses were probably due to radio failure and hunting-trapping mortality. However, harvest locations on sealing documents did not account for them. Eight of 10 of the losses were definitely due to dispersal which will be discussed more thoroughly in the Dispersal section of this report.

By early spring 1978, the pack contained 11 wolves. The pack denned at a new den site in 1978, located on Nickel Creek about 6.5 mi NW of the site used in 1976 and 1977. The number of pups raised was not determined, but by fall the pack numbered seven. By spring 1979, their number was reduced to four. They denned at the site used in 1976 and 1977 and by fall again numbered eight. Dispersal reduced the pack to four members by spring 1980. The pack denned in 1980 at the Nickel Creek den used in 1978.

Wolf 094 appeared to be the most stable member of the pack since she was always present with the pack after October 1977. At capture we estimated this wolf to be approximately 9 years old based on tooth wear. Guides in the area report that for several years prior to our contact with wolf 094 a white wolf was observed in the St. Anne area. Whether it was the same wolf is not known but since we have observed only one totally white wolf during this 5-year study this is probably the case. Whether she was the dam of the litters raised from 1976 through 1980 is unknown but her affinity to the den site in 1979 and 1980 suggest that she was.

From 1976 through 1980, the St. Anne wolves occupied a territory ranging from 366 mi^2 (948 km^2) to 397 mi^2 (1,028 km^2). Overall, an area of 513 mi^2 (1,329 km^2) was occupied. Although our monitoring intensity for the 1978-1980 period was not as thorough as it had been, it appeared the pack had shifted its intensive use area to the south and east toward the Klutina River. Reasons for this possible shift are unknown but may have been related to differences in prey abundance.

Sinona Creek Pack - A young female (#989) collared in April 1975 provided all radio-tracking data until November 1975 when two males (#'s 038 and 048) were collared. This pack included seven adults and four pups reared during 1975. The pack of 11 apparently suffered no mortality during winter 1975-76 and two litters totaling nine pups were reared in 1976 at two dens 11 miles (18 km) apart. By early June, pups from the northern den site were moved to the main den site.

During the 1976 denning season, we never observed the Sinona pack using a rendezvous site that was any significant distance from the main den site. On 19 July, however, the pups and adult pack members began using a slightly elevated ridge approximately 100 yds south of the main site. This site resembled a den site and was used for several weeks. We began to observe the pups traveling with the adults on a regular basis in late August.

By fall 1976 the pack numbered 11 adults and nine pups. Males 038 and 048 provided most of the radio locations obtained for this pack. The adult gray female (#989) was believed to be present in fall 1976 but her radio was not operational.

During the 1976-77 hunting-trapping season, most of the Sinona pack members were ground shot. We were able to account for the harvest of at least 16 and perhaps as many as 18 wolves from this pack. We suspected, however, that more than just two members escaped being harvested. At least two wolves, an adult with a distinctive white head and the adult gray female (#989), were not presented for sealing. If the latter wolf lost its radio collar, it would be the first adult wolf to do so during this study. Further, when we reestablished radio contact with the known remaining members of the pack in March 1977 tracks indicated that five wolves may have been present. However, only the two radio-collared wolves were present in subsequent observations. Aerial trappers also believed that more than two wolves remained on the Gakona River in the Sinona pack territory.

Following the heavy harvests from this pack in 1976-77, we never observed the remaining two known pack members (#048 and #084) in the territory used the previous year. They occupied the area Stephenson (1978) thought was occupied by the "lower Gakona pack." We refer to this area and the two wolves as Sinona #2 pack.

During summer 1977, the Sinona #2 pack denned close to the Gakona River approximately 14 mi (22 km) SW of the 1976 main den site. Wolf 084 began frequenting the den site by 12 May 1977. The den site was difficult to observe from the air because of dense aspen stands, but in 1977 we were able to confirm that the site was no longer used by the pups after 20 July. In 1977 we first observed the pups regularly traveling with adults by 15 September. At least six pups were raised and the pack numbered eight in fall 1977.

We suspect that at least two wolves, perhaps from the 1976 Sinona pack, continued to occupy the old Sinona territory, now referred to as Sinona #1 pack territory. A pack's presence was partially confirmed during the 1977-78 hunting-trapping season when at least eight wolves, three adults and five pups, were shot in the middle and upper Gakona River areas. Both of the 1976 den sites were checked, but no activity was observed. Thus, if any wolves from the old Sinona pack reproduced they denned at a new site.

During the 1977-78 hunting-trapping season, four pups were harvested from the Sinona #2 pack. The pack numbered four during spring 1978. Denning occurred approximately 1 mile (1.6 km) north of the site used in 1977.

Six pups were raised in 1978 and the pack numbered 10 by fall 1978. During winter 1978-79 at least eight of 10 members of the pack were ground shot by aerial trappers. Wolf 048 may have escaped being harvested because, after most of the pack had been shot, he began traveling alone. However, we lost radio contact with this wolf in January 1979. Radio contact with wolf 213, however, was lost at the same time the remainder of the pack was harvested and we believe she was killed.

Following loss of radio contact with wolves 048 and 213 in January 1979 we had neither contact nor public reports of wolves occupying this area until January 1980. At that time wolf 229 and possibly two associates from the Susitna pack immigrated into this area and were joined by one additional gray wolf. This new pack began occupying the area previously occupied by the Sinona #2 pack and in spring 1980 denned close to the site used by that pack in 1977. The den sites utilized by the Sinona pack in 1976 and the one site used in 1978 were not used again during this period of study.

Based upon our observations of these packs, we calculated two territory areas. Sinona #1 pack occupied an area of 301 mi^2 (780 km^2) during summer and early winter 1976-77. Pack #2, on the other hand, occupied a year-round territory of approximately 235 mi^2 (600 km^2). Had both packs functioned as one, the combined territories would total approximately 623 mi^2 (1,614 km^2).

Stephan Lake Pack - The Stephan Lake female (#016) was radio-collared in February 1976. A total of 14 radio locations were obtained from 18 June through 18 October 1976, but this wolf was observed on only two occasions because of dense spruce cover. Only once was she accompanied by another wolf, a small dark gray. No kills were ever observed in the vicinity of the radio locations, although both cow and bull moose were present within 1/4 to 1/2 mi (0.4 to 0.8 km) of the wolves on many occasions. On 14 July, the radio signal was located along Prairie Creek. Salmon were numerous in this creek and possibly were being fed upon by this wolf. On 18 October, she was located at her most southerly location. She was found at the same location on 22 November, and on 3 December when she was found dead there under a spruce tree. The cause of death was not immediately diagnosed because the carcass had been scavenged. Necropsy revealed internal hemorrhage and what appeared to be tooth and/or fang marks on the neck in addition to a 3-inch laceration across the top of the skull. It appeared that this wolf may have been killed by another wolf or by a brown bear (*Ursus arctos*). This wolf's left rear femur was greatly deformed and was only 185 mm long, indicating that at one time she had suffered a fracture which had not healed properly.

Stephenson (1978) speculated that this pack of two denned in 1976 but our subsequent observations in the suspected denning area revealed no denning activity.

Following the mortality of wolf 016 we did not attempt to reestablish contact with this pack because of the logistic obstacles involved in routinely monitoring the radios. We had too few radio locations to assess territory size.

Susitna Pack - Radio contact with this pack was established in February 1979 within the Deep Lake territory. At that time we observed the Susitna wolves fleeing from the carcass of the Deep Lake female (#009) which they had just killed. Reasons for this conflict and the fate of the uncollared gray which had been accompanying wolf 009 are not known, particularly since this pack never returned to the Deep Lake area.

When collared, the pack was comprised of at least two adults and seven pups. We suspected, on the basis of size and later capture records, that the tenth wolf was an adult male. Following capture, the pack moved to the area south of the big bend in the Susitna River. Whether these wolves had always occupied this area is unknown, but seems likely based on the gaps between territories illustrated in Figs. 2 and 3 for the periods 1975 through 1978. By late spring 1979, the pack numbered six or seven. Pack losses between fall and spring were probably the result of one to two wolves being ground shot and at least one dispersal.

The pack was first observed at the 1979 den site by 13 April. At least six pups, which were not observed until 3 August, were raised. Between late summer and October 1979, the pack declined to 10, possibly due to dispersal.

During December and January 1979-80, large concentrations of Nelchina caribou were found within the Susitna pack territory as they began migrating toward the Wrangell Mountains. In late January 1980, wolf 229, a yearling male, and at least two gray associates appeared to follow the caribou migration and dispersed to the east. Further details are presented in the Dispersal section of this report. By early February the pack numbered seven.

In early March 1980, the pack was reduced by two members because of a conflict with the Tyone pack. Details of this conflict follow:

On 8 March, we tracked wolf 295 (the adult gray female of the Susitna pack) to a location 2 miles (3.2 km) south of Vermillion Lake. She was observed alone. We backtracked her in the snow for several miles to the west to the confluence of Sanona and Tyone Creeks where we observed three wolves walking through a medium dense spruce stand. We assumed these wolves were members of the Susitna pack but closer examination revealed

a total of seven wolves, which was more than we had observed in the Susitna pack during the previous 2 weeks. A check of other wolf radio frequencies revealed that seven radio-collared members of the Tyone pack, which was comprised of two adults and six pups, were also present. We then searched for other radio-collared members of the Susitna pack and found wolf 296, the light adult gray male, which on the basis of tail posture and leadership in the pack was assumed to be the alpha male, 0.5 miles (0.8 km) north of Tyone Creek. Wolf 296 was dead and an examination revealed puncture marks on the neck and shoulders. In addition, at least seven distinct wolf trails radiated from the area, leaving little doubt that wolf 296 had been killed by other wolves. From blood in the snow, we backtracked wolf 296 to the location where the struggle had begun. At this site, we discovered a fresh adult moose kill.

There were at least two wolf beds in the snow approximately 20 feet from the moose kill. We also found a moose fetus, a dead ptarmigan (*Lagopus* sp.), and two wolf beds on the opposite side of the creek from the moose kill. Tracks of a single wolf (possibly wolf 296) indicated that it had fled from the moose kill. The carcass of the moose and the carcass of wolf 296 were about 100 yards apart.

One of the wolf trails radiating from the moose kill site was spotted with blood. We followed this trail for approximately 0.25 miles (0.4 km) upstream where the trails of four wolves came together, suggesting that an apparent pursuit continued. Approximately 0.25 miles (0.4 km) north of the creek, members of the Tyone pack had apparently caught wolf 303 (a gray yearling male). Wolf 303 was still alive, but had lost a considerable amount of blood.

We radio-located wolf 302 of the Susitna pack at 1130 hr. and found her 3.5 miles (5.6 km) east of the carcass of wolf 296. When originally located at 1030 hr. she had been within 0.25 miles (0.4 km) of the Tyone wolves. At this time, the location of four of seven Susitna wolves and eight of eight Tyone wolves was known.

While leaving the site we observed an additional fresh calf moose kill close to the adult moose kill. The calf had been killed by punctures in the neck and anal regions but had not been fed upon.

On 9 March 1980, we located wolves 295 and 302 of the Susitna pack. Wolf 295 had moved to the east side of the Tyone River. Wolf 302 was within 5 miles (8 km) of wolf 295 and appeared to be heading directly toward her. The Tyone pack, however, was in the same location observed on 8 March and had revisited the kill site of wolf 296 and the site of injured wolf 303. Wolf 303 had moved approximately 50 feet where members of the Tyone pack finally killed him; he had punctures in the neck and around the ears.

Based upon our ground and aerial observations we concluded that the Susitna pack had come upon a moose kill made by the Tyone wolves. The moose kill was located close to the territorial boundary area between the two packs (Fig. 4). Therefore, in addition to competition for possession of the kills, the conflict may have involved a territorial dispute. The Susitna area appeared to have a relatively poor availability of prey in comparison to the Tyone pack's area during this winter. Comparison of prey abundance between the two areas will be discussed in the Food Habits section.

Following the dispersal of wolf 229 and its associates, and the deaths of at least wolves 296 and 303, the Susitna pack was reduced to four wolves by late spring 1980. They denned at the same site they had used in 1979 and were first observed there on 23 April.

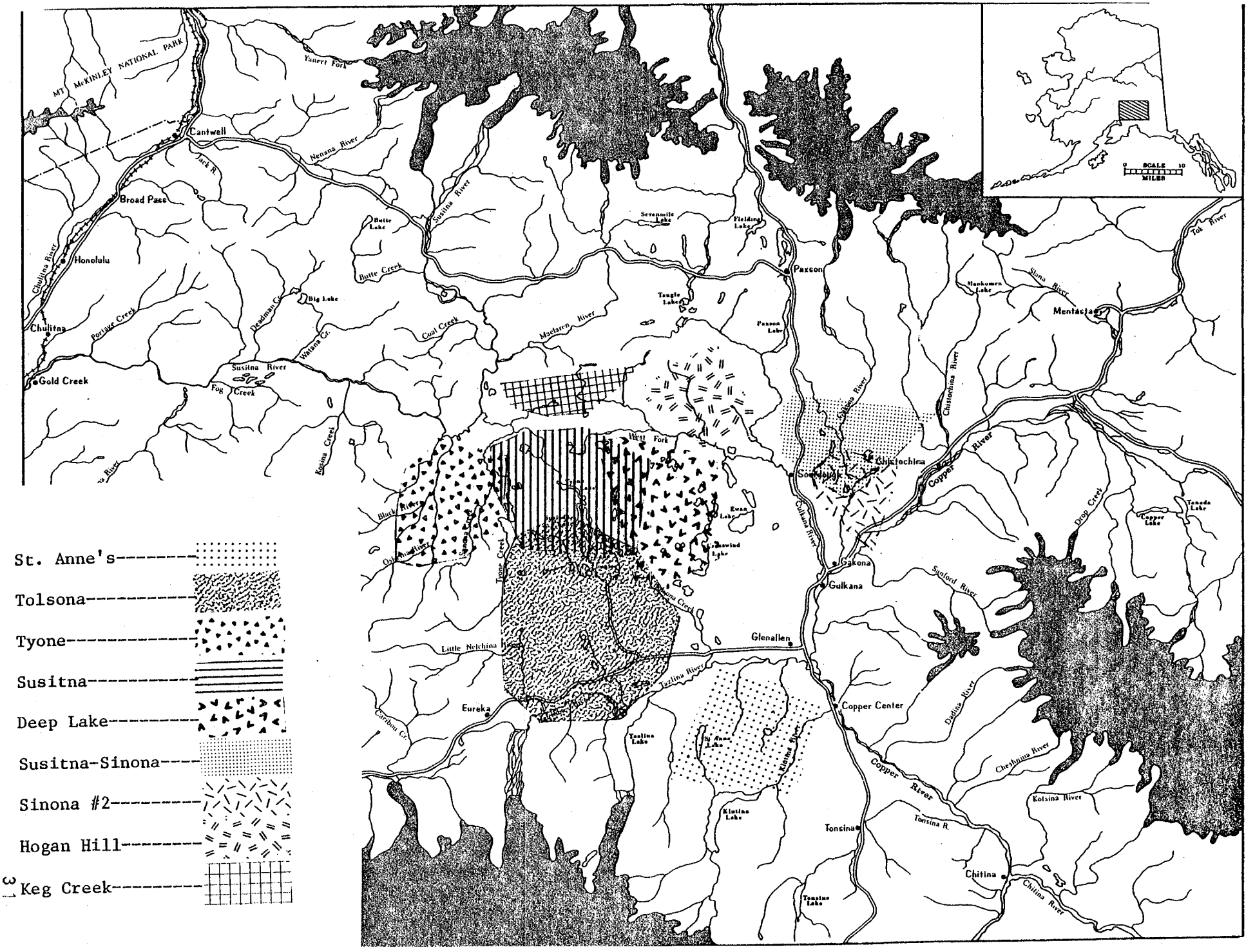
During the 1980 denning season, three of four (#'s 295, 302, 305, and 306) remaining pack members were fitted with activity radio transmitters. In addition, ground observations at the den site were made from 1 May through the middle of June 1980. Methods and results from this study period are being prepared for publication by James Foster, Woodland Park Zoo and Warren Ballard, Alaska Department of Fish and Game. At least six pups were raised during the 1980 denning season.

From early 1979 through June 1980, the Susitna pack occupied a territory of 462 mi^2 (1,197 km^2). This latter figure does not include four locations recorded when the pack was apparently trespassing into the Deep Lake territory in February 1979.

Tolsona Pack - Prior to mid-June 1978 our contact with this pack consisted of public sightings, track counts, and harvest records. These data indicated that in early fall 1977 the pack had numbered at least 11. By the end of winter, the pack had been reduced to three by trappers.

We established radio contact with this pack in early June 1978 by searching aspen-covered knolls from fixed-wing aircraft as it searched for a potential den site. The den site was found and a yearling gray male (#210) was radio-collared. At that time the pack was comprised of wolf 210, an adult gray female, and a small black wolf which may have been a yearling. At least eight pups were raised at the site. Pups were moved to a rendezvous site 3.5 mi (5.6 km) away from the den site between 24 and 26 June 1978. During late summer 1978, wolf 210 began exhibiting a propensity to travel to the western extremes of the old Mendeltna territory which was thought to have been vacant since February 1978. During these forays, wolf 210 was always observed alone. In mid-September 1978 radio contact was lost. At that time the pack numbered 10.

Figure 4. Wolf pack territories derived from plotting radio locations obtained from July 1978 through June 1980 in Game Management Unit 13 of Southcentral Alaska.



We had no radio contact with this pack from September 1978 until late January 1979, at which time we purchased a black yearling pup from a local trapper. The pup had been caught by the toes and was in good enough condition to be radio-collared. At the time we were uncertain as to her pack affiliation. Within 2 weeks of capture, however, she had joined the Tolsona pack which then numbered seven (3 blacks and 4 grays).

By 10 May 1979, the pack began frequenting the den site utilized in 1978. Pups were first observed outside the den on 25 June. We never obtained an accurate count of the number of pups produced. In mid-October, however, the pack numbered 16 (11 grays and 5 blacks). On the basis of size and the scruffy appearance of pups at that time of the year, we believed at least six and perhaps nine pups were raised (3 blacks and 6 grays).

During summer 1979, members of this pack appeared to continuously expand their range to the west into the old Mendeltna territory. In mid-October, when we obtained the largest count (16) of the pack, they were located close to Moore Lake which had been the northern territory boundary of the Mendeltna pack (Fig. 3). Wolf 210, which had not been radio-located since late August of 1978, was with the pack at that time.

During winter 1979-80, the pack suffered attrition from trapping and perhaps dispersal even though portions of their territory were included in an area closed to hunting and trapping. Radio contact was temporarily lost when wolf 220's radio transmitter failed prematurely. We did not reestablish contact with this pack until early June 1980 when they were discovered at the Nickolson Lake den site which had been used by the Mendeltna pack in 1977. Wolf 220 was recaptured in July 1980, and at that time the pack was comprised of at least two black and seven gray adults. At least six pups were present at this den site.

Based upon the presence of an adult black wolf in the Tolsona pack from summer 1978 to 1980 and the known expansion of this pack's territory into the Mendeltna area, we suspect the black wolf may have been a survivor of the Mendeltna pack. As mentioned in the Mendeltna pack section, following winter 1977-78 all but two black wolves were accounted for according to wolf sealing documents. Perhaps, following drastic reduction in numbers, these two blacks dispersed and became integrated with the Tolsona pack, which in spring 1978 was thought to contain only three wolves.

From June 1978 through June 1980, the Tolsona pack occupied an area of 821 mi^2 (2,126 km^2). Their range extended from Tazlina Lake to Lake Louise, west to Tyone Creek and then east several miles past Tolsona Creek (Fig. 4). During this time, no other pack territories were believed to overlap the Tolsona territory.

Tsusena Creek Pack - Radio contact with this pack was established in mid-February 1976 in the area north of the Susitna River between Tsusena and Portage Creeks. Two (#'s 199 and 994) of nine members were captured and radio-collared. Shortly after being radio-collared, however, wolf 199 dispersed to the southeast and after being chased by the two Coal Creek wolves established a territory at Jay Creek along the Susitna River. Wolf 994 remained with the Tsusena pack but relatively few radio locations were obtained probably because of radio failure. A den site was not located in 1976.

In March 1977 we located a pack of seven wolves at the head of Clark Creek. From the location we assumed it was the original Tsusena pack. We radio-collared an adult gray male (#056) and a gray male pup (#057). The presence of this pup indicated that the pack had denned in 1976. On the basis of size and behavior it appeared that four or five of the pack members may have been the previous year's pups. Unfortunately, we never established contact with the radio-collared animals. Unsubstantiated reports from the public suggested that the radio-collared animals had been taken by illegal aerial hunting. The nature of the terrain within this pack's territory and the extensive snow cover which was present at that time would have made this pack highly vulnerable to aerial shooting. No attempt was made to reestablish contact with wolves in this area until spring 1980, however, no wolf sign was observed during intensive aerial searches in mid-April suggesting that this territory may be vacant.

Tyone Male - Wolf 001 was radio-collared in February 1976 at the west end of the Alphabet Hills. During the subsequent 5 months, this wolf traveled alone over a wide area of 1,400 mi^2 (3,626 km^2), traversing parts of at least four of the radio-marked pack territories described in this study. During this period wolf 001 was not observed at any kills but was seen near small bands of caribou on three occasions. After ranging widely over the lower portions of the Black, Oshetna and Tyone River drainages and the west fork of the Gulkana River, the Tyone male was found at an active den near Clearwater Creek in the Susitna River study area on 20 June 1976. Only one other adult wolf, a black female, and three pups were observed at this den. Although it is possible that the female and male were not previously associated, they may have been since the male was radio-collared only 14 miles (23 km) from the eventual location of the active den. The wolves associated with this den were probably members of a pack which used a territory to the west of and adjacent to the Maclaren and Keg Creek packs in 1975. The den site was abandoned in early July and we suspected the pups had been moved to a rendezvous site, possibly in the vicinity of Valdez Creek.

During June and July the wolves occupied an area of approximately 290 mi^2 (751 km^2). They were observed at two kill sites: a calf caribou at Valdez Creek on 27 July 1976, and an

adult moose on 28 July 1976 which was also being eaten by a brown bear with two yearling cubs. The latter kill may have been made by the bears.

Department personnel attempted to remove this pack from the experimental area in July 1976. However, only wolf 001 was taken at that time. The remainder of the pack was believed to have been removed during winter 1976-77 leaving this pack area vacant.

Tyone Creek Pack - Prior to establishment of radio contact with this pack in November 1977, our data consisted of track counts and public sightings. Between spring 1976 and fall 1977, the pack numbered from six to eight individuals. In fall 1977 the pack numbered 12. Apparently the pack denned in 1977 because one pup (#151) was radio-collared.

During the 1977-78 hunting-trapping season, 11 of 12 known pack members were harvested in this area, one of which was not retrieved. The remaining wolf (#116) dispersed from the area. By 27 February he was observed accompanied by a black adult female in the western edge of the Keg Creek territory. During March both wolves emigrated to the Susitna River Study Area. In late March the black female was removed by Department personnel. Wolf 116 continued to reside in the Susitna study area and by 20 June was observed with a yearling female which was also removed in mid-July. By late fall wolf 116 was observed alone at Monahan Flats, having dispersed over 60 miles (96 km) from his original capture location. Following this latter observation we lost radio contact with wolf 116 and assume he dispersed farther to the north or west.

During fall 1977 and early winter 1978, the Tyone pack occupied an area of 253 mi^2 (655 km^2). Public observations and track sightings indicated that the pack also ranged to upper Goose Creek on the west and the Susitna River to the north.

In November 1978 we reestablished contact with wolves in this area when two adults (#215 and 216) were radio-collared. Whether these wolves were descendants of the original Tyone Creek pack, which we thought was eliminated by ground shooting in 1978, or represented wolves colonizing a new area is not known. They did, however, occupy the area previously occupied by the Tyone pack.

During winter 1978-79, no other wolves were observed with this pair. They were first observed at the 1979 den site on 23 April. Seven pups, which were first observed on 6 July, were reared.

In early March 1980, this pack killed two wolves from the Susitna pack during a conflict near two recently killed moose. Details of this conflict were provided in the description of the Susitna pack.

Wolf hunting and trapping within this pack's territory were closed in both 1978-79 and 1979-80 so wolf numbers would remain stable for predation rate studies. In March 1980, however, we apprehended two individuals who were harvesting and attempting to herd wolves from fixed-wing aircraft in the closed area. Both admitted guilt and the Piper Super Cub was forfeited to the State and one individual was given a suspended jail sentence and placed on 2 years probation. Five wolves, three of which were radio-collared (#215, 216 and 301), were removed from the pack. One of these was legally ground shot when the pack ventured out of the closed area in January 1980. These mortalities reduced the pack to four pups by late March 1980.

Following the removal of the alpha male and female from the pack, the remaining pups apparently were unable to kill either moose or caribou. From mid-March through July these wolves were never observed on a fresh kill and revisited many of the old kills made prior to the reduction in pack numbers. In mid-April the pack began exhibiting an erratic movement pattern: on 14 April they were observed at Kosina Creek approximately 20 miles (32 km) northwest of the original territory boundary, then on 25 April they were observed on the middle fork of the Susitna River approximately 50 miles (80 km) north of the territory boundary. In both cases, however, the pack returned to the old pack territory within a few days of the observation. Obviously the pack did not den in 1980 but the pups did show a tendency to linger around the old 1979 den site.

Before the adult members of the pack were ground shot in March 1980 the pack occupied a relatively small territory of 302 mi^2 (782 km^2).

Watana Pack - Contact was temporarily established with this pack in March 1978 when three wolves were removed by Department personnel as part of the experimental wolf removal program and one adult male (#197) was radio-collared. Wolf 197 occupied the area from upper Watana Creek to lower Fog Creek. We lost contact with this wolf in April due to unknown causes.

From April 1978 to April 1980 our data for this pack consisted only of track counts and Department observations. By fall 1978, the pack numbered three and may have remained at that size through spring 1979, but we were only certain of the presence of two wolves. The pack apparently denned in 1979 because seven wolves were present by fall.

In late April and early May 1980, three adults (#308, 310 and 311) and one pup (#309) were captured and radio-collared near Watana Creek. They were first observed at a den site on 13 May where at least six pups were raised. Based upon a limited number of radio locations obtained from April through June 1980 the pack occupied on area of approximately 258 mi^2 (668 km^2).

Wolf Territories

For the purposes of this report we used Etkin (1964) definition of territorality; "any behavior on the part of an animal which tends to confine . . . its movements to a particular locality." Most definitions of territorality assume that the territory is defended against intruders. Although wolves in the Nelchina Basin apparently do at times defend their area against other wolves, intrusions into a neighboring territory often occur when the home pack is not using that portion of the area.

Table 2 summarizes territory sizes for 19 wolf packs studied from April 1975 through June 1980. Territory sizes were calculated only for those packs which had been intensively studied during that time period. We calculated the size of territories for four separate time periods: 1) wolf packs studied from April 1975 through June 1976 (includes some packs killed during experimental wolf removal in 1976); 2) packs studied from June 1976 through June 1978; 3) packs studied from July 1978 through June 1980; and 4) a summary of all packs for all study years. The first two time periods correspond with analyses reported in previous progress reports by Stephenson (1978) covering the 1975-76 period and by Ballard and Spraker (1979) for the 1976-78 period. We separated territory sizes in this manner because of differences in sampling intensity and differences or apparent shifts in wolf territories.

As this study progressed we began analyzing the number of pack locations in relation to computed territory size. We had anticipated that, as more locations were obtained, the increase in territory size would level off, and in turn provide us with an indication of the number of locations necessary to adequately measure territory size in the Nelchina study. This was not the case, however. As the number of locations increased the rate of increase in territory size decreased, but overall computed territory size continued to increase. It became apparent that although wolf packs continued to occupy the same general area their use of outlying areas changed by season and year. Therefore, the apparent boundaries of individual territories appeared to be in a constant state of flux even though core areas remained fairly constant. Haber (1977) working in nearby Mt. McKinley National Park, felt that territory boundaries remained stable over long periods of time. This may well be the case in a saturated, unhunted wolf population but does not appear to be the case in GMU 13 where wolves are exploited and for various other reasons exist at less than maximum densities.

Some of the apparent differences in territory size were undoubtedly attributable to seasonal differences in monitoring intensity. This was most evident for the following packs: Hogan Hill from 1976-80, Keg Creek from 1978-80, and Sinona #2 from 1978-80. During these time periods these packs continued to use the core areas.

Table 2. Summary of territory sizes for wolf packs intensively studied in Game Management Unit 13 of southcentral Alaska from April 1975 through June 1980.

Pack name	1975-1976		1976-1978		1978-1980		Total		Maximum annual density in terr. per wolf	
	mi^2	km^2	mi^2	km^2	mi^2	km^2	mi^2	km^2	mi^2	km^2
Brushkana	468	1212	--	--	--	--	468 [1/]	1212	47	121
Butte Lake	1188	3077	--	--	--	--	1188 [1/]	3077	297	769
Deadman	108	280	--	--	--	--	108 [1/]	280	22	56
Deep Lake	701	1816	548	1419	392	1015	828 [1/]	2145	104	268
Delta	288	746	--	--	--	--	288 [1/]	746	36	93
Ewan	864	2238	--	--	--	--	864	2238	79	203
Hogan Hill	567	1469	345	894	181	469	597 [1/]	1546	50	129
Jay Creek	--	--	288	746	--	--	288 [1/]	746	29	75
Keg Creek	432	1119	414	1072	106	275	506	1311	39	101
Maclaren	279	723	--	--	--	--	279	723	47	120
Mendeltna	--	--	559	1448	--	--	559	1448	37	97
Middle Fork	--	--	514	1331	--	--	514	1331	47	121
Saint Anne	--	--	397	1028	366	948	513	1329	37	95
Sinona #1	432	1119	301	780	--	--	472	1222	24	61
Sinona #2	--	--	235	609	146	381	268	694	27	69
Susitna	--	--	--	--	462	1197	462 [1/]	1197	36	92
Susitna-Sinona	--	--	--	--	284	736	284 [1/]	736	71	184
Tolsona	--	--	--	--	821	2126	821	2126	51	133
Tyone	--	--	253	655	302	782	364	943	30	79
Mean							537	1390		
Standard deviation							189	488		

[1/] Not included in mean due to inadequate data or nondenning pack.

Because of changes in use patterns by individual packs and differences in sampling we believe the most representative territory sizes are presented in the total column of Table 2. These figures include the core use area and encompass changes in peripheral areas. Average territory size for 14 denning wolf packs from 1975-80 was 537 mi^2 (1,390 km^2). Territories ranged in size from 268 mi^2 (694 km^2) up to 864 mi^2 (2,238 km^2). One nondenning pack of three males occupied an area of 1,188 mi^2 (3,077 km^2) which overlapped the territories of four other packs. Similarly, one lone male (#001) ranged over an area of 1,400 mi^2 (3,626 km^2) which also overlapped four pack territories. The movements of this latter wolf began resembling those of a regular pack member when he became associated with a female at a den site.

The Deep Lake, Ewan and Tolsona wolf packs had the largest territories of the denning packs, averaging over 800 mi^2 (2,072 km^2). Of possible significance is that these three packs accounted for 51 percent of the caribou kills observed during this study. In view of the low density of moose on the Lake Louise flats, and the relatively greater dependence of these packs on caribou during winter, we suspect the larger territories were a result of the low year-round density of ungulates in these areas.

Wolf pack territories derived from plotting radio-locations obtained in 1975-76 are illustrated in Fig. 2. This diagram differs slightly from the preliminary assessment provided by Stephenson (1978). In an effort to provide comparable illustrations, the outermost point of pack locations was used to determine territory size consistent with the method described by Mohr (1947). These territory boundaries represent what appeared to be the situation at the time with the possible exception of the Butte Lake pack, which was a non-denning group comprised of males.

Wolf territories derived from radio-locations obtained from July 1976 through June 1978 are illustrated in Fig. 3. During this time period territories were similar to those presented in Fig. 2 for the Deep Lake, Ewan, Hogan Hill, Keg Creek, Middle Fork, and Sinona #1 packs. Differences in territory boundaries were the result of excessive harvests by either experimental wolf removal by Department personnel or ground shooting by the public. Packs that established new territories through dispersal or shifting use patterns include Coal Creek, Jay Creek, Tyone male, and Sinona #2.

The greatest overlap in territory boundaries was exhibited by the Delta and Middle Fork packs. The area occupied by the Delta wolves from March through May 1977, and subsequent movements described in the preceding section, indicate that these wolves probably did not actively maintain a territory but rather were in the process of colonizing a new area. In contrast, the area depicted for the Middle Fork wolves was occupied during 1977 and 1978.

Territories derived from radio-locations obtained from July 1978 through June 1980 are illustrated in Fig. 4. Of particular interest are the unoccupied areas between the Tyone and Deep Lake packs and the Ewan and Mendeltna packs depicted in Fig. 3. Contact with packs in the identified gap areas was established in 1978 and 1979, respectively, suggesting that these wolf packs were present prior to July 1978.

From June 1978 through fall 1978 the Tolsona pack occupied the void area depicted in Fig. 3. In late fall, however, a Tolsona pack member (a radio-collared yearling male) was observed in the Mendeltna pack territory. All, or most, of the Mendeltna pack had been killed by ground shooting in February and March 1978. During the winter months, the Tolsona pack shifted their movements to the west and by late 1979 they occupied their own area and the old Mendeltna's pack territory. The expansion of the Tolsona pack's territory appeared to be directly related to the elimination of the Mendeltna pack.

Contact with the Susitna pack was established in February 1979 when two adults and eight pups appeared to be trespassing into the Deep Lake territory. Because at least two adults were present, and examination of scatter diagrams of wolf pack sightings revealed little overlap with the Depp Lake and Tyone Creek pack areas, this pack was probably present in 1977-78 but was probably a relatively small pack.

The territory depicted in the Sinona area probably represents establishment of a new pack in a vacant area. During winter 1979-80 at least one radio-collared wolf and probably three wolves from the Susitna pack appeared to leave the pack and follow migrating caribou to the Sinona area. They did not return to their former territory but began inhabiting the area formerly occupied by the Sinona #2 pack. At least eight and perhaps all 10 members of this latter pack were killed by ground shooting in 1978. It was possible that one wolf remained in the Sinona area since we could only account for three members missing from the Susitna pack while the new group numbered four.

Territory boundaries depicted in Figs. 2, 3, and 4 were essentially nonoverlapping during the course of any particular year. What overlap did occur during a year was either seasonally temporary in nature or was the result of the way territories were illustrated.

Den and Rendezvous Site Usage

The earliest date when the members of a radio-collared wolf pack were observed at a natal den was 13 April (Table 3). Wolves usually began visiting den sites in late April and May when they appeared to be in the process of cleaning the site in preparation for parturition.

Table 3. Chronology of den and rendezvous site usage of selected study wolf packs in the Nelchina Basin study area from 1975 through 1980.

	Wolves first found at natal den						Date pups first seen outside den						Date moved to 1st rendezvous site						Date Pups appeared to travel with adult					
Pack	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980
Butte Lake	5/21	--	--	--	--	--	6/19	--	--	--	--	--	8/1	--	--	--	--	--	9/26-10/6	--	--	--	--	--
Deadman Lk	6/26	3/9	--	--	--	--	--	--	--	--	--	--	7/10	--	--	--	--	--	11/12	--	--	--	--	--
Delta Riv	6/3	--	--	--	--	--	6/6	--	--	--	--	--	7/29	--	--	--	--	--	9/12?	--	--	--	--	--
Ewan Lake	6/13	--	--	--	--	--	--	--	--	--	--	--	7/30	--	--	--	--	--	9/23?	--	--	--	--	--
Hogan Hill	5/14	--	--	5/23	--	--	6/13	--	--	5/30	--	--	7/23	--	--	6/19	--	--	?	--	--	10/13	--	--
Keg Creek	5/23	4/13	--	5/9	--	--	6/13	8/21	--	6/8	--	--	7/2	7/14	--	8/25	--	--	9/23-9/30	8/29	--	<9/12	--	--
Maclaren R	5/21	--	--	--	--	--	--	--	--	--	--	--	6/16	--	--	--	--	--	10/4	--	--	--	--	--
Mendeltna	--	5/25	4/21	--	--	--	--	7/2	6/1	--	--	--	--	6/28-7/2	6/22	--	--	--	--	9/1-8	<9/13	--	--	--
Sinona Ck	5/22	5/6	5/12	<5/29	--	4/16	7/22	7/19	9/15	9/12	--	--	--	7/11	7/20?	?	--	?	9/25-10/4	8/25	9/15	9/12	--	--
Susitna	--	--	--	--	4/13	4/23	--	--	--	--	8/3	6/6	--	--	--	--	7/19	6/6[1/]	--	--	--	--	9/11	8/12
St. Anne	--	--	5/11	5/23	5/24	5/12	--	--	8/17	9/25	9/12	8/15	--	--	<7/13	?	?	?	--	--	8/17	9/25	9/12	8/15
Tolsona	--	--	--	<6/4	5/10	--	--	--	--	6/16	6/25	<6/10	--	--	--	6/24	7/19	6/9[1/]	--	--	--	--	9/1	--
Tyone	--	--	--	--	4/26	--	--	--	--	--	7/6	--	--	--	--	?	--	--	--	--	--	--	9/11	--
Watana	--	--	--	--	--	5/13	--	--	--	--	--	7/14	--	--	--	--	--	7/14	--	--	--	--	--	--

[1/] May have been induced by human disturbance.

Dates at which pups were first observed outside dens or rendezvous sites ranged from 1 June to 15 September. Late sightings were the result of infrequent radio contact and dense vegetation which prevented observation. Mech (1970) indicated that wolf pups were commonly observed outside of dens when 3 weeks old. Clark (1971) observed 10-day-old pups outside dens on Baffin Island while Foster (pers. comm.) indicated that pups of captive wolves begin going outside the den when 16 days old.

Aerial observations of wolf den site usage and pup emergence suggest that in southcentral Alaska parturition occurs from mid to late May. However ground observations in 1980 at the Susitna wolf den revealed that parturition had occurred by 1 May (Foster and Ballard, unpub. data). Based upon this observation and our observations of obvious size differences in pups of different litters, we suggest that parturition is variable and probably occurs throughout the month of May.

Natal dens were, in most cases, vacated during July with dates ranging from 4 June to 1 August. Distances between natal dens and first rendezvous sites ranged from a few hundred yards to 9 miles (14 km). In a few instances, we observed packs moving to a second rendezvous site in August and early September. Usually these latter sites were used only for several days. Pups began traveling with adults on a regular basis between late August and mid-September.

Most wolf dens were roughly centered within the observed territorial boundaries, but the Hogan Hill, Keg Creek and Maclaren dens were located near territorial boundaries. The average distance between eight natal dens used in 1975 was 22.8 air miles (37 km) and ranged from 16 to 28.5 air miles (25 to 46 km). These figures represent only those cases in which we are certain that no dens existed in intervening areas. This average distance is somewhat less than that described in the northcentral Brooks Range (Stephenson and Johnson 1973) where the minimum average distance between dens was about 25 miles (40 km).

Food Habits in Relation to Availability of Prey

The following section describes the summer and winter food habits of wolf packs that were intensively studied from April 1975 through June 1980. Food habits of packs for which only limited data were available were partially described in the preceding section of this report and have been included in the food habits summary section.

Brushkana Pack - From April through mid-November 1975 the Brushkana pack was observed at five kills: four moose and one of unidentified species. Scats collected from the 1975 den site suggested that moose were the most important prey item in late spring and summer (Table 4), and caribou the second most important. Overall, ungulates comprised 87 percent of the prey items found in scats collected from the den site.

Table 4. Incidence of food remains in wolf scats collected at the Brushkana Creek wolf den occupied during late spring and early summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 40 adult scats		Items in 144 pup scats		Items in 184 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	2	5.0	12	8.2	14	7.5
Calf moose	17	42.5	77	52.7	94	50.5
Adult caribou	12	30.0	22	15.1	34	18.3
Calf caribou	2	5.0	9	6.2	11	5.9
Dall sheep	2	5.0	6	4.1	8	4.3
Beaver	3	7.5	9	6.2	12	6.5
Muskrat	0	0	1	.7	1	.5
Unid. furbearer	0	0	2	1.4	2	1.1
Wolf	0	0	1	.7	1	.5
Vegetation	0	0	3	2.1	3	1.6
Unidentified	2	5.0	4	2.7	6	3.2
Total	40	100.0	146	100.1	186	99.9

Grouped Data for 184 Scats

Food item	Number of items	Percent occurrence
Ungulate	161	86.6
Small mammals	13	7.0
Other	12	6.5
Total	186	100.1

Moose were the most numerous year-round large prey species within the Brushkana territory. Studies of moose movements in this area indicated that moose were nonmigratory with movements consisting of short altitudinal movements from summer to winter range (Ballard and Taylor 1980). Caribou, however, appeared to be very migratory except for a small subpopulation which appeared to be year-round residents of Monahan Flats, wintering on the flats and spending summer through fall at higher elevations within the pack's territory.

Secondary prey species within this pack's area included beaver (*Castor canadensis*) muskrat (*Ondatra zibethica*), snowshoe hare (*Lepus americanus*), ptarmigan (*Lagopus* sp.) and numerous microtine rodents. Both beaver and muskrat appeared to be numerous within the northern half of this pack's territory and along Brushkana Creek. Ptarmigan appeared numerous along Brushkana Creek and Butte Lake during this period of study. Dall sheep (*Ovis dalli*), however, were not numerous.

Butte Lake Pack - Food habits information pertaining to this pack consisted solely of radio location data because the pack consisted of males only and did not den in 1975. From April 1975 through January 1976 the pack was observed on 5 kills: 3 adult moose, unidentified 1 moose and 1 caribou.

This pack's territory encompassed the Clearwater Mountains. Moose appeared to be the most numerous large prey item followed closely by caribou. Caribou were year-round residents within the Butte Lake territory while moose in the Clearwater Mountains were highly migratory (Ballard and Taylor 1980). Based upon movement studies, moose would only have been available to this pack on a year-round basis in the western half of the territory. Caribou were also available on a year-round basis within the western half of the territory.

Information pertaining to population levels of secondary prey species is quite limited. Both beaver and muskrat were numerous along the Susitna River and its tributaries. Dall sheep were occasionally observed on the southern slopes of the Alaska Range near the middle fork of the Susitna River. Sheep populations in this area have been quite low for a number of years and only within recent years have they begun to increase. Ptarmigan could also constitute an important prey item during some years. Snowshoe hares were not numerous according to aerial observations.

Clearwater Pack - Contact with this pack was not established until June 1976 when wolf number 001, which previously had been a loner, was found at the Clearwater den site. Prior to this, wolf 001 ranged over a 1,400 mi^2 (3,626 km^2) area but was never observed at a fresh kill. Our aerial observations suggested that wolf 001 fed on an occasional caribou and often hunted small game.

During June and July the two adult members of this pack were observed on one caribou and one adult moose kill which was contested by a brown bear. The limited number of scats (n = 33) collected at the den site indicated that calf moose (86%) were an important summer food for this pack (Table 5).

Deadman Pack - Although this pack denned in 1975, no den site was located. However, two rendezvous sites were located and scats were collected (Table 6) at one of these. The 30 scats suggested high dependence on moose: 34 percent occurrence of adult moose and 47 percent occurrence of calf moose. The small number of kills located while radio-tracking during winter (3 moose) also indicated that moose were the primary source of food. Moose in this area were relatively numerous on a year-round basis and were relatively sedentary. Caribou were available in limited numbers during much of 1975-76 and may also have been taken but not detected during the study.

Deep Lake Pack - From 1975 through spring 1980 we located only one den site (1975) even though the pack also denned in 1976 and 1977. Scats from the 1975 site indicated that calf and adult moose were the most important prey items (53% occurrence) but that snowshoe hare (13.1%) and beaver (15.6%) were also important prey items (Table 7) during summer. Caribou comprised less than 5 percent of the food items.

Aerial observations made primarily during winter months from 1976 to early 1979, indicated that moose and caribou were important prey during winter. Of 23 observed kills, 11 were moose, 12 were caribou, and 3 appeared to be small game species. Caribou were most numerous within this pack's territory during winter months and least common during summer months.

Fall moose sex and age composition count data indicate that moose densities within this pack's territory were quite low. In 1976, only 158 moose were counted in the 697 mi^2 (1,805 km^2) Lake Louise Moose Management area. Undoubtedly mid-winter moose densities were higher than those in fall because of moose migration from the Alphabet Hills. Despite this, year-round moose densities within this pack's large territory, were the lowest of any of those pack's studied except for the Ewan and St. Anne wolf packs. Therefore, it appeared that the Deep Lake wolves were favoring moose over caribou.

Information pertaining to snowshoe hare, muskrat and beaver population levels was scanty but reports from trappers and our own observations suggest that the latter two species were quite abundant during the study period. Snowshoe hare numbers were low in this area from 1975-1978 and only in recent years have they appeared to increase.

Delta Pack - The summer diet of this pack in 1975, as indicated by scats collected at both den and rendezvous site (Tables 8 and 9), was comprised primarily of small mammals.

Table 5. Incidence of food remains in wolf scats collected at the Clearwater wolf den occupied during June 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 2 adult scats		Items in 31 pup scats		Items in 33 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	0	0	1	3.0	1	2.9
Calf moose	2	100	28	84.8	30	85.7
Microtine	0	0	1	3.0	1	2.9
Vegetation	0	0	3	9.1	3	8.6
Total	2	100.0	33	99.9	35	100.1

Grouped Data for 33 Scats

Food item	Number of items	Percent occurrence
Ungulate	31	88.6
Small mammals	1	2.9
Other[1/]	3	8.6
Total	35	100.1

1/ Includes birds, invertebrates, unidentified, wolf, fish, vegetation.

Table 6. Incidence of food remains in wolf scats collected at the Deadman Lake wolf rendezvous site occupied during mid-summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 1 adult scat		Items in 29 pup scats		Items in 30 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	0	0	11	35.5	11	34.4
Calf moose	1	100	14	45.2	15	46.9
Beaver	0	0	2	6.5	2	6.3
Microtine	0	0	1	3.2	1	3.1
Lynx	0	0	3	9.7	3	9.4
Total	1	100.0	31	100.1	32	100.1

Grouped Data for 30 Scats

Food item	Number of items	Percent occurrence
Ungulate	26	81.3
Small mammals	3	9.4
Lynx	3	9.4
Total	32	100.1

Table 7. Incidence of food remains in wolf scats collected at the Deep Lake wolf den occupied during late spring and summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 34 adult scats		Items in 72 pup scats		Items in 106 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	5	13.5	14	16.5	19	15.6
Calf moose	15	40.5	31	36.5	46	37.7
Caribou	1	2.7	2	2.4	3	2.5
Beaver	11	29.7	8	9.4	19	15.6
Snowshoe hare	3	8.1	13	15.3	16	13.1
Microtine	0	0	2	2.4	2	1.6
Lynx	0	0	3	3.5	3	2.5
Vegetation	0	0	8	4.4	8	6.6
Fish	0	0	1	1.2	1	.8
Eggshells	2	5.4	0	0	2	1.6
Unidentified	0	0	3	3.5	3	2.5
Total	37	99.9	85	100.1	122	100.0

Grouped Data for 106 Scats

Food item	Number of items	Percent occurrence
Ungulate	68	55.7
Small mammals	40	32.8
Other	14	11.5
Total	122	100.0

Table 8. Incidence of food remains in wolf scats collected at the Delta River wolf den occupied during late spring and summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 24 adult scats		Items in 113 pup scats		Items in 137 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	10	25.1	10	8.1	20	12.3
Calf moose	4	10	35	28.5	39	23.9
Snowshoe hare	16	40.0	51	41.5	67	41.1
Beaver	3	7.5	21	17.1	24	14.7
Muskrat	0	0	1	.8	1	.6
Sciurids	2	5.0	1	.8	3	1.8
Eggshells	0	0	1	.8	1	.6
Bird	4	10.0	2	1.6	6	3.7
Insecta	0	0	1	.8	1	.6
Fish	1	2.5	0	0	1	.6
Total	40	100.1	123	100.0	163	99.9

Grouped Data for 137 Scats

Food item	Number of items	Percent occurrence
Ungulate	59	36.2
Small mammals	95	58.3
Other	9	5.5
Total	163	100.0

Table 9. Incidence of food remains in wolf scats collected at the suspected rendezvous site of the Delta River wolf pack occupied during summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 13 adult scats		Items in 67 pup scats		Items in 80 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	2	14.3	2	2.6	4	4.3
Calf moose	4	28.6	5	6.4	9	9.8
Snowshoe hare	2	14.3	3	3.8	5	5.4
Beaver	0	0	45	57.7	45	48.9
Ground squirrel	6	42.9	15	19.2	21	22.8
Eggshells	0	0	1	1.3	1	1.1
Insecta	0	0	1	1.3	1	1.1
Microtine	0	0	6	7.7	6	6.5
Total	14	100.1	78	100.0	92	99.9

Grouped Data for 80 Scats

Food item	Number of items	Percent occurrence
Ungulate	13	14.1
Small mammals	77	83.7
Other	2	2.2
Total	92	100.0

Snowshoe hare (41%), calf moose (24%) and beaver (15%) comprised 80 percent of the food items at the den site. At the rendezvous site, however, beaver (48.9%) and ground squirrel (*Spermophilus undulatus*) (22.8%) were the most important foods.

The Delta pack inhabited an area with the lowest ungulate density of any of the areas studied. During radio-tracking flights, only two ungulate kills were observed during 1975-76 and both were jointly occupied by brown bears. Moose movement studies in similar habitat in other portions of GMU 13, suggest that moose only utilize the pack area in late summer and fall, spending winter and spring farther to the south in areas with less snowfall. Similarly, caribou were rarely observed in the area.

As mentioned in the previous section, after winter 1975-76 this pack area was suspected of being vacant except for an occasional public observation and our radio contact with wolves 063 and 064, which apparently dispersed shortly after being radio-collared. Both pups and adults killed in 1975-76 exhibited characteristics of poor nutrition. If the latter observations were representative, then it would appear that the Delta area is not capable of supporting many wolves. Wolves which do reproduce and survive are subjected to intense hunting and trapping under ideal terrain and snow conditions. Therefore, poor nutrition and hunting pressure will likely preclude the establishment of a stable population of wolves in this area in the near future.

Ewan Pack - From May 1975 through June 1976 the Ewan pack was observed on 18 kills: 10 caribou, 7 moose and 1 red fox (*Vulpes vulpes*). Following this period, radio contact with this pack was highly sporadic and never of sufficient duration to determine numbers of caribou and moose being taken.

During late spring and early summer 1975, small mammals appeared to comprise the bulk of the diet (65%) of this pack while it was at the den site (Table 10). Sixty-three percent of the food items were either beaver or snowshoe hare. By the end of July, however, when the pack moved to the first rendezvous site, scat analysis indicated that calf moose (41% occurrence) followed by beaver (33% occurrence) were the most important food items (Table 11).

During 1975-76, there were indications that this pack may have been nutritionally stressed. Throughout summer 1975 the Ewan pups appeared smaller than those in other study packs. Additionally, wolves 991 and 992 were thin and small when collared, and, at best, were in only fair condition.

The Ewan pack area appeared to have the lowest year-round moose density of any of the areas studied from 1975 through spring 1980. Moose sightings were rare during radio-tracking flights and moose counts in the Lake Louise count area also indicated that moose numbers were quite low in this area.

Table 10. Incidence of food items in wolf scats collected at the Ewan Lake wolf den occupied during late spring and summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 58 adult scats		Items in 89 pup scats		Items in 147 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	12.9	4	3.7	13	7.3
Calf moose	15	21.4	22	20.6	37	21.0
Caribou	3	4.3	5	4.7	8	4.5
Beaver	17	24.3	41	38.3	58	32.5
Snowshoe hare	22	31.4	32	29.9	54	30.5
Microtine	2	2.8	1	0.9	3	1.7
Wolf	0	0	1	0.9	1	0.6
Eggshells	1	1.4	1	0.9	2	1.1
Bird	1	1.4	0	0	1	0.6
Total	70	99.9	107	99.9	177	99.8

Grouped Data for 147 Scats

Food item	Number of items	Percent occurrence
Ungulate	58	32.8
Small mammals	115	65.0
Other	4	2.3
Total	177	100.1

Table 11. Incidence of food remains in wolf scats collected at the Ewan Lake wolf rendezvous site occupied during mid-summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 35 adult scats		Items in 84 pup scats		Items in 119 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	19	47.5	38	38.8	57	41.3
Calf moose	5	12.5	10	10.2	15	10.9
Beaver	12	30.0	34	34.7	46	33.3
Snowshoe hare	3	7.5	2	2.1	5	3.6
Wolf	0	0	2	2.1	2	1.4
Vegetation	1	2.5	10	10.4	11	8.0
Unidentified	0	0	2	2.1	2	1.4
Total	40	100.0	98	100.4	138	99.9

Grouped Data for 119 Scats

Food item	Number of items	Percent occurrence
Ungulate	72	52.2
Small mammals	51	37.0
Other	15	10.9
Total	138	100.1

Following 1975-76 our contact with this pack was limited to track counts and sporadic observations. These observations suggested that the pack's nutritional status had not improved since it only numbered 3 to 5 animals until fall 1979 when it numbered seven. From 1976 through mid-1980 large numbers of caribou wintered on the Lake Louise flats. We suspect that during these winters caribou were the major prey and probably allowed for the continued existence of the pack. During years when caribou did not winter in this area, this pack appeared to dwindle in number, probably due to starvation and dispersal.

Beaver, muskrat and, in recent years, snowshoe hare have been numerous in this area. Only snowshoe hare, however, could be viewed as an important alternate winter food source.

Hogan Hill Pack - During 1975-76 and from March 1977 through January 1979, members of the Hogan Hill pack were observed on 39 kills. Adult or yearling moose appeared to be the most important year-round food item, comprising 74 percent of the observed kills. Observations of prey taken during summer 1978 were summarized and compared with those of the Mendeltna pack in a paper presented at the Portland Wolf Symposium entitled "Gray wolf-brown bear relationships in the Nelchina Basin of Southcentral Alaska." A copy of the paper is presented as Appendix III.

A comparison of food items contained in wolf scats collected at the 1975 and 1978 den sites is contained in Tables 12 and 13. In 1975 ungulates, primarily moose, comprised 55 percent of the prey items, whereas in 1978 ungulates comprised 73 percent of the food items. The main difference between these years was the percent occurrence of calf moose and snowshoe hare: 29 percent calf moose and 40 percent snowshoe hare in 1975 and 56 percent calf moose and 5 percent snowshoe hare in 1978. These data indicate that more calves were taken in 1978 than in 1975. By July 1978, the percent of calf moose in scats from the rendezvous site increased to 81 percent (Table 14). High summer dependence on newborn moose calves in 1978 was not supported by our aerial observations which indicated a predominance of adult and yearling moose. Discrepancies between these data will be discussed in the Food Habits Summary section.

The Hogan Hill pack area supports one of the highest moose densities in GMU 13; in 1978 1.1 moose per mi^2 were observed during fall composition counts. Therefore, this pack's high year-round dependency on moose was not surprising. Caribou were probably available to this pack on a year-round basis but usually in very low densities except during spring and fall migrations to and from the Wrangell Mountains. Beaver and muskrat populations appeared to be lower than those found in adjacent pack areas, primarily because there is less aquatic habitat. No information is available on snowshoe hare populations but it appears probable that in 1979 and 1980 hare populations increased as they have elsewhere in GMU 13.

Table 12. Incidence of food items in wolf scats collected at the Hogan Hill wolf den occupied in late spring and early summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 39 adult scats		Items in 96 pup scats		Items in 135 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	11	22.9	9	8.1	20	12.6
Calf moose	15	31.3	31	27.9	46	28.9
Caribou	4	8.3	18	16.2	22	13.8
Snowshoe hare	16	33.3	48	43.2	64	40.3
Wolf	0	0	1	1.0	1	0.6
Vegetation	1	2.0	3	2.7	4	2.5
Eggshells	1	2.0	1	1.0	2	1.3
Total	48	99.8	111	100.1	159	100.0

Grouped Data for 135 Scats

Food item	Number of items	Percent occurrence
Ungulate	88	55.3
Small mammals	64	40.3
Other	7	4.4
Total	159	100.0

Table 13. Incidence of food remains in wolf scats collected at the Hogan Hill wolf den occupied during late spring and summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 126 adult scats		Items in 77 pup scats		Items in 203 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	24	16.0	2	2.3	26	10.9
Calf moose	73	48.7	59	67.0	132	55.5
Adult caribou	10	6.7	2	2.3	12	5.0
Calf caribou	1	0.7	2	2.3	3	1.3
Beaver	19	12.7	8	9.1	27	11.3
Muskrat	3	2.0	2	2.3	5	2.1
Snowshoe hare	11	7.3	1	1.1	12	5.0
Parka squirrel	0	0	0	0	0	0
Microtine	2	1.3	1	1.1	3	1.3
Bird	0	0	1	1.1	1	0.4
Fish	0	0	0	0	0	0
Unidentifiable	3	2.0	5	5.7	8	3.4
Vegetation	4	2.7	5	5.7	9	3.8
Other	0	0	0	0	0	0
Total	150	100.1	88	100.0	238	100.0

Grouped Data for 203 Scats

Food item	Number of items	Percent occurrence
Ungulate	173	72.7
Small mammals	47	19.7
Other	18	7.6
Total	238	100.0

Table 14. Incidence of food remains in wolf scats collected at the Hogan Hill wolf rendezvous site occupied during mid-summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 17 adult scats		Items in 24 pup scats		Items in 41 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	3	12.5	1	3.4	4	7.5
Calf moose	19	79.2	24	82.8	43	81.1
Adult caribou	0	0	0	0	0	0
Calf caribou	0	0	0	0	0	0
Beaver	0	0	0	0	0	0
Muskrat	0	0	0	0	0	0
Snowshoe hare	1	4.2	0	0	1	1.9
Parka squirrel	0	0	0	0	0	0
Microtine	0	0	0	0	0	0
Bird	0	0	0	0	0	0
Fish	0	0	0	0	0	0
Other	0	0	2	6.9	2	3.8
Vegetation	1	4.2	1	3.4	2	3.8
Unidentifiable	0	0	1	3.4	1	1.9
Total	24	100.1	29	99.9	53	100.0

Grouped Data for 41 Scats

Food item	Number of items	Percent occurrence
Ungulate	47	88.7
Small mammals	1	1.9
Other	1	9.4
Total	53	100.0

Jay Creek Pack - Limited aerial observations of this pack suggested a high dependence on adult moose (7 of 10 kills) during winter. During winter months the pack frequented the riparian areas along the Susitna River where both resident and migratory moose wintered (Ballard and Taylor 1980). Although we only observed one caribou kill, caribou were probably an important food item in summer and during migrations to and from the calving grounds on Kosina Creek. Although the pack denned in 1978, the site was not visited for scat collection because of logistic problems.

Keg Creek Pack - Members of the Keg Creek pack were observed on 28 kills during this study. Moose comprised 79 percent of the observed kills and 86 percent of these were adult moose. Abundance of moose and caribou in this area was similar to that described for the Hogan Hill pack area and, therefore, the high predominance of moose kills was not surprising since moose were the most common ungulate prey.

Summer food habits, as indicated by scat analyses from den and rendezvous sites, are summarized in Tables 15 through 18. Percent occurrence of ungulate food items at the same den site used in 1975, 1976, and 1978 was 67, 92, and 53 percent, respectively. In all cases calf moose comprised the predominant food item (58, 73, and 53%). Small mammals, particularly snowshoe hares, were an important prey item in 1975 (28%) but not in either 1976 or 1978. The decline in percent occurrence of snowshoe hare was similar to that exhibited by the Hogan Hill pack during the same years suggesting that perhaps hare abundance declined in these pack areas. Also similar was the increase in percent occurrence of calf moose remains in scats collected at the den compared to those collected at the rendezvous site. This might indicate that movement to the rendezvous sites was partially related to calf moose abundance. Regardless, calf moose were an important summer food item during the 3 years of scat analyses.

Maclaren River Pack - From April 1975 to mid-January 1976, members of the Maclaren River pack were observed on 12 kills: 10 moose and two caribou, suggesting a winter dependency on moose. Moose populations within this pack's area were both sedentary and migratory, with the migratory segment involving moose from the Clearwater Mountains (Ballard and Taylor 1980). Densities observed during fall composition counts were not high: 0.4 moose per mi^2 were observed in 1976. Caribou were seasonally abundant and available to this pack primarily during late winter.

Although this pack denned in 1975, the den site was not located and thus no scats were collected. A small number of scats (n = 26) collected from the 1975 rendezvous site suggested that moose were also the most important prey item during summer (Table 19).

Table 15. Incidence of food remains in wolf scats collected at the Keg Creek wolf den occupied during late spring and early summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 17 adult scats		Items in 65 pup scats		Items in 82 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	4	21.1	4	5.8	8	9.1
Calf moose	12	63.2	39	56.5	51	58.0
Beaver	0	0	8	11.6	8	9.1
Snowshoe hare	2	10.5	15	21.7	17	19.3
Wolf	0	0	1	1.4	1	1.1
Eggshells	1	5.3	1	1.4	2	2.3
Unidentified	0	0	1	1.4	1	1.1
Total	19	100.1	69	99.8	88	100.0

Grouped Data for 82 Scats

Food item	Number of items	Percent occurrence
Ungulate	59	67.0
Small mammals	25	28.4
Other	4	4.5
Total	88	99.9

Table 16. Incidence of food remains in wolf scats collected at the Keg Creek wolf rendezvous site occupied in mid-summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 12 adult scats		Items in 114 pup scats		Items in 126 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	64.3	15	12.1	24	17.4
Calf moose	4	28.6	96	77.4	100	72.5
Caribou	0	0	1	1.0	1	1.0
Snowshoe hare	0	0	10	8.1	10	7.2
Vegetation	1	7.1	1	1.0	2	1.4
Bird	0	0	1	1.0	1	1.0
Total	14	100.0	124	100.6	138	100.5

Grouped Data for 126 Scats

Food item	Number of items	Percent occurrence
Ungulate	125	90.6
Small mammals	10	7.2
Other	3	2.3
Total	138	100.1

Table 17. Incidence of food remains in wolf scats collected at the Keg Creek wolf den occupied during late spring and summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 36 adult scats		Items in 45 pup scats		Items in 81 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	4	10.5	1	2.1	5	5.9
Calf moose	21	55.3	41	87.2	62	72.9
Adult caribou	5	13.2	1	2.1	6	7.1
Calf caribou	4	10.5	1	2.1	5	5.9
Beaver	2	5.3	0	0	2	2.4
Unidentifiable	1	2.6	2	4.3	3	3.5
Vegetation	1	2.6	1	2.1	2	2.4
Total	38	100.0	47	99.9	85	100.1

Grouped Data for 81 Scats

Food item	Number of items	Percent occurrence
Ungulate	78	91.8
Small mammals	2	2.4
Other	5	5.9
Total	85	100.1

Table 18. Incidence of food remains in wolf scats collected at the Keg Creek wolf den occupied during late spring and summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 7 adult scats		Items in 38 pup scats		Items in 45 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	1	14.3	0	0	1	2.0
Calf moose	4	57.1	22	52.4	26	53.1
Adult caribou	0	0	1	2.4	1	2.0
Calf caribou	1	14.3	8	19.0	9	18.4
Beaver	1	14.3	0	0	1	2.0
Muskrat	0	0	0	0	0	0
Snowshoe hare	0	0	0	0	0	0
Ground squirrel	0	0	0	0	0	0
Microtine	0	0	1	2.4	1	2.0
Bird	0	0	0	0	0	0
Fish	0	0	0	0	0	0
Unidentifiable	0	0	9	21.4	9	18.4
Vegetation	0	0	0	0	0	0
Other	0	0	1	2.4	1	2.0
Total	7	100.0	42	100.0	49	99.9

Grouped Data for 45 Scats

Food item	Number of items	Percent occurrence
Ungulate	37	75.5
Small mammals	2	4.1
Other	10	20.4
Total	49	100.0

Table 19. Incidence of food remains in wolf scats collected at the Maclaren River wolf rendezvous site occupied during mid-summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 6 adult scats		Items in 20 pup scats		Items in 26 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	5	83.3	3	11.5	8	25.0
Calf moose	0	0	14	53.8	14	43.8
Beaver	0	0	1	3.8	1	3.1
Snowshoe hare	1	16.7	3	11.5	4	12.4
Microtine	0	0	2	7.7	2	6.3
Bird	0	0	2	7.7	2	6.3
Snail	0	0	1	3.8	1	3.1
Total	6	100.0	26	99.8	32	100.0

Grouped Data for 26 Scats

Food item	Number of items	Percent occurrence
Ungulate	22	68.8
Small mammals	7	21.9
Other	3	9.4
Total	32	100.1

Mendeltna Pack - From August 1976 through November 1977 members of the Mendeltna wolf pack were observed at 36 kills. Overall, adult and calf moose comprised 67 percent of the kills, followed by caribou at 18 percent. Beavers, rodents, brown bears and unknown species comprised the remaining 18 percent of the observed kills. Of the 36 moose kills, at least nine (25%) were also shared by one, or more, brown bear.

Moose in moderate densities (0.9 moose/mi^2 observed during fall composition counts) were year-round inhabitants of the Mendeltna area. Although no moose movement studies have been conducted in this area, movements of cows with radio-collared calves suggested that this population was comprised of both sedentary and migratory segments. The migratory segment appeared to migrate from summer to winter range in an east-west direction. Many of the migratory moose, however, appeared to summer and winter in this pack's territory. Overall, moose appeared to be the most abundant year-round residents.

Caribou were also available to this pack on a year-round basis but appeared to be most numerous during winter when portions of the Nelchina herd wintered on the Lake Louise flats. They were also quite abundant in late summer in the eastern Talkeetna foothills following the calving season.

Data pertaining to populations of small mammals were not collected but it appeared that muskrats were numerous in many ponds while beavers were restricted to creek drainages. Snowshoe hare numbers have increased since 1978 but hares were present in low numbers previously.

A detailed discussion of summer food habits as suggested by aerial observations is presented in Appendix III. These data indicated that yearling and adult moose were the predominant prey during late May and June rather than newborn calves.

Summer food habits, as indicated by scats collected from den and rendezvous sites in 1976 and 1977, are depicted in Tables 20 through 25. In 1976, caribou were the major food item (58%) while in 1977 moose were the predominant item (44%) at the main den. In both years calves were the most important age class represented. At all rendezvous sites, calf moose were the predominant prey item. Small mammals comprised less than 10 percent of the food items during all years and at all sites, except for the 1977 main den and the Kelly Lake rendezvous site where they occurred in 16 to 19 percent of the food items.

St. Anne Pack - From April 1977 through June 1980, members of the St. Anne's pack were observed on 20 kills, most of which were observed during winter. Sixteen (80%) of the kills were moose, of which 75 percent were adults, suggesting that moose were by far the most important winter food item.

Table 20. Incidence of food remains in wolf scats collected at the Mendeltna wolf den occupied during late spring and summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 28 adult scats		Items in 24 pup scats		Items in 52 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	4	13.3	1	3.7	5	8.8
Calf moose	10	33.3	6	22.2	16	28.1
Adult caribou	4	13.3	6	22.2	10	17.5
Calf caribou	10	33.3	13	48.1	23	40.4
Beaver	1	3.3	0	0	1	1.8
Snowshoe hare	1	3.3	0	0	1	1.8
Vegetation	0	0	1	3.7	1	1.8
Total	30	99.8	27	99.9	57	100.2

Grouped Data for 52 Scats

Food item	Number of items	Percent occurrence
Ungulate	54	94.7
Small mammals	2	3.5
Other	1	1.8
Total	57	100.1

Table 21. Incidence of food remains in wolf scats collected at the Mendeltna wolf pack rendezvous site near Daisy Creek occupied during summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 25 adult scats		Items in 62 pup scats		Items in 87 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	4	13.8	3	4.7	7	7.5
Calf moose	15	51.7	36	56.3	51	54.8
Adult caribou	4	13.8	5	7.8	9	9.7
Calf caribou	4	13.8	9	14.1	13	14.0
Muskrat	0	0	2	3.1	2	2.2
Snowshoe hare	1	3.4	1	1.6	2	2.2
Microtine	0	0	1	1.6	1	1.1
Red squirrel (*Tamiasciurus hudsonicus*)	0	0	1	1.6	1	1.1
Unidentifiable	0	0	3	4.7	3	3.2
Vegetation	1	3.4	2	3.1	3	3.2
Bird	0	0	1	1.6	1	1.1
Total	29	99.9	64	100.2	93	100.1

Grouped Data for 87 Scats

Food item	Number of items	Percent occurrence
Ungulate	80	86.0
Small mammals	6	6.5
Other	7	7.5
Total	93	100.0

Table 22. Incidence of food remains in wolf scats collected at the main Mendeltna wolf den occupied during late spring and early summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 40 adult scats		Items in 72 pup scats		Items in 112 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	0	0	2	2.1	2	1.3
Calf moose	26	44.8	41	42.3	67	43.2
Adult caribou	4	6.9	2	2.1	6	3.9
Calf caribou	8	13.8	9	9.3	17	11.0
Beaver	0	0	2	2.1	2	1.3
Muskrat	1	1.7	5	5.2	6	3.9
Snowshoe hare	5	8.6	4	4.1	9	5.8
Parka squirrel	1	1.7	0	0	1	.6
Microtine	6	10.3	5	5.2	11	7.1
Other	0	0	4	4.1	4	2.6
Vegetation	7	12.1	20	20.6	27	17.4
Unidentifiable	0	0	3	3.1	3	1.9
Total	58	99.9	97	100.2	155	100.0

Grouped Data for 112 Scats

Food item	Number of items	Percent occurrence
Ungulate	92	59.4
Small mammals	29	18.7
Other	34	21.9
Total	155	100.0

Table 23. Incidence of food remains in wolf scats collected at the Kelly Lake rendezvous site occupied by the Mendeltna wolf pack during mid-summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 17 adult scats		Items in 76 pup scats		Items in 93 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	2	9.1	2	2.3	4	3.7
Calf moose	13	59.1	54	62.1	67	61.5
Calf caribou	1	4.5	5	5.7	6	5.5
Beaver	0	0	1	1.1	1	.9
Muskrat	2	9.1	2	2.3	4	3.7
Snowshoe hare	0	0	5	5.7	5	4.6
Microtine	2	9.1	5	5.7	7	6.4
Bird	0	0	2	2.3	2	1.8
Insect	0	0	1	1.1	1	.9
Other	1	4.5	9	10.3	10	9.2
Vegetation	1	4.5	1	1.1	2	1.8
Unidentifiable	0	0	0	0	0	0
Total	22	99.9	87	99.7	109	100.0

Grouped Data for 93 Scats

Food item	Number of items	Percent occurrence
Ungulate	77	70.6
Small mammals	17	15.6
Other	15	13.8
Total	109	100.0

Table 24. Incidence of food remains in wolf scats collected at the Nickolson Lake wolf den used by the Mendeltna wolf pack in late spring and summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 66 adult scats		Items in 20 pup scats		Items in 86 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	12.9	1	4.5	10	10.9
Calf moose	48	68.6	16	72.7	64	69.6
Calf caribou	4	5.7	2	9.1	6	6.5
Muskrat	0	0	1	4.5	1	1.1
Snowshoe hare	3	4.3	1	4.5	4	4.3
Red squirrel	1	1.4	0	0	1	1.1
Wolf	2	2.9	1	4.5	3	3.3
Vegetation	1	1.4	0	0	1	1.1
Unidentifiable	2	2.9	0	0	2	2.2
Total	70	100.1	22	99.8	92	100.1

Grouped Data for 86 Scats

Food item	Number of items	Percent occurrence
Ungulate	80	87.0
Small mammals	6	6.5
Other	6	6.5
Total	92	100.0

Table 25. Incidence of food remains in wolf scats collected at the Nickolson Lake wolf rendezvous site utilized by members of the Mendeltna wolf pack during summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 49 adult scats		Items in 59 pup scats		Items in 108 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	3	4.8	2	2.9	5	3.8
Calf moose	40	64.5	49	70.0	89	67.4
Adult caribou	1	1.6	0	0	1	.8
Calf caribou	1	1.6	4	5.7	5	3.8
Muskrat	2	3.2	1	1.4	3	2.3
Snowshoe hare	1	1.6	1	1.4	2	1.5
Parka squirrel	0	0	1	1.4	1	.8
Microtine	1	1.6	3	4.3	4	3.0
Bird	5	8.1	2	2.9	7	5.3
Vegetation	0	0	4	5.7	4	3.0
Other[1/]	4	6.5	0	0	4	3.0
Unidentifiable	4	6.5	3	4.3	7	5.3
Total	62	100.0	70	100.0	132	100.0

Grouped Data for 108 Scats

Food item	Number of items	Percent occurrence
Ungulate	100	75.8
Small mammals	10	7.6
Other	22	16.7
Total	132	100.1

1/ Includes wolf hair, eggshell.

Moose numbers within this pack area were similar to those in the Ewan and Deep Lake areas. In 1979, only 0.2 moose per mi^2 were observed in the 517 mi^2 (1,339 km^2) moose count area. This moose population appears to be declining still further, since calf:100 cow ratios did not exceed 5 from 1975 through 1978. Reasons for the low calf survival are not known, but in addition to wolf predation and declining range conditions, the area probably supports one of the densest bear populations (both brown and black [*Ursus americanus*]) in GMU 13. Therefore, bear predation is probably a significant contributing factor.

During this study, caribou were rarely available to the St. Anne pack. From 1977 through June 1980, we recorded only three observations of caribou south of the Tazlina River. Small game, however, appeared quite abundant. Based upon observations it appeared that this pack area supported a relatively abundant hare population during the study. Both beaver and muskrat were numerous in ponds and along creeks. Ptarmigan and ground squirrels were numerous in some areas.

Summer food habits, as determined from scats collected at St. Anne den sites from 1975 through 1978, are presented in Tables 26 through 29. During this 4-year period the importance of ungulate food items varied from 25 percent in 1978 to 50 percent in 1977. In all years, calf moose were the predominant ungulate food item. The importance of small mammals and birds to this pack was greater than for any of the other packs studied. Both snowshoe hare and beaver were important summer food items.

As mentioned in the previous section, the St. Anne pack exhibited considerable annual fluctuations in wolf numbers, primarily due to dispersal. Because of the limited availability of ungulate prey and the relatively heavy reliance on small mammals, we suspect that pack size in this area was governed at least partially by prey availability. Similar to the Delta and Ewan packs, which also relied heavily on small mammals, pack numbers appeared to be unstable. It would appear that areas with relatively low moose and caribou populations have a low wolf carrying capacity regardless of the availability of smaller alternate prey.

Sinona Pack - During this study members of the Sinona wolf pack were observed at 40 kills. Moose comprised all but two (95%) of the kills, others were one beaver and one of unidentified species which may also have been a moose. Ages of the 38 identified moose kills were aged as follows: 19 adults, 9 unclassified, 8 calves, and 2 yearlings. Moose were clearly the most important prey species in this area.

Moose were by far the most abundant year-round ungulate species in this area. Moose densities undoubtedly were greater in winter than summer due to seasonal migrations of moose from the upper Gakona River and the eastern Alphabet Hills

Table 26. Incidence of food remains in wolf scats collected at the St. Anne wolf den occupied during late spring and early summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 106 adult scats		Items in 126 pup scats		Items in 232 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	6.0	15	8.3	24	7.3
Calf moose	30	20.0	31	17.2	61	18.5
Beaver	1	.7	8	4.4	9	2.7
Muskrat	5	3.3	5	2.8	10	3.0
Snowshoe hare	92	61.3	103	57.2	195	59.1
Red squirrel	2	1.3	0	0	2	.6
Microtine	3	2.0	13	7.2	16	4.8
Fish	2	1.3	1	.6	3	.9
Bird	6	4.0	1	.6	7	2.1
Vegetation	0	0	3	1.7	3	.9
Total	150	99.9	180	100.0	330	99.9

Grouped Data for 232 Scats

Food item	Number of items	Percent occurrence
Ungulate	85	25.8
Small mammals	232	70.3
Other	13	3.9
Total	330	100.0

Table 27. Incidence of food remains in wolf scats collected at the St. Anne wolf den occupied during late spring and summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 91 adult scats		Items in 85 pup scats		Items in 176 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	6.8	3	3.1	12	5.2
Calf moose	38	28.6	44	44.9	82	35.5
Adult caribou	3	2.3	2	2.0	5	2.2
Calf caribou	5	3.8	7	7.1	12	5.2
Beaver	14	10.5	3	3.1	17	7.4
Muskrat	1	.8	6	6.1	7	3.0
Snowshoe hare	42	31.6	7	7.1	49	21.2
Parka squirrel	1	.8	1	1.0	2	.9
Microtine	9	6.8	3	3.1	12	5.2
Bird	1	.8	0	0	1	.4
Other	4	3.0	7	7.1	11	4.8
Unidentifiable	4	3.0	10	10.2	14	6.1
Vegetation	2	1.5	5	5.1	7	3.0
Total	133	100.3	98	99.9	231	100.1

Grouped Data for 176 Scats

Food item	Number of items	Percent occurrence
Ungulate	111	48.1
Small mammals	87	37.7
Other	33	14.3
Total	231	100.1

Table 28. Incidence of food remains in wolf scats collected at the St. Anne wolf den occupied during late spring and summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 26 adult scats		Items in 23 pup scats		Items in 49 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	2	6.5	0	0	2	3.7
Calf moose	12	38.7	13	56.5	25	46.3
Beaver	8	25.8	4	17.4	12	22.2
Muskrat	1	3.2	1	4.3	2	3.7
Snowshoe hare	5	16.1	3	13.0	8	14.8
Microtine	1	3.2	1	4.3	2	3.7
Unidentifiable	1	3.2	0	0	1	1.9
Other	1	3.2	1	4.3	2	3.7
Total	31	99.9	23	99.8	54	100.0

Grouped Data for 49 Scats

Food item	Number of items	Percent occurrence
Ungulate	27	50.0
Small mammals	24	44.4
Other	3	5.6
Total	54	100.0

Table 29. Incidence of food remains in wolf scats collected at the St. Anne wolf den occupied during late spring and summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 68 adult scats		Items in 62 pup scats		Items in 130 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	3	3.5	0	0	3	1.8
Calf moose	21	24.4	16	20.5	37	22.6
Adult caribou	1	1.2	0	0	1	0.6
Calf caribou	0	0	0	0	0	0
Beaver	23	26.7	12	15.4	35	21.3
Muskrat	7	8.1	10	12.8	17	10.4
Snowshoe hare	16	18.6	14	17.9	30	18.3
Parka squirrel	0	0	0	0	0	0
Red Squirrel	0	0	2	2.6	2	1.2
Microtine	2	2.3	3	3.8	5	3.0
Bird	6	7.0	9	11.5	15	9.1
Fish	0	0	1	1.3	1	0.6
Vegetation	4	4.7	3	3.8	7	4.3
Other	0	0	3	3.8	3	1.8
Unidentifiable	3	3.5	5	6.4	8	4.9
Total	86	100.0	78	99.8	164	99.9

Grouped Data for 130 Scats

Food item	Number of items	Percent occurrence
Ungulate	41	25.0
Small mammals	89	54.3
Other	34	20.7
Total	164	100.0

(VanBallenberghe 1978). Caribou were probably also available on a year-round basis but at very low densities except during caribou migration to and from the Wrangell Mountains each fall and spring. Beaver and muskrat appeared to be fairly abundant in the area, while snowshoe hares were abundant in scattered pockets of habitat in the southern half of the territory.

Summer food habits as determined from scats collected at den and rendezvous sites from 1975 through 1978 are presented in Tables 30 through 35. As suggested by data obtained from aerial observations, moose of all ages were by far the most prevalent food item at all sites and in all years, ranging from 54 to 85 percent occurrence. Calf moose were the most prevalent age class. Beavers were the next most important prey item of this pack.

Susitna Pack - From February 1979 through June 1980, the Susitna pack was observed on 43 kills which were comprised of the following: 16 calf moose, 12 adult moose, 7 adult caribou, 5 unclassified caribou, 1 unclassified moose, 1 bear, and 1 unidentified species. Moose were the most important prey species during both years of study; however, in 1979-80 caribou were more important than in the previous year.

Moose were available to this pack in low numbers on a year-round basis except during winter when large numbers of migratory moose overwintered in the area (Ballard and Taylor 1980). Numbers of moose in relation to the rates of predation by this pack will be discussed further in the Predation Rate section of this report. Caribou were available to this pack primarily during late winter when large numbers wintered on the Lake Louise flats. They were also available during spring and fall migration and during summer in the southwestern extremes of the territory following the calving season. Beaver and muskrat were available during summer but snowshoe hare numbers were low relative to other areas in GMU 13.

No scats were collected at the 1979 den site.

Tolsona Pack - During this study the Tolsona Pack was observed at 29 kills, 48 percent of which were caribou. Moose comprised 41 percent of the total kills (calves 33%), suggesting that the Tolsona pack relied on moose less than most of the other packs studied.

Similar to the Deep Lake territory, the area occupied by this pack from 1977 to early 1979 had one of the lower moose densities in GMU 13: 0.2 moose were observed per mi^2 during 1976 composition counts. Consequently this pack relied to a large extent on prey other than moose. Caribou were undoubtedly the most abundant ungulate during winter when large numbers of caribou wintered on the Lake Louise flats. Beaver and muskrat were available during warmer months in relatively high numbers. Snowshoe hares were also present and probably increased in number after 1977.

Table 30. Incidence of food remains in wolf scats collected 6 September 1975 at the Sinona Creek wolf den occupied in late spring and summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 18 adult scats		Items in 110 pup scats		Items in 128 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	7	31.8	32	27.6	39	28.3
Calf moose	10	45.5	67	57.8	77	55.8
Caribou	0	0	1	0.9	1	0.7
Beaver	3	13.6	10	8.6	13	9.4
Snowshoe hare	1	4.5	1	0.9	2	1.4
Microtine	0	0	1	0.9	1	0.7
Vegetation	0	0	1	0.9	1	0.7
Eggshells	1	4.5	1	0.9	2	1.4
Bird	0	0	1	0.9	1	0.7
Unidentified	0	0	1	0.9	1	0.7
Total	22	99.9	116	100.3	138	99.8

Grouped Data for 128 Scats

Food item	Number of items	Percent occurrence
Ungulate	117	84.2
Small mammals	16	11.5
Other	6	4.3
Total	139	100.0

Table 31. Incidence of food remains in wolf scats collected at the Sinona Creek wolf pack den occupied during late spring and summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 34 adult scats		Items in 79 pup scats		Items in 113 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	5	11.6	14	15.1	19	14.0
Calf moose	19	44.2	47	50.5	66	48.5
Calf caribou	1	2.3	0	0	1	.7
Beaver	5	11.6	5	5.4	10	7.4
Muskrat	1	2.3	5	5.4	6	4.4
Snowshoe hare	4	9.3	1	1.1	5	3.7
Parka squirrel	1	2.3	1	1.1	2	1.5
Microtine	1	2.3	1	1.1	2	1.5
Fox	1	2.3	0	0	1	.7
Unidentifiable	0	0	10	10.8	10	7.4
Vegetation	5	11.6	9	9.7	14	10.3
Total	43	99.8	93	100.2	136	100.1

Grouped Data for 113 Scats

Food item	Number of items	Percent occurrence
Ungulate	86	63.2
Small mammals	25	18.4
Other	25	18.4
Total	136	100.0

Table 32. Incidence of food remains in wolf scats collected at the Sinona Creek wolf pack rendezvous site occupied in 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 17 adult scats		Items in 57 pup scats		Items in 74 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	1	4.8	0	0	1	1.2
Calf moose	16	76.2	47	78.3	63	77.8
Beaver	3	14.3	2	3.3	5	6.2
Muskrat	0	0	3	5.0	3	3.7
Snowshoe hare	0	0	1	1.7	1	1.2
Microtine	0	0	1	1.7	1	1.2
Bird	1	4.8	0	0	1	1.2
Unidentifiable	0	0	3	5.0	3	3.7
Vegetation	0	0	3	5.0	3	3.7
Total	21	100.1	60	100.0	81	99.9

Grouped Data for 74 Scats

Food item	Number of items	Percent occurrence
Ungulate	64	79.0
Small mammals	10	12.3
Other	7	8.6
Total	81	99.9

Table 33. Incidence of food remains in wolf scats collected at a second Sinona Creek wolf pack den site occupied during summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 24 adult scats		Items in 1 pup scats		Items in 25 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	21	84.0	1	100.0	22	84.6
Beaver	1	4.0	0	0	1	3.8
Unidentifiable	3	12.0	0	0	3	11.5
Total	25	100.0	1	100.0	26	99.9

Grouped Data for 25 Scats

Food item	Number of items	Percent occurrence
Ungulate	22	84.6
Small mammals	1	3.8
Other	3	11.5
Total	26	99.9

Table 34. Incidence of food remains in wolf scats collected at the Sinona wolf den occupied in late spring and summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 16 adult scats		Items in 136 pup scats		Items in 152 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	2	10.5	7	4.3	9	4.9
Calf moose	11	57.9	94	57.3	105	57.4
Beaver	3	15.8	20	12.2	23	12.6
Muskrat	1	5.3	10	6.1	11	6.0
Snowshoe hare	0	0	7	4.3	7	3.8
Microtine	1	5.3	1	.6	2	1.1
Bird	0	0	1	.6	1	.5
Porcupine	0	0	1	.6	1	.5
Other	1	5.3	3	1.8	4	2.2
Vegetation	0	0	12	7.3	12	6.6
Unidentifiable	0	0	8	4.9	8	4.4
Total	19	100.1	164	100.0	183	100.0

Grouped Data for 152 Scats

Food item	Number of items	Percent occurrence
Ungulate	114	62.3
Small mammals	43	23.5
Other	26	14.2
Total	183	100.0

Table 35. Incidence of food remains in wolf scats collected at the Sinona wolf den occupied during late spring and summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 54 adult scats		Items in 105 pup scats		Items in 159 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	3	4.3	5	4.2	8	4.3
Calf moose	32	45.7	55	46.6	87	46.3
Adult caribou	1	1.4	0	0	1	0.5
Calf caribou	2	2.9	3	2.5	5	2.7
Beaver	11	15.7	13	11.0	24	12.8
Muskrat	5	7.1	11	9.3	16	8.5
Snowshoe hare	6	8.6	4	3.4	10	5.3
Porcupine (*Erithiazan idorsatum*)	0	0	0	0	0	0
Ground squirrel	0	0	1	0.8	1	0.5
Microtine	0	0	1	0.8	1	0.5
Bird	2	2.9	3	2.5	5	2.7
Insect	0	0	0	0	0	0
Fish	0	0	0	0	0	0
Other	0	0	5	4.2	5	2.7
Vegetation	5	7.1	7	5.9	12	6.4
Unidentifiable	3	4.3	10	8.5	13	6.9
Total	70	100.0	118	99.7	188	100.1

Grouped Data for 159 Scats

Food item	Number of items	Percent occurrence
Ungulate	101	53.7
Small mammals	52	27.7
Other	35	18.6
Total	188	100.0

As would be predicted, scats collected from the den site in 1978 and 1979 suggested that moose, particularly calves, were the most important prey item during summer (Tables 36 and 37). Caribou were also an important food item. Both beaver and snowshoe hare also appeared to be important prey items accounting for 25 percent of identified food remains in 1978 and 10 percent in 1979.

Tyone Pack - From November 1977 through June 1980, members of the Tyone pack were observed on 33 kills. Adult and calf moose were the most important prey items. The observed kills included 14 adult moose, 12 calf moose, 4 of unidentified species, 2 adult caribou and 1 unclassified moose. Because most of our observations were made during winter months when caribou were not available, our aerial observations probably do not accurately reflect the importance of caribou during summer months. Since a majority of the Nelchina caribou herd calves in the Kosina Creek drainages, we suspect that large numbers of caribou become available in mid to late summer following calving.

Moose were available to this pack on a year-round basis, although densities were greater in winter than summer due to the presence of migratory moose from the Maclaren and upper Susitna Rivers (Ballard and Taylor 1980). We suspected that perhaps in response to winter snow conditions, more moose and caribou were available to this pack during winter 1979-80 than during winter 1978-79. Moose densities and pack predation rates will be discussed further in the Predator Rate section of this report.

Although this pack's den site was located in 1979, we were unable to examine it and thus no scat data are available. We suspect that calf moose and caribou comprised the bulk of the diet with small mammals being of secondary importance.

FOOD HABITS SUMMARY

Aerial Observations

Table 38 summarizes the kills at which radio-collared wolves were observed by month of observation from April 1975 through June 1980. Radio-collared wolves were observed at 360 kills, 38 (10.6%) of which were either occupied or had been previously visited by one, or more, brown bear. Adult moose (n = 144) were the most common prey item recorded, comprising 40 percent of the total number of kills. However, heavily consumed yearling moose may have been classified as adults and therefore yearlings are probably underrepresented in the kill data. For purposes of this report we define calves as those individuals born in May or June (assumed birthdate of 1 June) and surviving to 30 May of the following calendar year. In some cases we refer to short yearlings which we define as calves 6 through 12 months of age. Long yearlings are defined as those animals from 13 to 24 months of age. Thereafter they are referred to as adults.

Table 36. Incidence of food remains in wolf scats collected at the Tolsona wolf den occupied during late spring and summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 36 adult scats		Items in 89 pup scats		Items in 125 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	0	0	0	0	0	0
Calf moose	21	50	48	45.7	69	46.9
Adult caribou	0	0	0	0	0	0
Calf caribou	11	26.2	6	5.7	17	11.6
Beaver	7	16.7	24	22.9	31	21.1
Muskrat	0	0	4	3.8	4	2.7
Snowshoe hare	1	2.4	5	4.8	6	4.1
Parka squirrel	0	0	0	0	0	0
Microtine	0	0	6	5.7	6	4.1
Bird	0	0	0	0	0	0
Fish	0	0	0	0	0	0
Vegetation	1	2.4	6	5.7	7	4.8
Unidentifiable	1	2.4	3	2.9	4	2.7
Other	0	0	3	2.9	3	2.0
Total	42	100.1	105	100.1	147	100.0

Grouped Data for 125 Scats

Food item	Number of items	Percent occurrence
Ungulate	86	58.5
Small mammals	47	32.0
Other	14	9.5
Total	147	100.0

Table 37. Summary of incidence of food remains in wolf scats collected at the Tolsona wolf den occupied during late spring and early summer 1979 in GMU 13 of southcentral Alaska.

Food item	Items in 111 adult scats		Items in 37 pup scats		Items in 148 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	9	6.2	2	4.9	11	5.9
Calf moose	54	37.2	26	63.4	80	43.0
Adult caribou	12	8.3	0	0	12	6.5
Calf caribou	29	20.0	6	14.6	35	18.8
Beaver	2	1.4	0	0	2	1.1
Muskrat	4	2.8	0	0	4	2.2
Snowshoe hare	16	11.0	1	2.4	17	9.1
Parka squirrel	0	0	0	0	0	0
Microtine	3	2.1	1	2.4	4	2.2
Other[1/]	8	5.5	4	9.8	12	6.5
Vegetation	5	3.4	1	2.4	6	3.2
Unidentifiable	3	2.1	0	0	3	1.6
Total	145	100.0	41	99.9	186	100.1

Grouped Data for 148 Scats

Food item	Number of items	Percent occurrence
Ungulate	138	74.2
Small mammals	27	14.5
Other	21	11.3
Total	186	100.0

1/ Other includes birds, insects, wolf, red squirrel, unidentified ungulates.

Table 38. Summary by month of prey species discovered while tracking radio-collared wolf packs in GMU 13 of southcentral Alaska from April 1975 through June 1980.

Month of observation	Calf moose		Yearling moose		Adult moose	Unclassified moose	Calf caribou	Adult caribou	Unclassified caribou	Beaver	Misc. prey	Total
	n	Est. age (mos.)	n	Est. age (mos.)								
May	4	0	2	12	8	5	1	2	1	1	2	25
June	6	1	6	13	15	1		1		1	5	35
July	2	2	4	14	13		2	1		2	1	25
August	3	3		15	8	1		5		1	2	20
September	1	4		16	9						3	13
October	1	5	2	17	11	5		2	1			22
November	4	6		18	8	5		6	3		5	31
December	3	7		19	11	3	2		2	1	1	23
January	10	8		20	18			13				41
February	10	9		21	16			4	3	1	4	38
March	13	10		22	14	4		6	2		2	41
April	16	11	1	23	13	2	1	8	4	_	—	45
Total	73		15		144	26	6	48	16	7	25	360
Percent	20.3		4.2		40.0	7.2	1.7	13.3	4.4	1.9	6.9	99.9

Only 5.8 percent of the 360 kills at which radio-collared wolves were observed were calf moose. Short yearling moose, however, comprised 14.2 percent of the kills. Moose of all ages comprised 71.7 percent of the kills. Other prey items, in order of their importance, were adult caribou (13.3%), miscellaneous and unidentified species (6.9%), unclassified caribou (4.4%), beaver (1.9%) and calf caribou (1.7%). Obviously these data underrepresent the importance of small mammals and birds because of the difficulty involved in observing these small carcasses from fixed-wing aircraft. They probably also underrepresent the importance of calf caribou to one or two wolf packs which overlap the Kosina Creek caribou calving grounds because these packs were not intensively studied during the calving season. Also, observability of kills varied seasonally with kills being least observable during summer and most observable during winter.

Wolf kill data obtained from aerial observation were subjected to an analysis of residuals (Everith 1977) to determine which cells of a Chi-square table were significant in rejection of the null hypothesis. Kill data were compared between numbers of adult and calf moose and caribou by month of observation from April 1975 through June 1980. Significant ($P<0.05$) deviations were observed for short yearling moose during April, long yearling moose during June and July, adult moose in January, and adult caribou in December and January. Wolves appeared to select adult moose during most months of the year except during January through July, when short and long yearling moose appeared to comprise a disproportionate percentage of the kill. These particular moose cohorts comprised 12 to 19 percent of the moose counted during November composition counts for 1975 through 1979 when they were 6 months old. However, these cohorts comprised 42 percent (a much larger percent if potential bear kills were excluded) of the moose killed by wolves during this time period when 7 to 14 months of age. We conclude from this analysis that wolves were killing short and long yearling moose from January through July disproportionately to their presence in the moose population. Further, we conclude that, overall, moose of all age classes were the most important prey for wolves in the study areas.

The data presented in Table 38 do not support the hypothesis that wolves were actively selecting newborn moose calves in the Nelchina Basin. Intensive studies of selected wolf packs during late and early summer support this conclusion (Appendix III). However, the results of food habit studies based upon percent occurrence of food items in scat collections at den and rendezvous sites suggest that calf moose were more important.

Scat Analyses--Summer Food Habits

Scat analyses from den and rendezvous sites were pooled for each year of study and are presented in Tables 39 through 42.

Table 39. Summary of incidence of food remains in wolf scats collected at dens and rendezvous sites used during late spring and summer 1975 in GMU 13 of southcentral Alaska.

Food item	Items in 403 adult scats		Items in 1,129 pup scats		Items in 1,532 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	92	18.4	169	13.1	261	14.5
Calf moose	132	26.3	472	36.5	604	33.6
Caribou	22	4.4	58	4.5	80	4.5
Dall sheep	2	.4	6	.5	8	.4
Beaver	50	10.0	187	14.5	237	13.2
Snowshoe hare	158	31.5	281	21.7	439	24.5
Ground squirrel	8	1.6	16	1.2	24	1.3
Red squirrel	2	.4	0	0	2	.1
Muskrat	5	1.0	7	.5	12	.7
Microtine	5	1.0	26	2.0	31	1.7
Other[1/]	20	4.0	32	2.4	52	2.9
Vegetation	3	.6	29	2.2	32	1.8
Unidentifiable	2	.4	11	.9	13	.7
Total	501	100.0	1,294	100.0	1,795	99.9

Grouped Data for 1,532 Scats

Food item	Number of items	Percent occurrence
Ungulate	953	53.1
Small mammals	745	41.5
Other[1/]	97	5.4
Total	1,795	100.0

1/ Includes birds, invertebrates, unidentified, wolf, fish, vegetation.

Table 40. Summary of incidence of food remains in wolf scats collected at wolf den and rendezvous sites used during late spring and summer 1976 in GMU 13 of southcentral Alaska.

Food item	Items in 257 adult scats		Items in 384 pup scats		Items in 641 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	27	8.4	23	5.4	50	6.7
Calf moose	142	44.2	250	59.1	392	52.7
Adult caribou	16	5.0	14	3.3	30	4.0
Calf caribou	24	7.5	30	7.1	54	7.3
Beaver	26	8.1	10	2.4	36	4.8
Muskrat	2	.6	16	3.8	18	2.4
Snowshoe hare	48	15.0	10	2.4	58	7.8
Parka squirrel	2	.6	2	.5	4	.5
Microtine	10	3.1	7	1.7	17	2.3
Other[1/]	7	2.2	8	1.9	16	2.2
Vegetation	9	2.8	24	5.7	33	4.4
Unidentifiable	8	2.5	28	6.6	36	4.8
Total	321	100.0	423	100.1	744	99.9

Grouped Data for 641 Scats

Food item	Number of items	Percent occurrence
Ungulate	526	70.7
Small mammals	133	17.9
Other	85	11.4
Total	744	100.0

[1/] Other includes birds, insects, eggshells, wolf, red squirrel, unidentified ungulates.

Table 41. Summary of incidence of food remains in wolf scats collected at wolf den and rendezvous sites used during late spring and summer 1977 in GMU 13 of southcentral Alaska.

Food item	Items in 214 adult scats		Items in 386 pup scats		Items in 600 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	18	6.9	14	3.0	32	4.4
Calf moose	150	57.3	267	57.5	417	57.4
Adult caribou	5	1.9	2	.4	7	1.0
Calf caribou	14	5.3	20	4.3	34	4.7
Beaver	11	4.2	27	5.8	38	5.2
Muskrat	7	2.7	20	4.3	27	3.7
Snowshoe hare	14	5.3	21	4.5	35	4.8
Parka squirrel	1	.4	1	.2	2	.3
Microtine	11	4.2	15	3.2	26	3.6
Other[1/]	15	5.7	26	5.6	41	5.6
Vegetation	9	3.4	37	8.0	46	6.3
Unidentifiable	7	2.7	14	3.0	21	2.9
Total	262	100.0	464	99.8	726	99.9

Grouped Data for 600 Scats

Food item	Number of items	Percent occurrence
Ungulate	490	67.5
Small mammals	128	17.6
Other	108	14.9
Total	726	100.0

1/ Other includes birds, insects, wolf, red squirrel, unidentified ungulates.

Table 42. Summary of incidence of food remains in wolf scats collected at the den and rendezvous sites occupied during late spring and early summer 1978 in GMU 13 of southcentral Alaska.

Food item	Items in 308 adult scats		Items in 395 pup scats		Items in 703 combined scats	
	No.	% occ.	No.	% occ.	No.	% occ.
Adult moose	34	9.0	8	1.7	42	5.0
Calf moose	170	44.9	224	48.7	394	47.0
Adult caribou	12	3.2	3	0.7	15	1.8
Calf caribou	15	4.0	19	4.1	34	4.1
Beaver	61	16.1	57	12.4	118	14.1
Muskrat	15	4.0	27	5.9	42	5.0
Snowshoe hare	35	9.2	24	5.2	59	7.0
Parka squirrel	0	0	1	0.2	1	0.1
Microtine	4	1.1	12	2.6	16	1.9
Other[1/]	8	2.1	30	6.5	38	4.5
Vegetation	15	4.0	22	4.8	37	4.4
Unidentifiable	10	2.6	33	7.2	43	5.1
Total	379	100.2	460	100.0	839	100.0

Grouped Data for 703 Scats

Food item	Number of items	Percent occurrence
Ungulate	485	57.8
Small mammals	236	28.1
Other	118	14.1
Total	839	100.0

1/ Other includes birds, insects, wolf, red squirrel, unidentified ungulates.

Although no statistical tests were performed it appeared that there were few, if any, differences in the proportions of food items in adult versus pup scats. This suggests that adult wolves were feeding pups the same items they were feeding upon. Therefore, there appears to be no justification for analyzing pup and adult scats separately.

Theberge et al. (1978) determined that the contents of wolf scats collected at rendezvous sites in Alonquin Park, Ontario differed from those collected elsewhere in the park. In that study beaver was a common food item at rendezvous sites suggesting that local resources were being exploited. In areas away from rendezvous sites white-tailed deer (*Odocoileus virginianus*) remains were more common. In this study moose appeared to be the most common food item at both den and rendezvous sites as well as being the most important prey during winter. However, three packs (Delta, Ewan, and St. Anne) did not follow this pattern. In all cases, the ungulate densities in these areas were quite low indicating that dependence on small mammals was of necessity rather than selection. Interestingly, these three packs exhibited more nutritional deficiencies than in any of the other pack areas and also appeared to fluctuate in numbers more drastically, remaining at low numbers for longer periods of time. This indicates that areas with low ungulate density also have a low carrying capacity for wolves regardless of the abundance of small mammals and birds. However, our study did not encompass a period when snowshoe hare numbers were at peak levels over large areas. It is possible that high densities of small mammals under some circumstances could be an important food supplement.

There were differences in the percent occurrence of food items in scats collected at den sites versus rendezvous sites. Three packs had an increasing reliance on calf moose following movement to the rendezvous site. These increases were as follows: Hogan Hill in 1978--56 to 81 percent; Keg Creek in 1975--58 to 73 percent; Mendeltna in 1976--28 to 55 percent and again in 1977--43 to 62 percent; Sinona in 1976--49 to 78 percent. These data may reflect wolf movement into areas of higher ungulate abundance.

Of possible significance, were the differences in food habits from den to rendezvous sites for the Delta and Ewan packs. In 1975 the Delta pack had a decline in use of both calf moose (24 to 10%) and snowshoe hare (41 to 5%) following their movement from den to rendezvous site, but an increase in both beaver (15 to 49%) and squirrel (2 to 23%). In the same year, the Ewan pack exhibited a decline in use of calf moose (21 to 10%) and snowshoe hare (31 to 4%), while beaver remained constant at 33 percent, and the percent of adult moose rose from 7 to 41 percent. These changes in food habits could reflect wolf movement into areas of different prey abundance as well as seasonal differences in availability and/or vulnerability of prey.

A combined summary of food items identified in wolf scats by year of study for all packs and sites is presented in Table 43. During the 5 years of study, 4,290 food items were identified in 3,624 adult and pup wolf scats. The combined results were, in general, similar to most of the analyses for individual packs in that calf moose was the predominant food item comprising 44 percent of the total items. Adult moose, however, ranked only fourth, comprising 9.2 percent. Snowshoe hare and beaver ranked second (14.2%) and third (10.0%), respectively. Adult and calf caribou combined accounted for 7 percent of the total food items. This latter percentage was not surprising, however, because caribou were largely absent from many of the wolf pack territories during late spring and summer.

Perhaps coincidentally, the lowest percent occurrence of calf moose was in 1975 when calf:100 cow ratios were at their lowest level ever recorded in the Basin. To determine if there was a relationship between calf moose abundance and occurrence in wolf scats, we compared annual fall moose count data for the Basin with frequency of occurrence (arcsine square root transformation) of calf moose in wolf scats collected from 1975 through 1979 (Table 43). If wolf predation were a significant factor limiting calf moose survival, we would anticipate an inverse relationship between percent calf moose occurrence and subsequent fall indices of calf abundance. Instead, there appeared to be a positive but nonsignificant relationship ($P>0.05$, D.F. = 3) between calf moose occurrence in scats and moose abundance (calves observed per hr, $r^2 = .46$; calf % of herd, $r^2 = .54$; calves/100 cows, $r^2 = .57$). This relationship was investigated further by pooling den and rendezvous site collections for individual packs each year and then comparing percent calf moose occurrence in scats (Table 44) with calf abundance indices obtained in specific moose count areas where each pack resided. Significant ($P<0.05$) curvilinear relationships existed for percent calf moose occurrence versus calves observed per hour ($y = 2.02X^{2.07}$, $r = .57$), percent calves in herd ($y = -43.13 + 14.49 \ln (X)$, $r = .65$) and calf:100 cow ratios ($y = .01X^{1.87}$, $r = .68$). These analyses suggest that the occurrence of calf moose in scats was related to the number of calves available. Therefore, the number of moose calves eaten, did not determine subsequent calf moose numbers observed in fall. Further, this analysis suggests that wolves were taking calf moose in proportion to their annual abundance rather than continuing to select calves when they were not abundant.

To determine the degree of variability in occurrence of food items in scats for individual packs between years, den and rendezvous site scat data were pooled by pack per year and compared for packs for which more than 1 year of data were available (Table 44). Eventually percentages will be transformed to arcsine square-root percentages and analyzed with analysis of variance for comparison with the analyses presented by Voigt et al. (1976). Our simple comparison suggests that there was considerable variation in the occurrence of food items

Table 43. Summary by year of incidence of food remains in wolf scats collected at wolf den and rendezvous sites from 1975 through 1979 in Game Management Unit 13 of southcentral Alaska.

Food items	1975 1,532 scats		1976 641 scats		1977 600 scats		1978 703 scats		1979 148 scats		Total 3,624 scats	
	Number of items	Percent occurrence	Number of items	Percent occurrence	Number of items	Percent occurrence	Number of items	Percent occurrence	Number of items	Percent occurrence	Number of items	Percent occurrence
Adult moose	261	14.5	50	6.7	32	4.4	42	5.0	11	5.9	396	9.2
Calf moose	604	33.6	392	52.7	417	57.4	394	47.0	80	43.0	1,887	44.0
Adult caribou	--	--	30	4.0	7	1.0	15	1.8	12	6.5	64	1.5
Calf caribou	80[2/]	4.5	54	7.3	34	4.7	34	4.1	35	18.8	237	5.5
Beaver	237	13.2	36	4.8	38	5.2	118	14.1	2	1.1	431	10.0
Muskrat	12	0.7	18	2.4	27	3.7	42	5.0	4	2.2	103	2.4
Snowshoe hare	439	24.5	58	7.8	35	4.8	59	7.0	17	9.1	608	14.2
Parka squirrel	24	1.3	4	.5	2	0.3	1	0.1	0	0	31	0.7
Microtine	31	1.7	17	2.3	26	3.6	16	1.9	4	2.2	94	2.2
Other[1/]	62	3.5	16	2.2	41	5.6	38	4.5	12	6.5	169	3.9
Vegetation	32	1.8	33	4.4	46	6.3	37	4.4	6	3.2	154	3.6
Unidentified	13	0.7	36	4.8	21	2.9	43	5.1	3	1.6	116	2.7
Totals	1,795	100.0	744	99.9	726	99.9	839	100.0	186	100.1	4,290	99.9

1/ Other includes birds, insects, egg shells, wolf, red squirrel, unidentified ungulate.

2/ Adult and calf caribou combined.

Table 44. Comparison between years by individual wolf pack of incidence of food remains in wolf scats collected at dens and rendezvous sites used from 1975 through 1979 in Game Management Unit 13 of southcentral Alaska.

	Hogan Hill				Keg Creek						Mendeltna			
	1975		1978		1975		1976		1978		1976		1977	
	135 scats		244 scats		208 scats		81 scats		45 scats		139 scats		399 scats	
Food items	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.
Adult moose	20	12.6	30	10.3	32	14.2	5	5.9	1	2.0	12	8.0	21	4.3
Calf moose	46	28.9	175	60.1	151	66.8	62	72.9	26	53.1	67	44.7	287	58.8
Adult caribou	--[2]	--	12	4.1	--[2]	--	6	7.1	1	2.0	19	12.7	7	1.4
Calf caribou	22[2]	13.8	3	1.0	1[2]	0.4	5	5.9	9	18.4	36	24.0	34	7.0
Beaver	--	--	27	9.3	8	3.5	2	2.4	1	2.0	1	0.7	3	0.6
Muskrat	--	--	5	1.7	--	--	--	--	0	0	2	1.3	14	2.9
Snowshoe hare	64	40.3	13	4.5	27	11.9	--	--	0	0	3	2.0	20	4.1
Parka squirrel	--	--	0	0	--	--	--	--	0	0	0	0	2	0.4
Microtine	--	--	3	1.0	--	--	--	--	1	2.0	1	0.7	22	4.5
Other[1]	3	1.9	3	1.0	4	1.8	--	--	1	2.0	2	1.3	32	6.6
Vegetation	4	2.5	11	3.8	2	0.9	2	2.4	0	0	4	2.7	34	7.0
Unidentified	--	--	9	3.1	1	0.4	3	3.5	9	18.4	3	2.0	12	2.5
Totals	159	100.0	291	99.9	226	99.9	85	100.1	49	99.9	150	100.1	488	100.1

[1] Other includes birds, insects, egg shells, wolf, red squirrel, unidentified ungulates.
[2] Adult and calf caribou combined.

Table 44 (cont.). Comparison between years by individual wolf pack of incidence of food remains in wolf scats collected at dens and rendezvous sites used from 1975 through 1979 in Game Management Unit 13 of southcentral Alaska.

	Sinona								St. Anne's								Tolsona			
	1975		1976		1977		1978		1975		1976		1977		1978		1978		1979	
	128 scats		212 scats		152 scats		159 scats		232 scats		176 scats		49 scats		130 scats		125 scats		148 scats	
Food items	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ.	% of items	% occ
Adult moose	39	28.3	20	8.2	9	4.9	8	4.3	24	7.3	12	5.2	2	3.7	3	1.8	0	0	11	5.9
Calf moose	77	55.8	151	62.1	105	57.4	87	46.3	61	18.5	82	35.5	25	46.3	37	22.6	69	46.9	80	43.0
Adult caribou	--	--	0	0	0	0	1	0.5	0	0	5	2.2	0	0	1	0.6	0	0	12	6.5
Calf caribou	1[2/]	0.7	1	0.4	0	0	5	2.7	0	0	12	5.2	0	0	0	0	17	11.6	35	18.8
Beaver	13	9.4	16	6.6	23	12.6	24	12.8	9	2.7	17	7.4	12	22.2	35	21.3	31	21.1	2	1.1
Muskrat	--	--	9	3.7	11	6.0	16	8.5	10	3.0	7	3.0	2	3.7	17	10.4	4	2.7	4	2.2
Snowshoe hare	2	1.4	6	2.5	7	3.8	10	5.3	195	59.1	49	21.2	8	14.8	30	18.3	6	4.1	17	9.1
Parka squirrel	--	--	2	0.8	0	0	1	0.5	0	0	2	0.9	0	0	0	0	0	0	0	0
Microtine	1	0.7	3	1.2	2	1.1	1	0.5	16	4.8	12	5.2	2	3.7	5	3.0	6	4.1	4	2.2
Other[1/]	3	2.2	2	0.8	6	3.3	10	5.4	12	3.6	12	5.2	2	3.7	21	12.8	3	2.0	12	6.5
Vegetation	1	0.7	17	7.0	12	6.6	12	6.4	3	0.9	7	3.0	0	0	7	4.3	7	4.8	6	3.2
Unidentified	1	0.7	16	6.6	8	4.4	13	6.9	0	0	14	6.1	1	1.9	8	4.9	4	2.7	3	1.6
Totals	138	99.9	243	99.9	183	100.1	188	100.1	330	99.9	231	100.1	54	100.0	164	100.0	147	100.0	186	100.1

[1/] Other includes birds, insects, egg shells, wolf, red squirrel, unidentified ungulates.
[2/] Adult and calf caribou combined.

for individual packs between years. This appeared to be particularly true for adult and calf moose, adult and calf caribou, beaver and snowshoe hare. Whether these differences were due to shifts in prey distribution or abundance is unknown, but it appears likely.

Floyd et al. (1978) discussed some of the problems associated with using frequency of occurrence of food items as indicators of wolf food habits. Mech (1970) suspected, and Floyd et al. (1978) confirmed, that percent occurrence of small animals was overrepresented in relation to large animals because small animals have a relatively higher surface-volume ratio and are covered with relatively more hair (most predominant identifiers in wolf scats) than large animals. To correct for this discrepancy they determined the relationship between collectable scats and weight of prey consumed for several animal species. The relationship between these two variables allows calculation of kilograms of prey consumed and number of prey eaten as represented by the "collectable" scats.

Data in Table 43 were analyzed using the method derived by Floyd et al. (1978) to provide kilograms of prey consumed and number of individuals consumed per prey species per year (Table 45). To simplify calculations we used number of prey items rather than number of scats. Although this method is less accurate, it purportedly does not produce too great an error (Floyd et al. 1978). Conversion of the scat data to numbers of kilograms consumed indicated that, as Floyd et al. (1978) suggested, small animals were overrepresented when percent occurrence was used. The importance of calf moose, however, changed very little while the importance of adult moose increased substantially.

Mech (cited in Peterson 1977) determined that one Minnesota wolf pack declined after a winter when only 3.0 to 3.4 kg/wolf/day of food was available, increased at 5.8 kg/wolf/day, and remained stable at 3.6 kg/wolf/day. Based upon this Minnesota study, we estimated the number of days that adult wolves from the den and rendezvous sites could be sustained based upon collected scats at the above mentioned consumption rates. We assumed that the packs represented by the scat collections were capable of increasing or at least remaining stable based upon available prey. The number of days that wolves could be sustained based on the scats collected ranged from 46 days, at a consumption rate of 5.8 kg/wolf/day in 1979, to 956 days in 1975, based upon a consumption rate of 3.6 kg/wolf/day. In an effort to determine approximately how many individual days per adult wolf were represented, we divided the total days at each consumption rate per year by the number of adult wolves thought to be present. This analysis indicated that the scats represented from 6 to 17 days of consumption. These figures may be inflated, however, because some wolves are more sedentary than others, particularly mothers of pups (Murie 1944; Theberge et al. 1978; Foster and Ballard unpub. data) and, therefore, scat collections from these sites would be weighted in favor of these sedentary individuals.

Table 45. Summary of estimated numbers of kilograms and individual prey consumed by wolves as determined from wolf scats collected at den and rendezvous sites in Game Management Unit 13 of southcentral Alaska from 1975 through 1979.

Prey	Assumed weight (kg) of prey (X)	Kgs/scat[7] (y)		Number of scat food items					kgs consumed					Number of individuals/ prey species represented				
				1975	1976	1977	1978	1979	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979
			# of packs[8]	10	5	3	5	1	10	5	3	5	1	10	5	3	5	1
			# of adult wolves	55	31	19	25	7	55	31	19	25	7	55	31	19	25	7
			# of pups =	37	29	22	27	9	37	29	22	27	9	37	29	22	27	9
Adult moose	427.5[1]	8.93		261	50	32	42	11	2330.73	446.50	285.76	375.06	98.23	5.5	1.0	0.7	0.9	0.2
Calf moose	39.0[2][3]	1.16		604	392	417	394	80	700.64	454.72	483.72	457.04	92.80	18.0	11.7	12.4	11.7	2.4
Adult caribou	145.0[3]	3.28		-	30	7	15	12	-	98.40	22.96	49.20	39.36	-	0.7	0.2	0.3	0.3
Calf caribou	12.0[4]	.62		80[9]	54	34	34	35	49.6	33.48	21.08	21.88	21.70	4.1	2.79	1.8	1.8	1.8
Beaver	12.5[5]	.63		237	36	38	118	2	149.31	22.68	23.94	74.34	1.26	11.9	1.8	1.9	5.9	0.1
Muskrat	1.4[5]	.41		12	18	27	42	4	4.92	7.38	11.07	17.22	1.64	3.5	5.3	7.9	12.3	1.2
Snowshoe hare	1.8[6]	.42		439	58	35	59	17	184.38	24.36	14.70	24.78	7.14	102.4	13.5	8.2	13.8	4.0
Squirrel	.5[6]	.39		24	4	2	1	0	9.36	1.56	0.78	0.39	0.00	18.7	3.1	1.6	0.8	0.0
Microtine rodent	.1[6]	.38		31	17	26	16	4	11.78	6.46	9.88	6.08	1.52	117.8	64.6	98.8	60.8	15.2
Totals	--	--		1688	659	618	721	165	3440.72	1095.54	873.89	1025.19	263.65	281.9	104.49	133.5	108.2	25.2
Total number days represented based upon 5.8 kg available food/day/adult wolf for population to increase (Mech cited in Peterson 1977)									593.2	188.9	150.1	176.8	45.5					
Number days/wolf represented by consumption rate of 5.8 kg food/day/adult wolf									10.8	6.1	7.9	7.1	6.5					
Total number days represented based upon 3.6 kg available food/day/adult wolf for population to remain stable (from Mech cited in Peterson 1977).									955.8	304.3	242.7	284.8	73.2					
Number days/wolf represented by consumption rate of 3.6 kg food/day/adult wolf									17.4	9.8	12.8	11.4	10.5					

[1] From Franzmann and Bailey 1977.
[2] Weight of 1 month old moose calf computed as follows: newborn weight equals 18.0 kg (from Franzmann et al. 1980) with assumed weight gain of 1.0 kg/day for 21 days equals 39.0 kg.
[3] From Skoog 1968.
[4] From Floyd et al. 1978.
[5] From Burt and Grossenheider 1952.
[6] From Stephenson 1978.
[7] From Floyd et al. 1978 calculated by equation y = 0.38+0.02(x).
[8] Number in some packs in 1975 and 1976 were estimated.
[9] Calf and adult caribou combined.

We used percent kilograms of each prey species consumed as indicated by scat analyses to extrapolate the possible impact of wolf predation on individual prey species in GMU 13. This was done by calculating two estimates for spring GMU 13 wolf population estimates from 1975 through 1979 based upon consumption rates of 3.6 and 5.8 kg of food/wolf/day (Tables 46 and 47). These calculations indicated that at a consumption rate of 5.8 kg/wolf/day from mid-May through mid-July for 1975 through 1979, GMU 13 wolves were annually consuming the following numbers of ungulates: 42 to 132 adult or yearling moose, 434 to 1,013 calf moose, 11 to 59 adult caribou and from 75 to 329 calf caribou. These estimates were considerably lower when the consumption rate of 3.6 kg/wolf/day was used: 23 to 82 adult moose, 270 to 515 calf moose, 7 to 37 adult caribou, and 73 to 204 calf caribou. The implications of these estimates to GMU 13 moose populations will be presented in the section of this report entitled Evaluation of Wolf Predation on Moose.

Age and Condition of Prey

When possible, we examined kills to aid in determining the age, sex and physical condition of prey taken by wolves. During this study we examined 125 moose (Table 48) and 25 caribou (Table 49) which had died of various causes. Portions of the caribou data have been prepared for publication in an article entitled "Surplus Killing of Caribou by Wolves" authored by Sterling Eide and Warren Ballard. A draft copy of the manuscript submitted to the Canadian Field Naturalist is included as Appendix IV. Cause of death of kills examined on the ground were placed into one of five categories: (1) wolf predation, (2) accidental which included road kills, tagging mortalities, nuisance kills, potlatch kills (moose killed for religious purposes) and unknown causes, (3) winter kill (starvation), (4) bear (both brown and black) predation, and (5) unknown species predation.

In an effort to obtain an index of the physical conditon of moose and caribou at the time of death we collected long bones and mandibles (ramuses) at each kill to determine percent fat in bone marrow (Neiland 1970). Mandibles were collected in addition to long bones because at heavily consumed carcasses wolves had frequently chewed the ends of long bones and licked out the bone marrow and/or carried these bones away from the site. At these kills the only remaining items were visceral material, hair, and mandibles. Mandibles contain small volumes of bone marrow and, if found useful for determining percent fat, could greatly increase the sample of condition data on wolf-killed moose. Therefore, we began comparing percent fat of bone marrow between long bones and mandibles to determine what, if any, correlations existed. A preliminary analysis suggests a good correlation between percent fat values obtained from the two bones for adult moose and caribou but not for calf and short yearling moose and caribou. These data will be further analyzed in a future publication. The condition data examined in this report only pertain to percent fat values obtained from long bones (femurs, metatarsals).

Table 46. Estimated number of kilograms of prey consumed by Game Management Unit 13 wolves for a 61 day period ranging from approximately mid-May through mid-July 1975 through 1979 as extrapolated from scat analyses and wolf population estimates.

Prey	Percent kg of prey consumed by wolves according to scat analysis (derived from Table 44)					Estimated kgs prey consumed by GMU 13 wolves at consumption rate of 5.8 kg/day/wolf from approx. 5/1 - 6/30[1]					Estimated kgs prey consumed by GMU 13 wolves at consumption rate of 3.6 kg/day/wolf from approx. 5/1 - 6/30[1]				
	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979	1975	1976	1977	1978	1979
Adult moose	67.7	40.2	32.7	36.6	37.3	56288	38259	19089	15669	17948	34937	23747	11849	9725	11140
Calf moose	20.4	41.5	55.4	44.6	35.2	16961	39496	32340	19093	16937	10528	24515	20074	11851	10513
Adult caribou	--	9.0	2.6	4.8	14.9	--	8566	1518	2055	7169	--	5316	942	1275	4450
Calf caribou	1.4[2]	3.1	2.4	2.1	8.2	1164[2]	2950	1401	899	3946	722[2]	1831	870	558	2449
Beaver	4.3	2.1	2.7	7.3	.5	3575	1999	1576	3125	241	2219	1241	978	1940	149
Muskrat	0.1	.7	1.3	1.7	.6	83	666	759	728	289	52	414	471	452	179
Snowshoe hare	5.4	2.2	1.7	2.4	2.7	4490	2094	992	1027	1299	2787	1300	616	638	806
Squirrel	0.3	.1	0.1	0.03	--	249	95	58	13	--	155	59	36	8	--
Microtine rodents	0.3	.6	1.1	.6	.6	249	571	642	257	289	155	354	399	159	179
Totals	99.9	99.5	100.0	100.1	100.0	83059	94696	58375	42866	48118	51555	58777	36235	26606	29865

[1] Estimated spring GMU 13 wolf population was as follows (see Table 59): 1975 - 235, 1976 - 269, 1977 - 165, 1978 - 121, 1979 - 136.

[2] Adult and calf caribou combined.

Table 47. Estimated number of prey individuals consumed by Game Management 13 wolves for a 61 day period ranging from approximately mid-May through mid-July 1975 through 1979 as extrapolated from wolf scat analysis and wolf population estimates.

Prey	Assumed weight (kg) of prey (from Table 44)	Estimated number of prey consumed by GMU 13 wolves based upon consumption rate of 5.8 kg/wolf/day[1]						Estimated number of prey consumed by GMU 13 wolves based upon consumption rate of 3.6 kg/wolf/day[1]					
		1975	1976	1977	1978	1979	Subtotal	1975	1976	1977	1978	1979	Subtotal
Adult moose	427.5	132	90	45	37	42	346	82	56	28	23	26	215
Calf moose	39.0	435	1013	829	490	434	3201	270	629	515	304	270	1988
Adult caribou	145.0	--	59	11	14	49	133	--	37	7	9	31	84
Calf caribou	12.0	97[2]	246	117	75	329	864	60[2]	153	73	47	204	537
Beaver	12.5	286	160	126	250	19	841	178	99	78	155	12	522
Muskrat	1.4	59	476	542	520	206	1803	37	296	336	323	128	1120
Snowshoe hare	1.8	2494	1163	551	571	722	5501	1548	722	342	354	448	3414
Squirrel	.5	498	190	116	26	--	830	310	118	72	16	--	516
Microtine rodents	.1	2490	5710	6420	2570	2890	20080	1550	3540	3990	1590	1790	12460
Totals		6491	9107	8757	4553	4691	33599	4035	5650	5441	3221	2909	20856

[1] Estimated spring GMU 13 wolf population was as follows: 1975 - 235, 1976 - 269, 1977 - 165, 1978 - 121, 1979 - 136.
[2] Adult and calf caribou combined.

Table 48. Age, sex, condition as determined by percent fat and cause of mortality of moose kills examined from June 1975 through June 1980 in GMU 13 of southcentral Alaska.

Accession #	Age	Sex	Date of collection	Approximate location	Percent fat		Marrow color	Cause of death
					longbone	Ramus		
120000A	11	♀	06/06/75	Hogan Hill	56	--	--	Wolf predation
120000B	Calf	--	11/24/75	Sinona Lodge	--	--	--	Wolf predation
120000C	4	♀	05/05/75	Lake Louise	26	--	--	Wolf predation
120000D	Yearling	♂	06/21/76	Spring Creek	60	--	--	Wolf predation
120001	8	♀	01/03/77	Lower Sinona Ck.	--	--	--	Wolf predation
120002	17	♀	01/03/77	Lower Sinona Ck.	78.0	--	Light pink with red spots	Wolf predation
120003	15	♀	12/09/76	Grayling Lake	45.2	--	--	Wolf predation
120004	18	♀	12/ ?/76	Tonsina River	91.3	--	--	Wolf predation
120005	9	♀	09/25/76	Mendeltna Creek	78.0	--	White	Unknown predation
120006	Adult	♀	12/27/76	Gakona River	46.4	--	White with pink spots	Wolf predation
120007	Yearling	♀	10/29/76	Grayling Lake	43.9	--	Outer - red Inner - white	Wolf predation
120008	15	♀	01/ ?/77	Copper River	75.6	--	Light pink	Winter kill? (legs tucked under body)
120008B	Calf	♀	01/25/77	Marsh Lake	32.6	--	Red - semi gelatinous	Wolf predation
120009	Calf	?	01	Mendeltna	--	--	--	Wolf predation
120010	Calf	?	01/30/77	Gulkana	--	--	--	Road kill
120011	Calf	?	02/08/77	Susitna Lake	--	--	--	Drowned
120012	Calf	♀	02/10/77	Tok Highway	--	10.1	Red - gelatinous	Winter kill
120014	12	♀	02/21/77	Grayling Lake	88.0	--	White	Wolf predation
120015	Calf	?	03/03/77	Susitna River at Jay Creek	74.2	67.6	Red	Wolf Predation
120016	16	♀	02/16/77	Susitna River at Clarence Lake Stream	--	--	Red - gelatinous	Wolf predation
120017	Calf	?	02/16/77	W. Fork Gulkana River	--	--	Red - gelatinous	Wolf predation
120018	Calf	?	03/14/77	W. Fork Gulkana River	--	--	Red - gelatinous	Winter kill
120019A	13	♀	03/21/77	W. Fork Gulkana River	--	--	-	Wolf predation
120019B	Calf	?	03/21/77	W. Fork Gulkana River	--	--	Pink spotted	Wolf predation
120020	Calf	?	04/06/77	Gakona River	--	12.2	Red	Wolf predation
120021	Yearling	♀	04/13/77	Richardson Highway	78.4	66.7	Pink	Road kill
120022	Adult	♀	04/13/77	Edgerton Highway	91.5	--	Light pink	Road kill

Table 48 (cont.).

Accession #	Age	Sex	Date of collection	Approximate location	Percent fat		Marrow color	Cause of death
					longbone	Ramus		
120023	Adult	?	04/13/77	Unknown - Unit 13	90.0	--	Light pink	Poached or road kill
120025	Calf	♀	04/14/77	Richardson Highway	29.9	34.3	Red crystals near wall	Nusiance kill
120026	Yearling	♀	04/28/77	Roundtop Mountain	93.3	--	White	Brown bear predation
120062	Calf	♀	07/25/77	Glenn Highway	65.6	--	Red	Road kill
120085	Yearling	♂	01/17/77	Rat Lake	--	--	White	Wolf predation
120089	Adult	♀	01/26/78	Tok cutoff	97.7 1/	--	Dry cavity	Wolf predation
120090	Calf	?	02/03/77	Gulkana	--	--	--	Wolf predation
120091	Adult	♀	01/22/78	Copper River	--	--	--	Wolf predation
120092	Adult	♀	03/03/78	Richardson Highway	--	--	--	Road kill
120093	Adult-10 yr. tooth wear	♀	04/10/78	W. Fork Gulkana River	83.0	--	Pink	Wolf predation
120094	Calf	♀	04/09/78	W. Fork Gulkana River	17.7	--	Pink	Wolf predation
120095	Calf	♂	04/09/78	Dog Creek	7.0	--	Red	Wolf predation
120096	????	♀	04/10/78	Nickel Creek	84.2	--	Pink	Wolf predation
120097	Calf	♀	04/10/78	Nickel Creek	7.5	--	Red	Wolf predation
120184	Yearling	♀	05/12/78	Simpson Hill	36.5	--		Auto
120194	7	♀	07/17/78	Cat Lake	45.3	--	--	Brown bear predation
120195	Calf		07/17/80	Fish Lake	--	--	--	Brown bear predation
120196	Adult	♀	06/08/77	Middle Lake	8.5	--	Yellow	Black bear predation
120197	2	♀	01/23/79	Nelchina River	78.9	65.3	--	Wolf predation
120198	Yearling	♀	09/05/78	Haggard Creek	89.1	--	Pink	Road kill
120200	9	♂	03/08/79	Mile 17 Tok Road	67.0	32.1	Pink	Road kill
120201	2	♀	03/17/79	Chickaloon River	7.0	--	--	Probable road kill
120202	Yearling	?	03/12/79	Tyone Mountains	89	88.9	Pink	Wolf predation
120203	Adult	?	02/20/79	Dog Lake	96	--	White	Wolf predation
120204	Calf	?	02/22/79	Dog Lake	30	--	Pink	Wolf predation
120205	Calf	?	02/26/79	Lily Lake	--	73.2	Pink	Wolf predation
120206	15	♀	02/27/79	Lily Lake	81.7	73.3	Pink	Wolf predation
120207	Calf	?	02/27/79	Lily Lake	68.4	--	Pink	Wolf predation
120208	14	♀	02/20/79	Tyone-Goose Creek	86.9	78.0	White	Wolf predation
120209	6	♀	02/26/79	Tyone River	--	78.2	Pink	Wolf predation
120210	Calf	?	02/28/79	Oshetna River	56.2	--	Pink	Wolf predation
120211	Calf	?	03/20/79	Tyone River	10.0	--	Red	Wolf predation
120212	Calf	?	02/25/78	Glenn Highway	18.4	8.2	Red	Winter kill
120213	13	♀	03/30/79	Tyone Creek	91.3	68.8	Pink	Wolf predation

Table 48 (cont.).

Accession #	Age	Sex	Date of collection	Approximate location	Percent fat		Marrow color	Cause of death
					longbone	Ramus		
120350	Calf	♀	06/05/79	West Fork Gulkana	25.5	--	Pink	Unknown
120358	Adult	♀	05/17/79	Richardson Highway	85.6	--	Pink	Winter kill
120371	Adult	♀	04/27/79	Sanona Creek	--	--	--	Wolf predation
120372	Adult	♀	10/-/78	West Fork Maclaren R.	91.6	76.5	White	Unknown predation
120373	Adult	?	08/17/79	Twin Lakes	--	--	--	Brown bear predation
120374	Adult	♀	09/23/79	Kenny Lake	--	--	--	Road kill
120409	Calf	♀	12/16/79	Tonsina	11.6	27.7	Pink	Road kill
120601	2	♀	01/28/80	Kenny Lake	90.4	68.1	Pink	Accident
120602	Calf	?	02/21/80	Susitna Lake	24.0		Pink	Wolf predation
120603	Adult calf	?	02/21/80	Oshetna River	46.5	--	Pink	Wolf predation
120604	Calf	?	01/12/80	Sanona Creek	89.7	--	Pink	Wolf predation
120605	Adult		02/20/80	Black River	84.5	61.6	Pink	Wolf predation
120606	Calf	?	02/21/80	Little Nelchina River	53.3	41.0	Pink	Wolf predation
120607	2	?	02/21/80	Old Man Lake	84.1	65.2	Pink	Wolf predation
120608	Calf	?	02/21/80	Little Nelchina River				Wolf predation
120609	10	♀	02/21/80	Grayling Lake	88.1	72.6	Red	Unknown
120610	Adult	♀	02/04/80	Eureka	60.8	--	Pink	Potlach kill
120611	Adult	♀	04/01/80	Kenny Lake	98.1	--	White	Shot
120612	Adult	♀	03/18/80	Tyone Mountains	81.2	--	Pink	Wolf predation
120613	14	♀	03/13/80	Black River	83.7	67.2	White-red	Wolf predation
120614	Calf	?	03/25/80	Squaw Lake	57.1	44.9	Red	Wolf predation
120615	Calf	?	03/26/80	Black River	61.2	60.0	Pink	Wolf predation
120616	12	♀	03/26/80	Oshetna River	87.3	65.8	Pink-red	Wolf predation
120620	Adult	♀	04/22/80	Watana Creek	83.9	54.6	Pink	Tagging
120657	Calf	♀	04/30/80	Glenn Highway	5.9	9.1	Pink	Winter kill
120658	16	♀	03/08/80	Sanona Creek	85.6	77.1	Pink-red	Wolf predation
120659	Calf	♀	03/08/80	Sanona Creek	33.9	--	Pink	Wolf predation
120660	Adult	♀	05/21/80	Glennallen	15.0	--	Pink	Winter kill

Table 48 (cont.).

Accession #	Age	Sex	Date of collection	Approximate location	Percent fat longbone	Percent fat Ramus	Marrow color	Cause of death
120214	Calf	♂	04/02/79	Richardson Highway	10.3	--	Pink	Auto
120215	9	♀	04/01/79	Tolsona Lake	87.2	75.9	Pink	Accident
120216	Adult	♀	03/30/79	Boulder Creek	91.5	--	Pink	Winter kill
120217	Calf	?	03/23/79	Tyone Creek	--	16.8	Pink	Wolf predation
120218	Calf	?	03/25/79	Tyone River	6.9	--	Pink	Wolf predation
120219	Calf	?	03/25/79	Oshetna River	7.6	--	Pink	Wolf predation
120220	2	♀	03/24/79	Brushkana Creek	68.1	45.5	Pink	Prob. wolf predation
120221	Adult	?	03/25/79	Lone Butte	74.1	61.9	Pink	Wolf predation
120222	Calf	?	04/18/79	Tyone Creek	7.5	12.1	Pink	Wolf predation
120239	Calf	♀	03/28/79	Mendeltna	24.6	--	--	Tagging mortality
120270	Calf	♂	03/30/79	Tyone Mountains	15.6	--	Red	Prob. tagging mort.
120277	Calf	♂	03/20/79	Tyone River	--	--	--	Bear predation
120286	Adult	♀	04/14/79	Valdez Creek	8.6	--	Pink	Winter kill
120188	Calf	♀	04/10/79	Glenn Highway	12.8	31.0	Red	Tagging mortality
120289	Calf	♂	04/23/79	Nabesna Road	42.4	17.7	Red	Probable road kill
120292	Calf	♂	05/18/79	Square Lake	21.5	--	Light pink	Winter kill
120309	Adult	?	04/27/79	Oshetna River	--	59.5	White	Wolf predation
120310	14	?	04/27/79	Moore Lake	71.6	26.3	White	Wolf predation
120311	Calf	?	04/27/79	Oshetna River	53.4	60.5	Pink	Wolf predation
120312	Calf	?	04/27/79	Moore Lake	8.1	--	Red	Wolf predation
120313	Calf	?	04/27/79	Tyone Mountains	7.7	--	Red	Winter kill
120314	Calf		04/27/79	Tyone Mountains	7.7	--	Red	Winter kill
120315	Calf	♂	04/27/79	Tyone Mountains	8.1	9.9	Red	Winter kill
120316	Calf		04/27/79	Tyone Mountains	7.6	11.8	Pink	Winter kill
120317	Calf		04/27/79	Moore Lake	9.3	--	Red	Winter kill
120318	2	♀	05/01/79	Richardson Highway	92.6	Pink	White	Unknown
120319	14	♀	04/27/79	Moore Lake	87.7	84.6	White	Wolf predation
120320	Calf	?	04/27/79	Moore Lake	--	--	--	Wolf predation
120321	Calf	♂	04/27/79	Moore Lake	11.4	14.7	Pink	Winter kill
120322	Calf	?	04/27/79	Sanona Creek	28.9	12.9	Red	Winter kill
120323	Calf	?	04/27/79	Tyone Creek	47.1	9.9	Red	Winter kill
120324	Calf	?	04/27/79	Lily Lake	9.0	7.8	Red	Winter kill
120325	Calf		04/27/79	Sanona Creek	31.7	--	Red	Wolf predation
120326	Calf	?	04/28/79	Nickolson Lake	20.4	23.3	Pink	Unidentified predator
120343	Calf	♀	06/08/79	Middle Fork Susitna R.	--	35/3	Pink	Pneumonia
120344	Calf	♂	07/03/79	Susitna River	88.7	--	Pink	Bear predation

Table 49. Age, sex condition as determined by percent marrow fat, and cause of mortality of caribou kills examined in GMU 13 of southcentral Alaska from November 1975 through June 1980.

Accession #	Age	Sex	Date of collection	Approximate location	Percent fat		Marrow color	Cause of death
					longbone	Ramus		
55100A	Adult	♂	11/12/75	Tyone Creek	8	--	--	Wolf predation
55100B	Adult	-	12/05/75	Keg Creek	--	--	--	Wolf predation
55100C	Adult	♀	04/21/76	West Fork Gakona River	8	--	--	Wolf predation
55100D	Adult	♀	05/03/76	Grayling Lake	60	--	--	Wolf predation
55101	Adult	♂	11/03/76	Marie Lake	10.4	--	Red-gelatinous	Possible wolf predation
55102	4-7	♂	01/18/77	Tolsona Creek	81.5	83.8	Pink	Wolf predation
55103	10	♀	01/25/77	Moose Lake	87.5	--	Light pink	Wolf predation
55104	Calf	?	04/08/77	Lake Louise	59.3	--	Red	Winter kill?
55105	9	♀	03/28/79	Nickoli Lake	82.4	67.7	Pink	Wolf predation
55106	10+	♀	04/01/79	Moore Lake	8.6	28.9	Red-pink	Winter kill
55107	3-5	♀	03/31/79	Copper River	86.1	69.4	Pink	Wolf predation
55108	3-5	♀	03/31/79	Copper River	87.6	66.9	Pink	Wolf predation
55109	2+	♀	03/31/79	Copper River	63.1	48.4	Red	Wolf predation
55110	3-5	♀	03/31/79	Copper River	85.7	68.8	Pink	Wolf predation
55111	2+	♀	04/01/79	Copper River	57.3	49.2	Pink	Wolf predation
55112	2+	♀	04/01/79	Copper River	52.2	52.4	Pink	Wolf predation
55113	3-5	♂	04/01/79	Copper River	83.4	66.7	Pink	Wolf predation
55115	6-9	♂	04/18/79	Glenn Highway	79.2	77.1	Pink-white	Wolf predation
55116	Adult	♀	04/23/79	Lake Louise Road	90.4	84.8	Pink	Wolf predation
55117	Old adult	♀	04/30/79	Bell Lake	61.6	40.9	Pink	Wolf predation
55118	Calf	?	04/30/79	Bell Lake	--	36.6	Pink	Wolf predation
55119	Yearling	?	04/?/79	Unit 13	69.5	62.2	Pink	Unknown
55121	Adult	♀	01/27/80	Susitna Lake	90.5	--	Pink	Wolf predation
55122	Calf ?	?	02/03/80	Minnesota Lake	75.6	--	Pink	Wolf predation
55123	Adult	♂	02/21/80	Tolsona Creek	29.4	--	Pink	Wolf predation

The moose carcasses examined (Table 48) consisted of 68 wolf kills, 29 accidental deaths, 19 winter kills, 7 bear kills, and 2 killed by unknown predators. Wolf kills were comprised of 32 calves (27 of unknown sex) and 36 adults. Of the adult moose killed by wolves, 2 were bulls, 27 were cows, and 8 were of unidentified sex. Accidental moose kills included 2 adult bulls, 13 adult cows, 1 adult of unknown sex, 3 bull calves, 7 cow calves, and 3 calves of unknown sex. Winter kills consisted of 5 adult cows and 14 calves, and bear kills were comprised of 4 adults and 3 calves. Two kills were by unknown predator species.

Franzmann and Arneson (1976), on the Kenai Peninsula, found that percent fat varied by month of study because of a lag in deposition and mobilization of marrow fat. High fat values were observed in summer and fall but these values declined as winter progressed, with a definite decrease occurring between December and January. We expected a similar pattern for Nelchina moose so we compared percent marrow fat for calves and adults for the five classified causes of mortality by month of kill. None of these comparisons were significant ($P>0.05$), however, the data did reveal a trend of declining fat as winter progressed and, thus, did not contradict the hypothesis.

Aerial observations during this study and previous studies in GMU 13 (Stephenson and Johnson 1972, 1973) have indicated that wolves were preying upon calf and short yearling moose in excess of their presence in the moose population. Of particular importance, however, was the physical condition of the individual moose wolves were preying upon. If wolves prey upon calves and yearlings in weak physical condition then it might be surmised that these animals would die anyway due to starvation (winter kill). Thus, the impact of wolves on calves and yearlings would be diminished. If, however, they were preying upon healthy calves which could or would otherwise survive, then wolf predation would hamper recruitment into the population and possibly could prevent it from growing.

Marrow fat levels of calf and short yearling moose killed by wolves ($\bar{X}$ = 35.7%) were significantly ($P<0.01$) higher than those dying from accidental causes ($\bar{X}$ = 25.9%). There were also significant differences ($P<0.01$) between marrow fat of winter-killed calves and short yearlings ($\bar{X}$ = 14.8%) and those killed by accidental causes (25.9%). On the Kenai Peninsula, Alaska, Franzmann and Arneson (1976) suggested that marrow fat values below 10 percent were indicative of winter-killed (starved) moose. In this study, six calves dying from starvation had percent fat values in excess of 10 percent (range of 10.1 to 47.1). Perhaps these latter calves died as a result of other complicating factors besides malnutrition. During this study we noted several calf carcasses with malformed (swollen) leg bones in the vicinity of the carpus and tarsus. Unfortunately we were unable to document the occurrence of this abnormality in the moose population nor do we know what influence it may have on a calf's ability to survive.

We were unable to explain the differences in percent fat between accidental and wolf-killed calves. In other studies, there were no apparent differences in marrow fat levels between wolf-caused and accidental deaths among calves (Stephenson and Johnson 1973; Franzmann and Arneson 1976). Perhaps the differences recorded here were attributable in part to sample size, especially because most of the samples of accidentally killed calves were collected in late March and April when percent fat values were declining. Also, it appears possible that the opportunistic manner in which samples of moose killed in accidents were collected may have biased our sample toward moose which may have been close to succumbing to winter kill. There probably are few if any differences between wolf and accidentally killed calves. In any case these comparisons indicate that wolves were preying upon relatively healthy calf and short yearling moose during this study.

In an effort to better assess age and physical status of adult moose taken by wolves, data from this study were combined with those collected from 1970-1972 (Stephenson and Johnson 1972; 1973). In addition, the age composition of wolf-killed adult moose was compared with that of moose live-captured and tagged from 1976 through spring 1980 (Table 50). Wolf-killed adult moose averaged 9.3 years of age (S.D. = 5.4) while tagged moose averaged 7.1 years of age (S.D. = 3.7). Significant differences in age were detected for the following: wolf-killed versus tagged moose ($P<0.005$), wolf-killed versus winter-killed moose ($P<0.10$), wolf versus accidentally killed moose ($P<0.05$), winter versus accidentally killed moose ($P<0.01$), and tagged versus winter-killed moose ($P<0.001$). There was not a significant difference, however, between tagged and accidentally killed moose ($P>0.10$).

Our findings that wolves were preying upon moose which were older than those tagged from 1976-1980 suggest that wolves selected for relatively old adults. This comparison includes wolf kills from the period 1970-72, during which time no moose were tagged. As a result, the comparisons are not directly comparable due to the assumption that the tagged animals also represented the age structure of moose during this earlier period. Therefore, we compared the age structure of tagged moose to wolf kills by individual year from 1976-1980. Significant ($P<0.10$) differences existed for 1976, 1977, and 1980. Sample sizes were too small (df = 3) for 1978; however, no significant differences ($P>0.05$) were evident for 1979. Winter 1978-79 was the second most severe winter in the Nelchina Basin (Eide and Ballard, in review). Thus, during a severe winter wolves preyed upon adult moose of various ages in proportion to their presence in the population, while during mild winters older moose were preyed upon more heavily.

Winters 1970-71, 1971-72 and 1978-79 are considered the most severe winters in the study area in terms of total snowfall and its impact on the moose population (Stephenson and Johnson

Table 50. Summary of average age of adult cow moose suffering mortality in comparison to average age of tagged moose in GMU 13 of southcentral Alaska from 1971 through spring 1980.

	Wolf kills		Accidental kill		Winter kills		Tagged sample	
Year	$\bar{x}$ age	n	$\bar{x}$ age	n	$\bar{x}$ age	n	$\bar{x}$ age	n
1971	6.60	5						
1972	7.75	16	9.67	3	14.50	2		
1975	7.50	2						
1976	11.33	3					6.54	39
1977	13.20	5	1.00	1	15.0	1	6.02	49
1978	10.50	2	1.00	2			9.67	3
1979	9.43	7	5.50	2			8.58	12
1980	14.00	3	2.00	1			8.76	32

1972, 1973; Bishop and Rausch 1974, Ballard et al. 1980). Although we could detect no significant correlations ($P>0.10$) between total snowfall and average age of adult moose preyed upon by wolves, it does appear that during "mild" winters wolves were selecting older moose, whereas during "severe" winters they were preying upon younger moose, indicating that younger moose became more vulnerable to wolf predation because of deep and perhaps crusted snow.

There were no significant ($P>0.05$) differences in mean marrow percent fat of adult moose killed accidentally and those preyed upon by wolves for winters of 1970 through 1980 (Table 51). Winter-killed adult moose had a significantly lower ($P<0.001$) percent marrow fat ($\bar{X}$ = 24.4%) than wolf-killed moose ($\bar{X}$ = 64.3%), while winter-killed adult moose had lower ($P<0.05$) marrow percent fat than did adult moose dying from accidental causes ($\bar{X}$ = 58.1). These data suggest that from 1970 through winter 1979-80, wolves were preying upon moose that were in better physical condition than those dying from winter-kill but similar physical condition to those dying from accidental causes (which were assumed to be in normal physical condition).

Because of small sample sizes it was difficult to make valid comparisons of percent marrow fat levels in different age classes of adult moose killed by wolves. There did not appear to be any relationship between average age of adult moose and average marrow percent fat. Therefore, we conclude that during winter, wolves preyed upon adult, short yearling, and calf moose which were in better condition than those succumbing to winter-kill. During winter, wolves were preying upon calves out of proportion to their presence in the moose population. In severe winters young, relatively healthy adults, were being preyed upon while in relatively mild winters relatively healthy older adults were being killed. The latter classification, except for physical condition, appears to correspond with the traditional predator-prey scheme elaborated upon by Mech (1970). Markgren (1969) suggested that even though twinning rates decline with age, most moose continue producing calves and, therefore, removal of these productive members of the moose population must be of concern to game managers.

Twenty-two of 25 caribou carcasses examined during this study were attributed to wolf predation (Table 49). Two of the remaining kills (one calf and one 10+ yr old cow) were classified as winter kills, and cause of death for one was unknown. Wolf caused mortalities were comprised of 20 adults (6 bulls, 13 cows and 2 of unknown sex) and 2 calves (sex unknown). Ages of adult caribou killed by wolves ranged from 1.5 to 10 or more years. The overall age structure of wolf-killed adults appeared to be fairly low ($\bar{x}$ = 4.91, S.D. = 2.80), however, 7 of these caribou were killed by one wolf pack (Appendix IV) and, therefore, may not be representative of caribou normally preyed upon by wolves.

Table 51. Average bone marrow percent fat of moose kills examined from 1971 through spring 1980 in GMU 13 of southcentral Alaska.[1/]

	Wolf kills		Accidental kill		Winter kills	
Year	$\bar{x}$% fat	n	$\bar{x}$% fat	n	$\bar{x}$% fat	n
1971	81.18	5				
1972	55.39	13	52.60	2	6.78	5
1975	41.00	2				
1976	56.70	4				
1977	66.20	3	64.53	4	42.85	2
1978	57.78	5	62.80	2		
1979	76.40	6	35.83	3	50.05	2
1980	85.53	3	79.45	2		

1/ 1971 and 1972 data from Stephenson and Johnson (1972;1973).

The physical condition of wolf-killed adult caribou as indicated by percent fat marrow was quite variable, ranging from 8 to 80.5 percent but averaging 63.7 (n = 20, S.D. = 28.4). Neiland (pers. comm.) considered caribou with less than 25 percent fat to be in poor physical condition. Based upon that criterion 4 of 20 (20%) of the adult caribou killed by wolves were in poor physical condition (<30% fat). Greer (cited in Franzmann and Arneson 1976) classified elk (*Cervus canadensis*) as in excellent condition when fat exceded 80 percent. Using Greer's general criteria for elk, 11 of 20 (55%) wolf-killed caribou had percent fat in excess of 75 percent and would be considered in good physical condition. The remaining five wolf-killed caribou had fat values varying from 52.2 to 63.1 and averaged 58.8 percent (S.D. = 4.29). The condition of these animals was probably declining as winter progressed.

Because our sample of caribou killed by factors other than wolf predation was so small, it is impossible to compare the physical condition of wolf kills with other mortality factors. It is also difficult to generalize about the condition of caribou taken by wolves during this 5-year study. Fifty-six percent of the wolf-killed caribou were examined during winter 1978-79 which, in terms of total snowfall, was the second most severe winter since 1952. The relatively large number of caribou carcasses examined during that winter reflect the increased vulnerability of caribou due to excessive snow accumulation. Caribou taken by wolves during that severe winter were, for the most part, in relatively good physical condition. Whether caribou taken later in spring 1979 were also in good condition is unknown.

Wolf Predation Rates

We calculated predation rates for selected study packs with which we had the most radio contact (Table 52) by dividing the number of kills we observed into the number of pack days. Fuller and Keith (1980) suggested that this method tends to overestimate the kill rate because wolf packs comprised of less than 12-15 animals (includes nearly all of our packs) often remain at kills longer than 1 day, and, therefore, the chance of locating them at a kill is greater than the actual daily kill.

Nevertheless, the average rate listed in Table 52 provides a fair approximation of the kill rate for a GMU 13 wolf pack. It also reveals the range of predation estimates which can be generated by this method of calculation. According to these data, the year-round kill rate of various packs was from 1 kill/3.1 days to 1 kill/12.7 days and averaged 1 kill/4.9 days. This method of estimating kill rates assumes that all kills were observed. In this study there was large variation in observability by pack area, and for some packs we probably were unable to locate a significant number of ungulate kills. Also it was possible to miss one kill when a pack had two kills but radio-collared wolves were all at one. We

Table 52. Rates of predation of radio-collared wolf packs studied in GMU 13 of southcentral Alaska from April 1975 through June 1980.

Wolf pack	Number pack days	Number of kills observed	Days/kill
Brushkana	34	5	6.8
Butte Lake	31	5	6.2
Deadman	38	3	12.7
Deep Lake	145	23	6.3
Ewan	151	18	8.4
Hogan Hill	176	39	4.5
Jay Creek	43	10	4.3
Keg Creek	240	28	8.6
Maclaren River	52	12	4.3
Mendeltna	128	36	3.6
Middle Fork	27	5	5.4
Saint Anne	76	20	3.8
Sinona	170	40	4.3
Susitna	135	43	3.1
Tolsona	89	29	3.1
Tyone	170	33	5.2
Watana	30	3	10.0
	1735	352	x 4.9

subjectively believe that we missed a significant number of kills for the following packs: Deadman, Ewan, Keg Creek, Middle Fork, and Watana. Also, these estimates include those kills which were also occupied by brown bears (10.6%) and, thus, some of the kills were not made by wolves even though they fed upon them. Further these kill rates include observations of prey species other than ungulates and do not take into account the large variations in individual pack numbers that occurred for some packs.

During late spring and early summer in 1977 and 1978, we intensively monitored three wolf packs (1 in 1977 and 2 in 1978) in an effort to better document food habits and determine predation rates for that season of the year. During this portion of the study we also had an opportunity to witness some interactions between wolves and brown bears. Predation rates and brown bear-wolf interactions for the Mendeltna pack in 1977 and the Hogan Hill pack in 1978 were combined and presented in a paper entitled "Gray Wolf-brown Bear Relationships in the Nelchina Basin of Southcentral Alaska" which was presented by Ballard at the Portland Wolf Symposium in August 1979. A copy of the paper is presented as Appendix III and, therefore, no further discussion of those data are warranted at this point in the report. One pack studied in 1978, which was not reported upon in the aforementioned paper, deserves mention because it provides data on the activity of a single pack member.

Between 29 May and 24 June 1978, the two radio-collared members (#'s 009 and 204) of the Deep Lake pack were monitored either once or twice daily. From 30 May through 24 June wolf number 009 (3- or 4-year-old nonbreeding female) was observed traveling the Deep Lake territory alone except on two occasions. During this period she was observed alone at a total of four kills: one calf moose which was also occupied by a brown bear sow with a yearling cub, one adult moose, and two kills which could not be identified. We do not know if this single wolf actually made any of these kills. If we assume that she did, the indicated rate of kill would be one every 6.5 days. However, we suspected that she also fed on small mammals and birds and thus this rate may pertain only to ungulates.

During winters 1979 and 1980 we began radio-tracking two to three wolf packs every 2 days in an effort to determine predation rates according to sex, age and number of individuals per pack.

1979 Predation Rate Study

Susitna Pack - From 20 February through 22 April 1979, this pack of two adults and seven pups was observed on 18 kills, 17 of which were made during the study period (Table 53). Kills were comprised entirely of moose: 10 calves, 7 adults, and 1 long yearling. Due to deep snow which provided excellent tracking conditions we were able to back track these wolves to

Table 53. Chronological record of kills made by the Susitna wolf pack in Game Management Unit 13 of southcentral Alaska from 20 February through 22 April 1979.

Date of observation	Time	Kill made	Species and age	Percent consumed	Estimated date of kill or comments
2/20/79	2:30 p.m.	Yes	Moose - adult	100%	2/19/79
2/22/79	9:30 a.m.	Yes	Moose - calf	100%	2/21/79
2/24/79	10:00 a.m.	Yes	Moose - calf	100%	2/23/79
2/26/79	8:20 a.m.	Yes	Moose - calf	100%	2/25/79
2/27/79	12:30 p.m.	Yes	Moose - adult cow Moose - calf	10-20%	2/27/79
2/28/79	11:40 a.m.	No	-- --	still on 2/27 kills	
3/02/79	9:00 a.m.	No	-- --	close to 2/27 kills	
3/05/79	8:45 a.m.	No			
3/07/79	11:30 a.m.	Yes	Moose - calf	95-100%	3/06/79
3/09/79	3:15 p.m.	Yes	Moose - adult	90-100%	
3/12/79	1:50 p.m.	Yes	Moose - adult	85-95%	3/11/79
3/14/79	4:30 p.m.	No			
3/16/79	1:50 p.m.	No			
3/18/79	4:00 p.m.	No			
3/20/79	2:45 p.m.	Yes	Moose - calf	100%	3/19/79
3/23/79	2:05 p.m.	Yes	Moose - calf	100%	3/23/79 a.m.
3/25/79	9:00 a.m.	Yes	Moose - calf	100%	3/24/79 p.m.
3/27/79	5:45 p.m.	Yes	Moose - adult	75%	3/26/79
3/29/79	8:10 a.m.	No	-- --	still on 3/27 kill	
3/30/79	11:10 a.m.	No	-- --	still on 3/27 kill	
3/31/79	1:15 p.m.	No	-- --	still on 3/27 kill	
4/02/79	12:30 p.m.	Yes	Moose - adult cow Moose - calf	25%	
4/04/79	3:35 p.m.	No	-- --	75% still on 4/2 kills	
4/06/79	10:55 a.m.	No	-- --	100% still on 4/2 kills	
4/08/79	12:00 noon	No	-- --	½ mile from 4/2 kill	
4/10/79	2:30 p.m.	No			
4/12/79	10:00 a.m.	Yes	Moose - adult cow Moose - long yrlg.	30%	4/12/79
4/14/79	5:50 p.m.	No	-- --	60% still on 4/2 kills	
4/16/79	7:05 a.m.	No			
4/18/79	2:30 p.m.	No	-- --	traveling SW - 2 mi. from den	
4/20/79	8:20 a.m.	No			
4/22/79	6:50 p.m.	Yes	Moose - calf	assume 75 to 100%?	

their previous locations and, therefore, felt confident that no kills were missed. During 62 pack days of observation the kill rate was one per/3.6 days. Calf moose (short yearlings) comprised 55.6 percent of the kills. Of the 17 kills, six were cows with calves or long yearlings. All kills were heavily consumed. Assuming that short yearlings weighed an average of 197.5 kg (from Franzmann and Arneson 1973) and that adults (includes long yearlings) weighed 427.5 kg, and also that 75 percent (Peterson 1977) of the live weight was consumable, then 6.7 kg of food was potentially available to each pack member per day.

Tyone Pack - From 20 February to 24 April 1979, this pack was comprised of an adult female and an adult male. We were able to observe these wolves every other day from 20 February through 14 March and from 18 March through 24 April 1979 (Table 54). These observations represent 58 pack days. During this period we observed eight moose kills, seven of which were made during the study period yielding a kill rate of 1/8.3 days. No cow-calf pairs were killed. In contrast to the Susitna pack, 75 percent of the kills from the Tyone pack were adult moose. Using the same conversion factors used for the Susitna pack to determine kgs of available prey, each adult wolf had 16.4 kgs of food available per day. They did not, however, consume this amount. These wolves lingered around adult moose kills considerably longer than did the Susitna pack and we noticed that scavengers, particularly ravens (on one kill 30 were observed) and wolverines (*Gulo gulo*) were taking advantage of the time required for these two wolves to consume a kill.

1980 Predation Rate Study

Susitna Pack - From 23 January through 27 March 1980, members of the Susitna pack were observed on nine kills (Table 55). These data were divided into two periods because of changes in pack numbers described in the pack history section. The first period extended from 23 January through 12 February 1980 during which time the pack numbered seven (3 adults, 2 yearlings, and 2 pups). During this interval they preyed upon four caribou and one adult moose for a kill rate of 1/4.2 days. Caribou comprised 80 percent of the kills in 1980 while in 1979, all of the observed prey were moose. Differences appeared to be related to the availability of prey because in 1979 few, if any, caribou were available to this pack while in 1980 relatively large numbers of caribou overwintered in this pack's area.

In 1980, changes in prey availability and abundance and perhaps in pack numbers also appeared to alter the movement patterns of this pack compared to 1979. In 1979, they had frequented the drainages of the Tyone River while in 1980 they occupied the area near Susitna Lake. Based upon the kills observed during this time, this pack of seven wolves had 5.3 kg of available food/wolf/day.

Table 54. Chronological summary of kills the Tyone wolf pack were observed at from 20 February through 24 April 1979 in Game Management Unit 13 of southcentral Alaska.

Date of observation	Time	Kill made	Species and age	Percent consumed	Estimated date of kill or comments
2/20/79	1:00 p.m.	Yes	Moose - adult	50%	2/19/79(est.)
2/22/79	12:00 noon	No			
2/24/79	10:03 a.m.	No	-- --		little movement since 2/22 observation
2/26/79	9:15 a.m.	Yes	Moose - adult	10%	2/25/79(est.)
2/28/79	1:45 p.m.	Yes	Moose - calf	75%	2/27/79(est.)
3/02/79	10:30 a.m.(est.)	No			
3/05/79	9:45 a.m.	No			
3/07/79	11:50 a.m.	No			
3/09/79	3:50 p.m.	Yes	Moose - calf	50%	3/8/79 late or 3/9/79 early
3/12/79	3:30 p.m.	No			
3/14/79	5:00 p.m.	No			
3/16/79	No observation due to poor weather				
3/18/79	4:35 p.m.	Yes	Moose - adult	10%	morning of 3/18
3/20/79	3:05 p.m.	No	-- --	50%	still on 3/18 kill
3/23/79	2:25 p.m.	No	-- --		tracks lead by old kill of 2/20/79
3/25/79	No observation due to wolf collaring operation				
3/27/79	6:15 p.m.	No			
3/29/79	8:35 a.m.	No			have been visiting very old moose kill on ridge top
3/31/79	1:05 p.m.	No			still on 3/29 location
4/02/79	12:05 p.m.	No			observed digging den
4/04/79	4:00 p.m.	No			observed at old moose kill site of 2/28/79
4/06/79	11:10 a.m.	No			still at old kill site of 2/28/79
4/08/79	1:00 p.m.	Yes	Moose - adult	40%	4/7/79(est.)
4/10/79	3:00 p.m.	No		80%	still at 4/8/79 location
4/12/79	11:00 a.m.	No		90%	still at 4/8/79 location
4/14/79	6:15 p.m.	No		100%	had visited 4/8 kill
4/16/79	7:45 a.m.	No			
4/18/79	3:05 p.m.	No			female observed at den site
4/20/79	7:35 a.m.	No			at kill site of 4/8
4/22/79	6:20 p.m.	Yes	Moose - adult	25%	4/22/79
4/24/79	7:50 a.m.	No			had visited 4/22/79 kill

Table 55. Chronological summary of kills at which the Susitna wolf pack was observed from 23 January through 12 February and from 12 March through 27 March 1980 in Game Management Unit 13 of southcentral Alaska[1/].

Date of observation	Time	Kill made	Species and age	Percent consumed	Estimated date of kill or comments
1/23/80	1:00 pm	Yes	Moose - adult	75%	1/22 or 1/23/- 7 wolves
1/25/80	11:08 am	No			
1/27/80	12:23 pm	Yes	Caribou - adult ♀	90%	1/26 - 7 wolves
1/28/80	9:23 am	No			
1/29/80	11:05 am	Yes	Caribou - adult	100%	1/28 - 7 wolves
2/01/80	2:32 pm	No			
2/03/80	12:03 pm	Yes	Caribou - adult	100%	2/2 - 7 wolves
2/05/80	10:30 am	No			
2/07/80	2:48 pm	No			
2/10/80	11:50 pm	No			
2/12/80	2:00 pm	Yes	Caribou - assumed adult	100%	2/11 or 2/12 - 7 wolves
3/12/80	9:35 am	No			- 4 wolves
3/14/80	12:20 pm	Yes	Caribou - adult ♀	90%	3/13 - 4 wolves
3/16/80	12:30 pm	No	-	95%	Still on kill of 3/14 - 4 wolves
3/18/80	10:45 am	No			
3/20/80	10:45 am	Yes	Caribou - adult	100%	3/18 - 4 wolves
3/22/80	3:40 pm	Yes	Moose - assumed calf	100%	3/20 or 3/21 - 4 wolves
3/25/80	11:30 am	Yes	Moose - calf	90%	3/23 or 3/24 - 4 wolves
3/27/80	8:45 am	No			

1/ From 23 January through 12 February 1980, pack was comprised of 3 adults, 2 yearlings and 2 pups while from 12 March through 27 March, pack was comprised of 2 adults, 1 yearling and 1 pup or yearling.

During the second sampling period from 12 March through 27 March 1980, this pack numbered four wolves providing an opportunity to compare kill rates of the pack when at a lower number. Kills were comprised of 1 adult moose, 1 calf moose, and 2 adult caribou which provided 5.7 kgs of available food/wolf/day. The kill rate was 1/4.0 days, which was fairly close to the rate of kill observed when the pack included seven members.

In an effort to determine possible impacts of this wolf pack on moose during early March we conducted a moose survey in this pack area. Four and one-half hours of flight time (0.59 minutes/mi^2) were spent surveying this 462 mi^2 area, and 51 moose were counted: 43 adults and 8 calves (15.7%). The observer subjectively estimated that he may have observed 25 percent of the moose present. Assuming moose were being taken at the rate indicated (caribou comprised 66.7% of kills), this pack killed eight adults and four calves from December through April. These kills represented 19 percent of the adult moose and 50 percent of the calf moose counted in March after most of the predation had occurred. If we assumed the observer had indeed counted only 25 percent of the moose, and if we include the projected kills as part of the base population, the projected predation loss would have been 4 percent of the adult moose and 11 percent of the calf (short yearling) moose in the area. Wolf predation appears to be contributing to high mortality of short yearling moose.

Tyone Pack - During early 1980 weather and tracking conditions were excellent, allowing this pack of two adults and six pups to be monitored during a 54-day period (23 January through 16 March 1980). The pack was observed on 11 kills: 3 adult moose, 7 calf moose, and 1 adult caribou (Table 56). The prey used by this pack was similar to that observed in 1979 when it was comprised of two adults. However, in 1979 calf moose (short yearlings) comprised only 29 percent of the kills while in 1980 they comprised 64 percent of the kill indicating a change in prey selectivity based on pack composition. This pack was observed on a fresh kill at the rate of 1/4.9 days, with an estimated 4.9 kgs of food available/wolf/day.

Similar to that reported for the Susitna pack, we also counted moose in this pack area during early March 1980. Four and one-half hours (0.89 minutes/mi^2) were spent surveying the 302 mi^2 pack area, and 266 moose were counted: 221 adults and 45 calves (17%). The observer subjectively estimated that he had observed 50 percent of the moose present. We extrapolated the observed moose kill rate to the months of December through April which yielded an estimated kill of 8 adult moose and 20 calf moose. These projections comprised 4 percent of the adult moose and 44 percent of the calf moose observed during the survey, which was conducted after most of the predation had occurred. If we assumed the moose survey had only observed 50 percent of the moose and if we include the projected kills as

Table 56. Chronological summary of kills at which the Tyone wolf pack (2 adults, 6 pups) was observed from 23 January through 16 March 1980 in Game Management Unit 13 of southcentral Alaska.

Date of observation	Time	Kill made	Species and age	Percent consumed	Estimated date of kill or comments
1/23/80	11:30 am	No			
1/25/80	10:35 am	Yes	Caribou - adult ♂		
1/27/80	11:51 am	No			
1/29/80	11:25 am	Yes	Moose - calf	95%	1/28
2/01/80	2:06 pm	No			
2/03/80	10:56 am	No			
2/05/80	10:00 am	No			Dug up old kill
2/07/80	3:05 pm	No			Visited caribou kill of 1/25/80
2/09/80	10:50 am	No			Visited old unidentified kill
2/12/80	2:20 pm	Yes	Moose - calf	50-70%	2/11 or 2/12
2/14/80	10:30 am	No		100%	still on kill of 2/12
2/16/80	5:22 pm	No			
2/17/80	1:00 pm	No			
2/18/80	10:10 am	No			
2/20/80	8:50 am	Yes	Moose - adult ♀	75%	2/19
2/22/80		No			
2/24/80	12:00 m	Yes	Moose - calf	60%	2/23/or 2/24
2/25/80	2:30 pm	No		95%	Still on kill of 2/24
2/27/80	9:15 am	No		100%	Still on kill of 2/24
2/29/80		No		100%	Still on kill of 2/24
3/02/80		No		100%	Still on kill of 2/24
3/04/80	10:15 am	No			
	4:30 pm	No			
3/06/80	11:00 am	Yes	Moose - calf	5%	3/6
3/08/80	10:30 am	Yes	Moose - adult ♀	25%	3/8 killed 2 Susitna pack members and consumed
			Moose - calf	<5%	3/8 two ptarmigan
3/09/80	11:45 am	No			Still at kill of 3/8
3/10/80	9:45 am	No			Still at kill of 3/8
3/12/80	10:00 am	No		60%	Still at kill of 3/8
3/14/80	11:00 am	Yes	Moose - adult	60%	3/13
3/16/80	1:00 pm	Yes	Moose - calf		3/16

part of the base population, the percentages would have been 2 percent of the adult moose and 18 percent of the calf (short yearling) moose in the area. In either case, it appears that wolf predation on short yearlings in this area was a significant mortality factor.

Predation Rates Summary

Peterson (1977) suggested that wolf packs preyed upon ungulates at relatively constant rates regardless of differences in pack size. Table 57 summarizes predation statistics acquired from studying the Susitna and Tyone wolf packs in 1979 and 1980. To determine if a relationship existed between pack size and predation rates in the Nelchina Basin, we performed a series of correlation analyses (Snedecor and Cochran 1973). Pack size and kgs of available food/day/pack were not significantly ($P<0.05$, df 4) correlated even though positive relationships ($r^2 = 0.55$) appeared to exist. There was, however, a significant ($P>0.05$) negative relationship between pack size and kgs of available food/wolf/day ($\hat{y} = 18.75 + -6.68 \log X$, $r^2 = 0.72$) indicating that smaller packs have more food available per kill per individual wolf than do larger packs. This relates only to available food, however, and not to actual consumption which at smaller pack sizes must be far less than the amount of food available.

Fig. 5 illustrates the relationship between pack size and predation rates calculated for the Susitna and Tyone pack during winter 1978-79 and 1979-80. Pack size and days/kill were positively correlated ($P<0.05$, $r = 0.83$) suggesting that, for the range of pack sizes studied, large packs were killing moose or caribou more often than were smaller packs. These findings do not necessarily refute those of Peterson (1977) because there may not be differences in predation rates for packs larger than nine individuals, which was the smallest pack studied by Peterson (1977).

Summer Activity Patterns

Data pertaining to summer activity patterns of wolf packs were collected in 1977 and 1978 concurrent with summer predation studies. Wolf observations were classified into five general categories: (1) resting at den, (2) traveling, (3) bedded away from den, (4) at kill site and (5) stalking. The first four categories are self explanatory; we classified an observation as stalking when we subjectively believed there was a relationship between the wolf's presence and the presence of prey.

Tables 58 and 59 summarize the activity patterns of six radio-collared members of the Mendeltna (1977) and Hogan Hill (1978) wolf packs during late May and June of each respective year.

Table 57. Summary of predation statistics derived from intensive radio-monitoring of the Susitna and Tyone wolf packs during winters 1978-79 and 1979-80 in Game Management Unit 13 of southcentral Alaska.

Size of wolf pack	Kgs of available food/day/pack	Kgs of available food/day/pack	Days/ungulate kill
9	60.1	6.7	3.6
8	38.9	4.9	4.9
7	36.9	5.3	4.2
4	22.9	5.7	4.0
2	32.8	16.4	8.3

Figure 5. Relationship of wolf pack size to predation rates of two wolf packs studied during winter 1978-79 and 1979-80 in Game Management Unit 13 of southcentral Alaska.

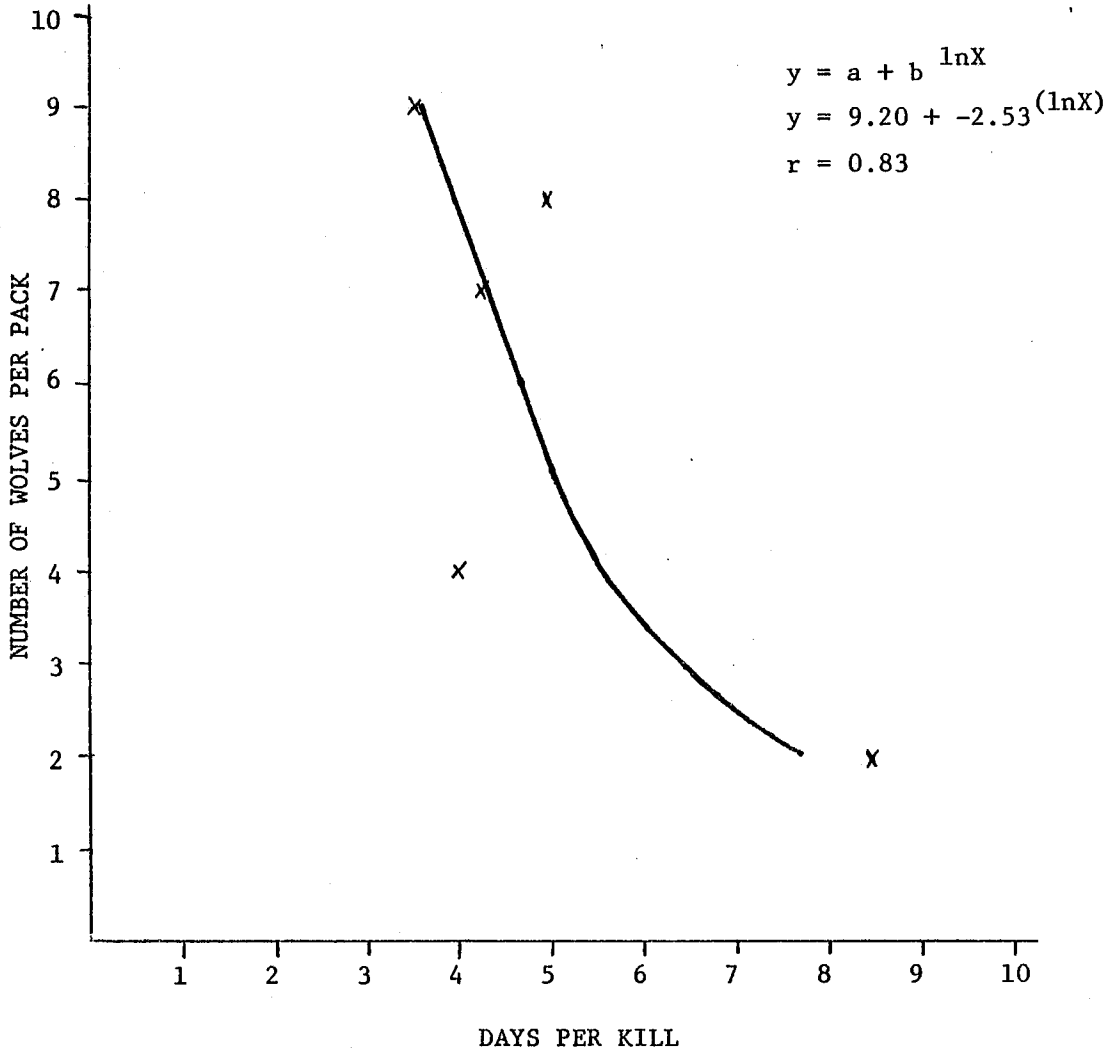


Table 58. Activity and association of three radio-collared members of the Mendeltna pack between late May and July, 1977 in Game Management Unit 13.

Individual wolf	Activity															Not found	Total relocations
	Resting at den or rendezvous site			Traveling			Bedded away from den			At kill site			Stalking				
	0	1	1+	0	1	1+	0	1	1+	0	1	1+	0	1	1+		
Adult ♂ 122083	16	9	7	2	7	10	2	1	--	4	1	7	1	1	3	4	75
Yrl. ♂ 122008	10	8	6	14	4	7	6	2	--	4	--	6	2	--	1	3	73
Yrl. ♀ 122007	60	8	5	2	--	1	--	--	--	1	--	1	--	0	--	0	78
Totals	86	25	18	18	11	18	8	3	--	9	1	14	3	1	4	7	226

Table 59. Activity and association of three radio-collared wolves from the Hogan Hill wolf pack in Game Management Unit 13 which were intensively monitored during late May and June 1978.

Individual wolf	Activity																		Not found	Total
	Resting at den or rendezvous site			Traveling			Bedded away from den			At kill site			Stalking							
Adult gray ♂ 122202	2	3	10	5	--	3	3	1	--	3	--	--	2	2	--				4	38
Yrl. gray ♂ 122205	1	2	12	2	1	2	8	1	--	3	--	--	1	--	--				5	38
Yrl. gray ♀ 122206	4	2	8	5	--	1	8	--	--	1	--	--	--	1	--				8	38
Totals	7	7	30	12	1	6	19	2	0	7	0	0	3	3	0				17	114

During 1977, we located the three Mendeltna wolves (#007, 008 and 083) on 219 (97%) of 226 occasions on which we searched for them. During these 219 observations they were resting at the den or rendezvous site on 129 (59%) occasions. Wolf 007, the dam of one litter of pups, was responsible for 57 percent of the den-rendezvous site radio-locations. The two adult males were located at these sites on 38 percent of the searches. When these wolves were either stalking or at a kill site, they were alone on only 12 (38%) of 32 occasions. We examined the association of male wolves with their kill activities and found that whenever a major kill (calf moose or larger) was made, wolf 083, (believed to be the alpha male), was present alone or in the company of other pack members.

Activity data for the Hogan Hill pack (Table 59) in 1978 revealed a slightly different pattern than that shown for the Mendeltna pack. This may have been due, in part, to the fact that the alpha female of the Hogan Hill pack was not radio-collared. Of the 114 occasions we attempted to locate the three radio-collared Hogan Hill wolves (#202, 205 and 206) we were only able to locate them on 97 (85%) occasions. Of those 97 locations the three wolves were located at the den or rendezvous site on 44 (45%) occasions. These data suggest that the Hogan Hill wolves were more solitary than the Mendeltna wolves when stalking prey or visiting kills. On 10 (77%) of 13 of these occasions the wolves were observed alone. Nevertheless, examination of these data, in relation to kills made, indicates that the adult male (#202) was present on every new kill of calf moose or larger prey. When other radio-collared pack members were observed alone at kills the prey was either a small unidentified kill or a kill previously made by wolf 202 and his associates.

Activity data collected during summer 1977 and 1978 support the conclusion of Theberge et al. (1978) that adult wolf scats collected at den and rendezvous sites are predominantly those of the lactating female. These wolves spend more time at these sites than do other pack members at least until the pups are weaned and moved to rendezvous sites.

Although wolf pack members are more solitary in their hunting habits during summer than in winter, our findings demonstrate the importance of adult males (probably alpha males) in food gathering activities. Adult males were involved in nearly all, if not all, of the major kills made by the pack. Other pack members, particularly yearling wolves, often appeared to be hunting, but rarely were they successful on their own; when they were, the kill was usually a small game species. We recommend that if summer predation data are to be collected, an attempt be made to radio-collar all adult members of each study pack.

GMU 13 Wolf Densities

Spring and fall wolf densities within a portion of GMU 13 were determined from spring 1975 through spring 1980 (Table 60). Density estimates were based on only those wolf packs for which accurate pack numbers were available within the Nelchina study area. Because radio contact with some packs was intermittent, the number of packs from which estimates were derived varied by season. These estimates differ slightly from earlier preliminary estimates given by Stephenson (1978) and Ballard and Spraker (1979) because for this report we used those packs with which we had the most contact during the study period. We believe this method provides a better comparison of the annual fluctuations in density occurring in the Unit.

Wolf densities in GMU 13, excluding the Susitna River study area, varied from 1 wolf/37.6 mi^2 (97.3 km^2) in fall 1975 to 1 wolf/121.7 mi^2 (315.2 km^2) in spring 1978. Spring densities reflected losses due to trapping and hunting, dispersal and natural mortality, while fall densities reflected subsequent pup production and survival and immigration. Both spring and fall densities showed a progressive decline from spring 1975 through spring 1978. The decline could be attributed primarily to hunting and trapping mortality, although natural mortality and dispersal, particularly for the St. Anne pack, also accounted for some of these losses.

From fall 1978 through spring 1980, wolf densities in portions of the Nelchina Study Area increased. The increase was the result of complete or partial closures of some study wolf pack areas to hunting and trapping. Boundaries of the closed areas were described by Eide (1979) and Tobey (1980).

Wolf densities in the Nelchina Study Area from spring 1975 through spring 1980 were used to derive wolf population estimates for GMU 13 (Table 60). Two sets of estimates were made, one for all of Unit 13 excluding the Susitna River study area and the other for wolf habitat only, where glaciers and all areas lying above 4,000 ft (1,219 m) elevation were excluded. We believe the second method provides a more realistic estimate of wolf numbers, since in this region neither wolves nor their prey regularly inhabit areas above 4,000 ft elevation. The main potential problem with this method was that some Dall sheep habitat is excluded from the estimate. Since our observations of study packs where sheep occur indicate that this prey species constitutes a very small percentage of the diet, the resulting error is small. Based upon this latter method the numbers of wolves in GMU 13 during this study have fluctuated from 390 wolves in fall 1975 to a low of 121 wolves in spring 1978. Because the 1979 and 1980 density estimates were partially based upon wolf numbers in protected areas, the resulting estimates were probably inflated and the actual population was undoubtedly lower than reported.

Table 60. Spring and fall wolf numbers from selected study packs utilized to calculate wolf density and population estimates for GMU-13 in Southcentral Alaska from spring 1975 through spring 1980.

Pack Name	Spring 1975	Fall 1975	Spring 1976	Fall 1976	Spring 1977	Fall 1977	Spring 1978	Fall 1978	Spring 1979	Fall 1979	Spring 1980
Deep Lake	?	?	8	5	2	8	3	3	1-2	2	?
Ewan	7	11	5?	5	3	5	3	3?	4	7	?
Hogan Hill	7	9	7	5	5	8	8	12	1?	?	?
Keg Creek	7	13	5	8	1	1	2	8	?	?	?
Mendeltna	?	?	5	9	7	15	0	-	-	-	-
Middle Fork	?	11	9	9	3	3	0	1	?	5	?
Saint Anne	?	11	8	8	8	14	8	7	4	8	2-3
Sinona	7	11	11	20	2	8	4	10	1-2	1-2	4
Susitna	?	?	?	?	?	?	2	10	7	13	4
Tolsona	?	?	?	4?	?	7+	3	10	6-7	16	9
Tyone	?	?	6	6	7-8	12	1	2	2	9	4
Subtotal	28	66	64	79	39	81	34	66	29	62	24
# lone wolves (10%)	3	7	6	8	4	8	3	7	3	6	2
Total	31	73	70	87	43	89	37	73	32	68	26
Sample area Sq. mi. (km^2)	1932 (5004)	2743 (7104)	3818 (9889)	4281 (11088)	3818 (9889)	4281 (11088)	4503 (11663)	4302 (11142)	3455 (8948)	3957 (10249)	2266 (5869)
Sq. mi. (km)/wolf	62.3(161.4)	37.6(97.3)	54.5(141.3)	49.2(127.4)	88.8(230.0)	48.1(124.6)	121.7(315.2)	58.9(152.6)	108.0(279.6)	58.2(150.7)	87.2(225.7)
Population estimate for GMU 13[2/] = 20,978 mi^2 ($54,333 km^2$)	337	558	385	426	236	436	172	356	194	360	241
Population estimate for wolf habitat in GMU 13[2/] 14,666 mi^2 ($37,985 km^2$)	235	390	269	298	165	305	121	249	136	151	168

[1/] Keg Creek pack reduced by experimental removal.
[2/] Excludes 2,800 mi^2 (7,252 km^2) wolf removal area.

Tables 61 through 64 summarize wolf sightings made by the public and Department personnel from 1976 through 1980. Based upon these observations and our radio-telemetry data we had estimated that from 1975 to 1978 between 40 and 50 wolf packs inhabited GMU 13 (Ballard and Spraker 1979). We estimated that by June 1980 between 20 and 30 packs inhabited the Unit.

GMU 13 wolf densities were compared with those reported elsewhere in North America (Table 65). In Alaska, reported wolf densities range from 1 wolf/25 mi^2 in southeast Alaska (Atwell et al. 1963) to 1 wolf/124 mi^2 in the Brooks Range (Stephenson 1975). Unit 13 densities fall in the middle of this range but in 1975 the density was close to that reported on the Kenai Peninsula, Alaska (Peterson 1980). Unit 13 densities fall roughly in the middle of densities reported in North America and appear quite similar to densities reported in other areas of southcentral Alaska (Murie 1944; Rausch 1967).

Trapping and Hunting Mortality

Table 66 summarizes wolf harvests for GMU 13 from the 1971-72 through 1979-80 seasons. During this period annual harvests ranged from 57 to 128 wolves. Method of harvest was classified into four categories: (1) trapped (snared or caught by leg-hold trap), (2) ground shot (which usually involves landing aircraft and shooting same day airborne) (3) experimental removal by ADF&G personnel, which involves shooting from helicopter or fixed-wing aircraft and, (4) other, which includes miscellaneous forms of mortality such as automobile collisions and natural mortality. Aerial hunting was legal only in 1971-72. Any subsequent illegal aerial harvest was lumped with ground shooting.

From 1972 through 1975-76, trapping was the most common method of harvesting wolves in GMU 13, accounting for 59 percent of the total harvest. Beginning with the 1976-77 season, however, ground shooting became the most common method of harvest, accounting for 52 percent.

Harvests for 1977-78 were the highest recorded for GMU 13 since 1968. A portion of the increase was the result of the Department experimental removal program. Most of the increase could be attributed to the increased efficiency of two or three aerial trappers; from 1976 through 1980 their harvest ranged from 12.2 percent to 60.9 percent of the total GMU 13 harvest. Figs. 6 through 9 depict the approximate distribution of the wolf harvests for both GMU 13 and adjacent GMU 11 from 1976-77 through 1979-80. In most cases, the reported kills and public observations of numbers of wolves per pack corresponded with our observations of declines in numbers of wolves in radio-collared packs, indicating that information provided from hunters, trappers, and the general public was generally accurate.

Table 61. Summary of reported Department and public wolf observations within the Nelchina, Susitna and Copper River Basins from 1 July 1976 through 30 June 1977.

Date of observations	Number and type of observations	Location	Source
7/11/76	1 wolf	Clarence Lake	?
7/16/76	1 wolf	Dump at Glenn-Rich	Russel
8/26/76	2 wolves (black-gray)	15 mile Denali Highway	Gardner
8/29/76	2 wolves (white)	Sikonsina Pass	McMahan
8/31/76	1 wolf (gray)	Athna Lodge	Potterville
9/1/76	1 wolf ("dark")	Mile 34 Denali Highway	Johnson
9/76	7 wolves (2 black-5 Gray)	Between Tazlina Lake and Klutina	Ronning
9/76	5 wolves (gray)	Stuver Creek	? (Ellis)
9/5/76	2 wolves (1 black-1 gray)	Opposite Tyone River on west side Sue	Hunter to ADF&G
9/5/76	1 wolf (white)	Chistochina	?
9/5/76	2 wolves (black-gray)	So. fork of Coal Creek	Hunter to ADF&G
9/6/76	12 wolves (1/2 blk-1/2 gray)	Head of Daisy Creek	M. Haggstran
9/10/76	10-15 wolves (hunter got 2-3)	Between Monsoon Lk. & Maclaren	Hunter to ADF&G
9/15/76	1 wolf	Chistochina	?
9/18/76	5-6 (howls)	Between Boulder and Drop Creek	ADF&G
9/26/76	3 wolves (2 black-1 gray)	N. Roundtop Mtn. on gut pile	McMahan
1/8/76	3 tracks	Between Goose Creek and Oshetna	ADF&G
10/8/76	6 tracks	Between Sanona-Oshetna	ADF&G
10/8/76	16 wolves	White River	Vaden
10/17/76	1 wolf (gray)	Tolsona Lake	Roberson
10/21/76	2-4 tracks	Big bend of Maclaren	ADF&G
10/21/76	2 tracks	On Denali between lodge & Clearwater	ADF&G
10/21/76	2-3 tracks	East Fork of Sue	ADF&G
10/21/76	4-6 tracks	7 miles above hwy. to 15 below	ADF&G
10/23/76	2 tracks	Sue River down to bridge	McMahan
10/23/76	1 track	Between lodge and Clearwater	McMahan
10/29/76	1 wolf (gray)	Kelly Lake	ADF&G
10/28/76	9 tracks	Dickey Lake	McMahan
10/30/76	3 tracks	West of Gulkana on pipe	ADF&G
11/2/76	3 tracks (1 wolf taken)	Warm Sp. Camp	ADF&G
11/3/76	1 track on caribou kill	Marie Lake	ADF&G
11/5/76	6 wolves (4 gray-2 black)	3 miles west of K.C. den on West Fork	ADF&G
11/5/76	2 wolves (gray-black)	Across from Maclaren Lake	ADF&G
11/5/76	2 wolves (gray)	2 miles N. of Tyone Butte on Tyone River	ADF&G
11/5/76	3-4 tracks	5-6 mi. below M. Brushkana	ADF&G
11/8/76	1 wolf (gray)	3-4 miles from H. Hill	ADF&G
11/3/76	1 wolf (gray)	Island Lake on caribou kill	ADF&G
11/3/76	1 wolf (gray)	SW of Island Lake on caribou kill	ADF&G
11/13/76	5 tracks	W. Fork to Sourdough	ADF&G

Table 61 (cont.)

Date of observations	Number and type of observations	Location	Source
11/13/76	3 tracks	Little Tonsina	McLaughlin
11/17/76	Fresh caribou kill	Lone Butte Lake	ADF&G
11/14/76	2 wolves (gray 1 small female or pup	Butte Creek	L. Steele
11/23/76	4 tracks (2A-2 pup)	2 mi. S. of Lake Louise	L. Steele
1/2/76	2 tracks	On pipe near Sourdough	ADF&G
10/76 or 12/27/76	6 wolves	Sanford River	ADF&G
12/6/76	6-8 wolves	Lower Tonsina	ADF&G
12/18/76	2 tracks	Chistochina, 2-3 mi. from road	Steele
12/23/76	1 wolf (gray)	Sheep Mountain	Schmidt
1/5/77	1 wolf (gray)	Round Lake	Steele
1/5/77	1 wolf (gray)	N.E. of Round Lake	Steele
1/10/77	3-4 tracks	S. of Ewan Lake & Glenn Hwy.	Hunt
1/10/77	7 tracks	W. Fork Gulkana	Hunt
1/10/77	4-5 tracks	Klutina Lake	Hunt
1/21/77	1 track	Between Sue Lodge-Valdez Creek	Shorty
1/21/77	6-8 tracks	lower Tyone Creek	ADF&G
1/24/77	3 tracks (one trapped and lost)	Fish Lake	D. Hansen
1/24/77	4-5 tracks (one trapped and lost)	Fish Lake	D. Hansen
1/24/77	1 wolf (black)	Simpson Hill	E. McKenzie
3/18/77	15 tracks on moose kill	Tazlina River	H. Billum
3/24/77	12 wolves (gray) on 2 moose kills	Mankomen Lake	C. Farnham
3/77	3-5 tracks	East Fork of Susitna	Hardy
Winter	6-7 tracks	Indian River	C. Farnham
4/5/77	6 wolves on moose kill	Woods Canyon on Copper River	A. Fejes
4/8/77	3 wolves (gray)	Ewan Lake	ADF&G
4/8/77	4 wolves	Ewan Lake	J. Smolen
4/19/77	1+ tracks on caribou kill	South of Lake Louise	ADF&G
4/19/77	4 tracks on caribou kill	Copper Lake, Unit 11	ADF&G
4/25/77	3 tracks on moose kill	Natat Creek on Slana, Unit 11	ADF&G
5/10/77	4 wolves (gray)	5 miles west Mankomen Lake	ADF&G
5/10/77	1+ wolf (gray) on collared moose kill	West of the Copper River near Gulkana Airport	K. Bunch
5/20/77	1 wolf (gray)	West of Sheep Mountain	ADF&G

Table 62. Summary of reported Department and public wolf observations within the Nelchina, Susitna and Copper River Basins from 1 July 1977 through 30 June 1978.

Date of observations	Number and type of observations	Location	Source
8/11/77	4-6 tracks	Dan Creek	R. Johnson
9/1-9/20/77	2 wolves	Lone Butte	ADF&G hunter check station
	1 wolf (gray)	Tanawa Lake	" "
	1 wolf (black)	Little Oshetna River	" "
	7 tracks	Confluence Tyone Creek-River	" "
	7 wolves (all gray)	Goose Creek and Susitna River	" "
	1 track	Middle Fork Chistochina River	" "
	7 wolves	Little Nelchina River	" "
	20 approx. wolves?	Head of Chistochina River	" "
	1 wolf (black)	8-10 miles N. of Eureka	" "
9/1/77	2 wolves (gray)	Swiss Lake	Hunter to R. Halfor
9/1/77	2 wolves (gray)(harvested)	West Fork Susitna River	Hunter to ADF&
9/7/77	1 track	Lower Clearwater Creek	Hunter to ADF&
9/26/77	14 wolves on moose kill	W. bank Big Nelchina River	Northright
10/20/77	6 tracks	Trappers Den Lake	R. Carter
10/24/77	5 tracks	Tyone River above village	ADF&G
10/27/77	2-3 tracks	3 miles S. Sourdough	ADF&G
10/28/77	3-4 tracks	Upper Gakona River	ADF&G
10/28/77	1+ tracks on yearling moose kill with bear and cub	Upper Gakona River	ADF&G
10/28/77	1 track	Mouth Windy Creek	ADF&G
10/30/77	5 tracks	1 mile N. Sourdough	ADF&G
10/31/77	3 tracks	Minnesota Lake	ADF&G
10/31/77	5 tracks	Tyone River	ADF&G
10/31/77	2 tracks	Across from Tyone River	ADF&G
10/31/77	2-5 tracks	East Fork Watana Creek	ADF&G
11/2/77	1+ tracks on caribou kill	South side Ewan Lake	ADF&G
11/3/77	3-4 tracks	Mouth Oshetna River	ADF&G
11/3/77	4 wolves (all grays)	On Susitna River between Jay and Watana Creek	ADF&G
11/3/77	2-4 tracks on moose kill	5 miles So. of confluence of Maclaren and Susitna R. on Sue	ADF&G
11/7/77	2 tracks	5 miles So. of confluence of Maclaren and Susitna R. on Sue	ADF&G
11/9/77	3 tracks	On pipeline at Roundtop Mtn	ADF&G
11/11/77	5 tracks	Meiers Lake	ADF&G
11/15/77	5 wolves (all gray)	On Lake Louise Road	J. Dimarco
11/17/77	4-5 tracks	Between Sourdough and Glennallen	ADF&G
11/22/77	1 wolf	On pipeline W. of Gulkana Airport	R. Armstrong
Early winter	3-5 tracks	Mae West Lake	H. Billum
Early winter	3-5 tracks	Ewan Lake	H. Billum
Early winter	6-7 wolves	Drop Creek to Boulder Creek	McMahan
Early winter	7 wolves	Boulder Creek to Sanford River	McMahan
Early winter	18 wolves	Sanford River to Nadina River	McMahan

Table 62 (cont.)

Date of observations	Number and type of observations	Location	Source
Early winter	12 wolves	Nadina River Chesnina River	McMahan
Early winter	5-6 wolves	Chesnina River to Kuskulana River	McMahan
Early winter	12+ tracks	Gold Creek (Susitna)	ADF&G
Early winter	4 tracks	Upper Talkeetna River	ADF&G
Early winter	5 tracks	Indian River	E. Ross
1/10/78	6 tracks (2 harvested)	Between Butte Creek and Deadman Lake	K. Bunch
1/22/78	8-9 tracks on adult and calf moose kill	Mouth of Gulkana River	ADF&G
1/24/78	7 tracks	Matanuska Glacier	R. Giger
1/27/78	4-6 tracks	Head of Moose Creek	ADF&G
1/27/78	2-4 tracks on moose kill	Maclaren River Bend	ADF&G
1/27/78	4 wolves (all grays)	Lower Watana Creek	ADF&G
2/9/78	3-4 tracks on 2 adult moose kills	On Susitna River near Jay Creek	ADF&G
2/9/78	5 old tracks	Moose Creek (Alphabets)	ADF&G
2/9/78	1-2 tracks	Maclaren River cabin	ADF&G
2/11/78	3 wolves (all grays) on adult moose kill	Jay Creek and Susitna River	ADF&G
2/11/78	1 wolf (gray) and 2 tracks	3 miles up Watana Creek	ADF&G
2/11/78	1-2 track	Kelley	ADF&G
3/7/78	2 tracks	15 miles So. Susitna River Br.	J. Wilson
3/7/78	4-5 tracks	W. Fork Gulkana River	J. Wilson
3/78	2 wolves	Mile 10 Denali Highway	C. Gardner
4/6/78	5 tracks	W. Fork Gulkana River	ADF&G
4/6/78	2 tracks	3 miles So. of Birch Lake	ADF&G

Table 63. Summary of Department and public wolf sightings 1 July 1978 through 30 June 1979 in the Nelchina, Susitna and Copper River Basins of southcentral Alaska.

Date		Location	Sightings by
8/17/78	1 wolf	Crater Lake	Public
8/20/78	2 wolves	Nabesna River	Public
8/23/78	1 wolf	Clarence Lake	Public
8/23/78	10 wolves	Capital Mtn.-Mt. Sanford	Public
9/78	1 black-1 gray	Roundtop Mountain	Public
9/78	17 wolves	Bremner	Public
9/78	6-7 wolves	Daisy Creek	Public
9/78	Tracks of 1	West Fork Susitna	Public
9/78	2 wolves	Monahan Flats	Public
9/2/78	1 black	Twelvemile Creek	Public
9/2/78	1 black-1 gray	Upper Chistochina River	Public
9/1/78	1 set tracks	Big Oshetna River	Public
9/1/78	1 wolf track	West Fork Gulkana	Public
9/1/78	11 wolves	Upper Slana	Public
9/1/78	1 gray	Upper Kuskalana River	Public
9/3/78	1 white	4 mi east Keg Creek	Public
9/5/78	1 black	Upper Twin Lakes	Public
9/6/78	1 wolf	Tyone River	Public
9/10/78	Tracks of 2	Susitna River-Fog Lakes	Public
9/13/78	2 gray	Bone Creek on Slana	Public
9/15/78	Tracks	E. Fork Chistochina River	Public
10/78	1 wolf	Tonsina	Public
11/14/78	4 wolves	Mankomen Lake	ADF&G
11/14/78	Tracks 6-8	East of Hogan Hill	ADF&G
11/15/78	Tracks of 3	Watana-Butte Creek	ADF&G
11/15/78	Tracks 2-4	Tyone-Jay Creek	ADF&G
11/15/78	Tracks of 2?	Upper Clearwater Creek	ADF&G
12/78	12 wolves	Boulder Creek-Copper	Public
12/15/78	Pack of 9-10, 3 taken	Sinona Creek	Public
12/15/78	Pack of 11, 4 left	Fox Lake	Public
12/15/78	Pack of 8 or 9	Sanford River	Public
12/16/78	Tracks of 7	Lower Gulkana	Public
12/21/78	Tracks 3-4	So. Highway-Little Nelchina River	ADF&G
1/2/79	1 black	Richardson Highway	Public
4/2/79	Tracks of 6	Ewan to Crosswinds	Public
4/2/79	1 track	Little Tulsona Creek	ADF&G
5/9/79	1 track	Gulkana	ADF&G

Table 64. Summary of Department and public wolf sightings 1 July 1978 through 30 June 1979 in the Nelchina, Susitna and Copper River Basins of southcentral Alaska.

Date		Location	Sightings by
9/79	5 grays	W. Fork Maclaren River	Public
11/79	6 wolves	Dadina River	Public
12/79	Tracks 2-3	Chistochina River	Public
12/79	5 wolves	Boulder Creek-Copper River	Public
12/1/79	2 wolves tracks of 5	South end Paxson Lake	Public
12/9/79	1 wolf pup	Between Richardson & Gakona River	Public
12/19/79	Tracks 3-4	South of Lake Louise	Public
1/5/80	5 wolves	Mouth Maclaren River	Public
1/6/80	Track 2-3	Gakona River	ADF&G
1/17/80	1 gray	Tolsona	Public
1/20/80	20 wolves-7 caught	Nabesna Glacier	Public
2/80	Tracks of 2+	Barnet Creek	Public
2/10/80	7 grays	West of Fish Lake	ADF&G
2/18/80	Tracks of 10, 4 taken	Mouth Maclaren River	Public
2/18/80	4 wolves	Northeast of Fish Lake	Public
2/18/80	Tracks 4-5	Between Gakona and Gulkana River	Public
2/20/80	1 wolf	Dog Lake	Public
2/25/80	Tracks of 6	5 mi northeast of Bell Lake	Public
3/80	7 wolves	Mouth Watana Creek	Public
3/6/80	4 grays	Susitna River opp. Clarence Lake	ADF&G
3/12/80	7 wolves	Hudson Lake	Public
3/13/80	Tracks 4-6	West Fork Gulkana	ADF&G
5/22/80	2 blacks	East Fork Susitna River	Public
6/80	Tracks of 3	Mouth Gulkana River	Public

Table 65. Summary of reported wolf densities in North America.

Wolf density		Size of study area			
mi^2/wolf	km^2/wolf	mi^2	km^2	Location of study area	Source
3[1]	7.8	30	78	Coronation Isl., Alaska	Merriam 1964
4.6[2]	11.9	210	544	Isle Royale, Michigan	Peterson 1976
6.9[2]	17.9	384	995	NW Territories	Kuyt 1972
7-10[2]	18-26	210	544	Isle Royale, Michigan	Mech 1966
7.8-13.8[2]	20.2-35.7	1,274	3,300	Manitoba-Saskatchewan	Parker 1973
9.2	23.8	717	1,857	Minnesota	VanBallenberghe et al. 1975
10	26	1,000	2,590	Algonquin Park, Ontario	Pimlott et al. 1969
10	26	2,490	6,449	Minnesota	Olson 1938
10.6	27.5	4,203	10,886	Minnesota	Mech 1973
12.9-55.2	33.3-142.9	121-998	313-2584	Beltram, Isl. St. For., Minnesota	Fritts & Mech In Press
17	44	4,100	10,619	Minnesota	Stenlund 1955
24-42	62-109	1,500	3,885	Mt. McKinley Nat. Park Alaska	Haber 1968
25-40	65-104	7,500	19,425	SE Alaska	Atwell et al. 1963
25-29	65-75	1150-1845	2979-4779	Kenai Peninsula, Alaska	Peterson and Wolvington 1978
35	91	7,000	18,130	Tanana Flats, Alaska	Stephenson 1977
37.6-121.7	97-315.2	1932-4503	5004-11663	Nelchina Basin, Alaska	This study
40-83	104-215	--	--	Saskatchewan	Banfield 1951
50	130	2,000	5,180	NcKinley Nat. Park, Alaska	Murie 1944
50	130	20,000	51,800	Nelchina Basin Study area, Alaska	Rausch 1967
58	151	9,653	25,000	NE Alberta	Fuller & Keith 1980
60-120	155-311	48,0000	1,243,200	NW Territories	Kelsall 1957
65-124	168-321	3,600	9,324	NC Brooks Range, Alaska	Stephenson 1975
87-111(10[3])	225-287	4,200	10,878	W. Canada	Cowan 1947
88	228	593	1,536	W. Canada	Carbyn 1974
120	311	1,800	4,662	Baffin Isl., Canada	Clark 1971
200	518	109,000	282,310	Manitoba-Sasketchewan-NW Territories	Parker 1973

[1] Artificial situation - four wolves transplanted to Island.
[2] Wolves concentrated on caribou winter range.
[3] Maximum abundance on winter range.

Table 66. Summary of reported wolf harvests for Game Management Unit 13 of southcentral Alaska by method of take from 1971 through 1979-80 season.

Harvest year	Method of take	GMU 13 Subunits 13A	13B	13C	13D	13E	Subunits unreported	Sub-totals	Totals
1971-72	Trapped							43	
	Ground shot							22	
	Aerial shooting							46	
	Other							0	111
1972-73	Trapped	11	4	20	16	6		57	
	Ground shot	4	4	4	3	4	1	20	
	Other	1	0	2	0	0		3	80
1973-74	Trapped	15	10	8	9	11		53	
	Ground shot	4	4	4	6	4		22	
	Other	0	0	0	0	0		0	75
1974-75	Trapped	25	5	3	21	6		60	
	Ground shot	7	11	3	9	11		41	
	Other	0	1	0	1	0		2	103
1975-76	Trapped	16	9	8	12	3		48	
	Ground shot	7	3	2	9	15		36	
	Exp. removal	6	2	0	0	17		25	
	Other	0	0	1	0	0		1	110
1976-77	Trapped	5	3	9	7	1		25	
	Ground shot	2	9	21	6	11		49	
	Exp. removal	0	14	0	0	10		24	
	Other	1	1	0	1	1		4	102
1977-78	Trapped	8	2	16	20	5		51	
	Ground shot	27	7	20	6	8		68	
	Exp. removal	3	1	0	0	3		7	
	Other	2	0	0	0	0		2	128
1978-79	Trapped	5	2	3	6	4		20	
	Ground shot	0	12	30	4	1		47	
	Exp. removal	1	1	0	0	0		2	
	Other	0	0	0	0	0		0	69
1979-80	Trapped	11	1	10	9	4		35	
	Ground shot	1	3	2	3	11		20	
	Other	2	0	0	0	0		2	57

Figure 6. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1976-77 regulatory year.

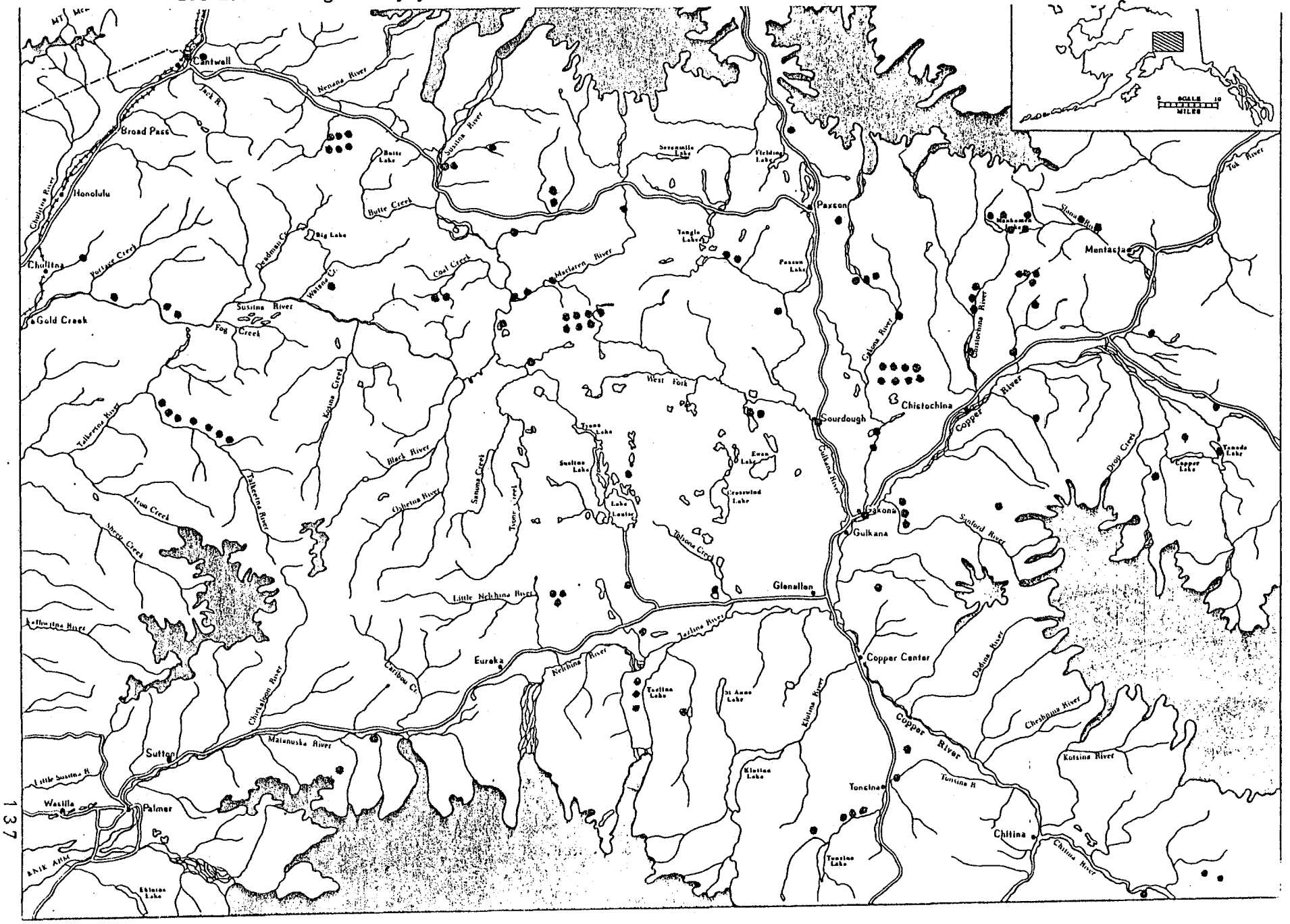


Figure 7. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1977-78 regulatory year.

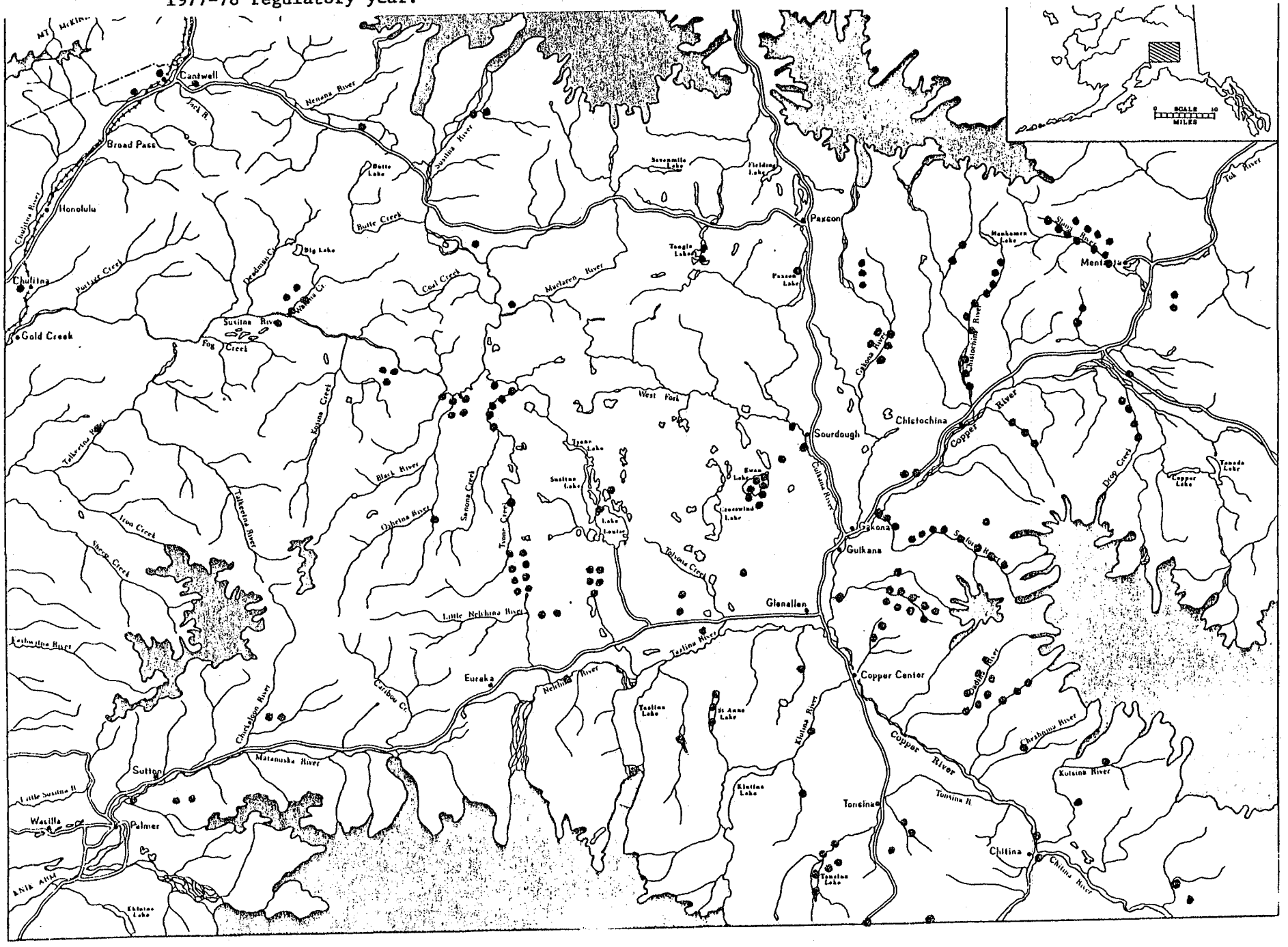


Figure 8. Diagram of hunting-trapping location of wolf harvests in Game Management Units 11 and 13 of Southcentral Alaska for 1978-1979 regulatory year.

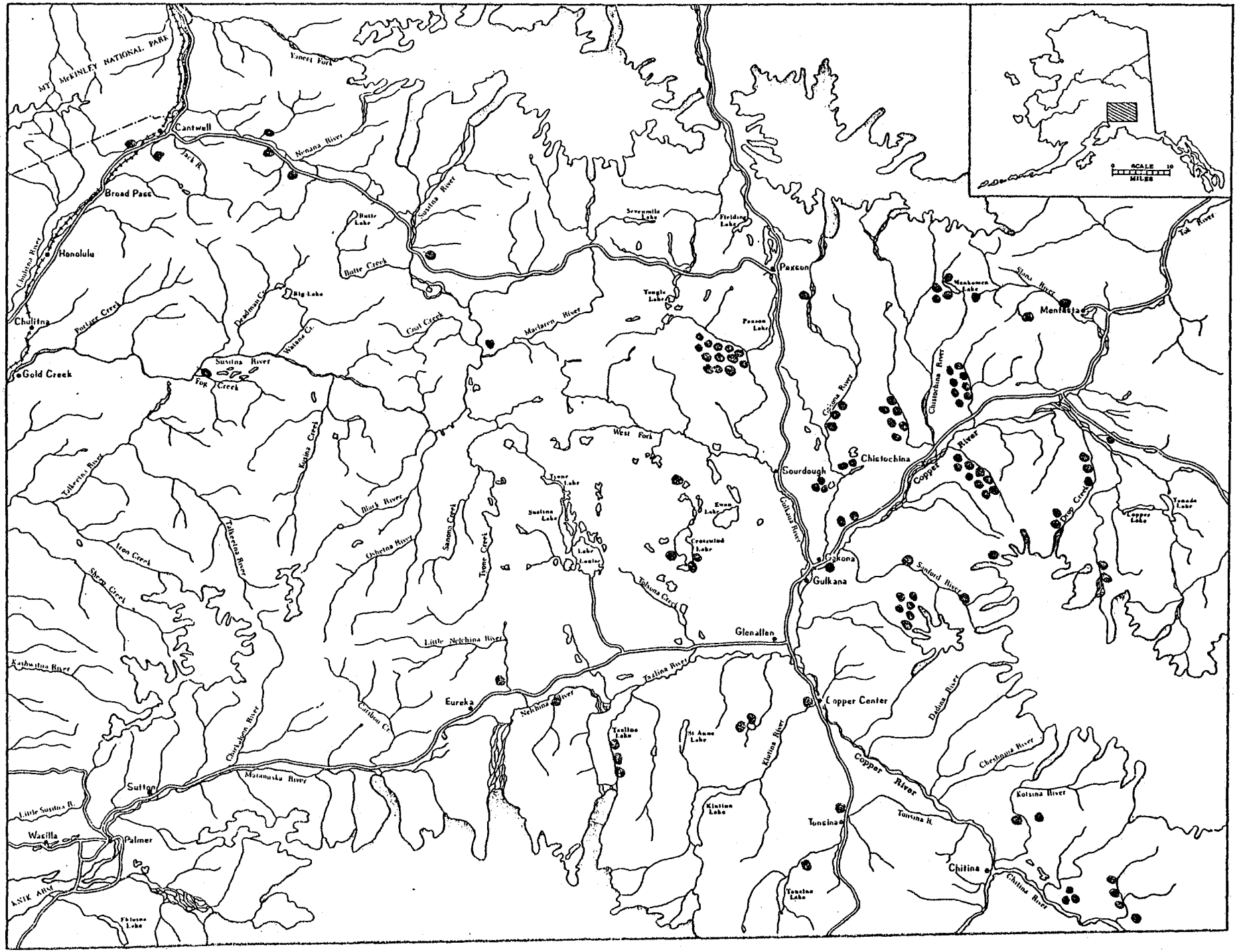
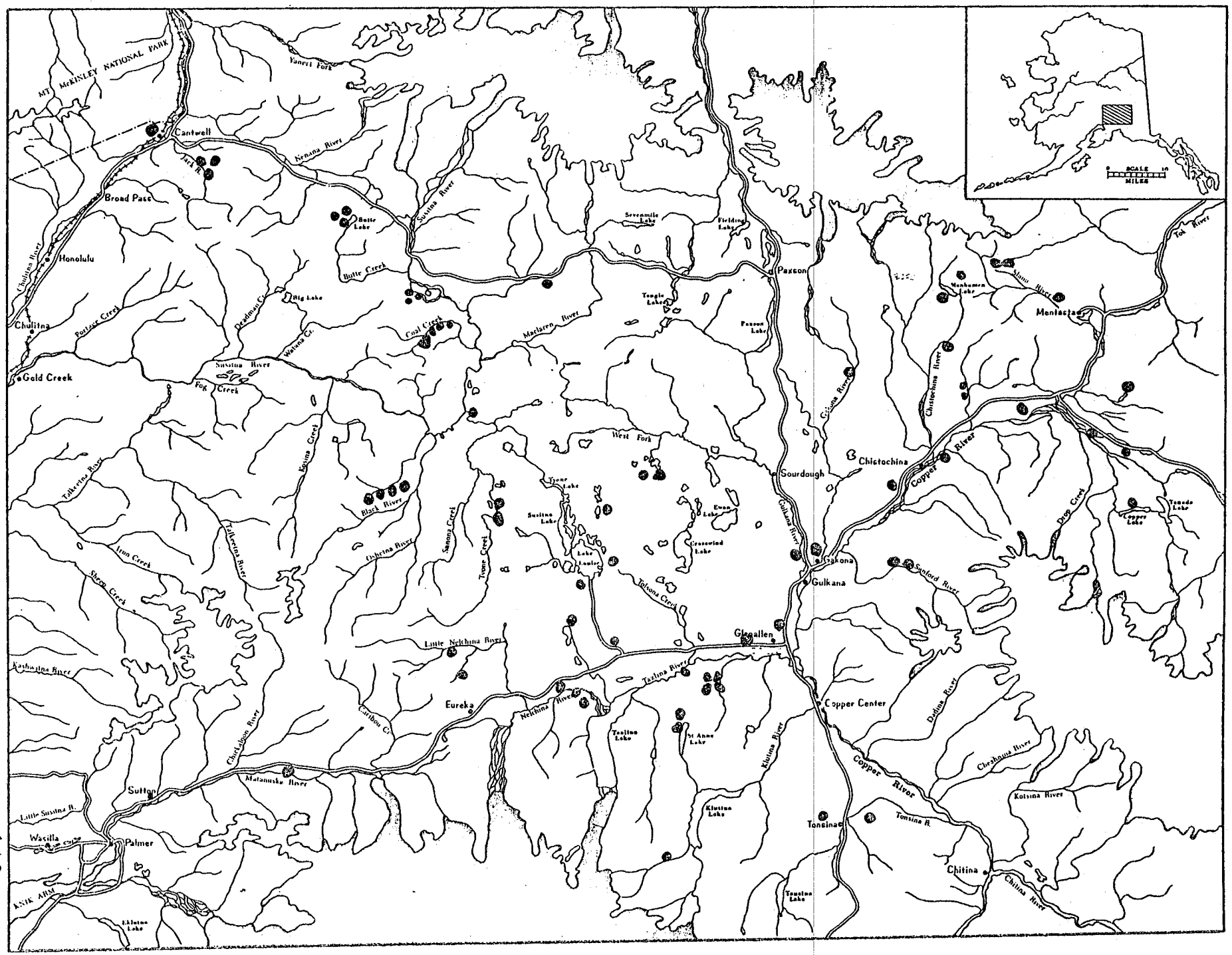


Figure 9. Diagram of hunting-trapping location of wolf harvests in Game Management Units 11 and 13 of Southcentral Alaska for 1979-1980 regulatory year.

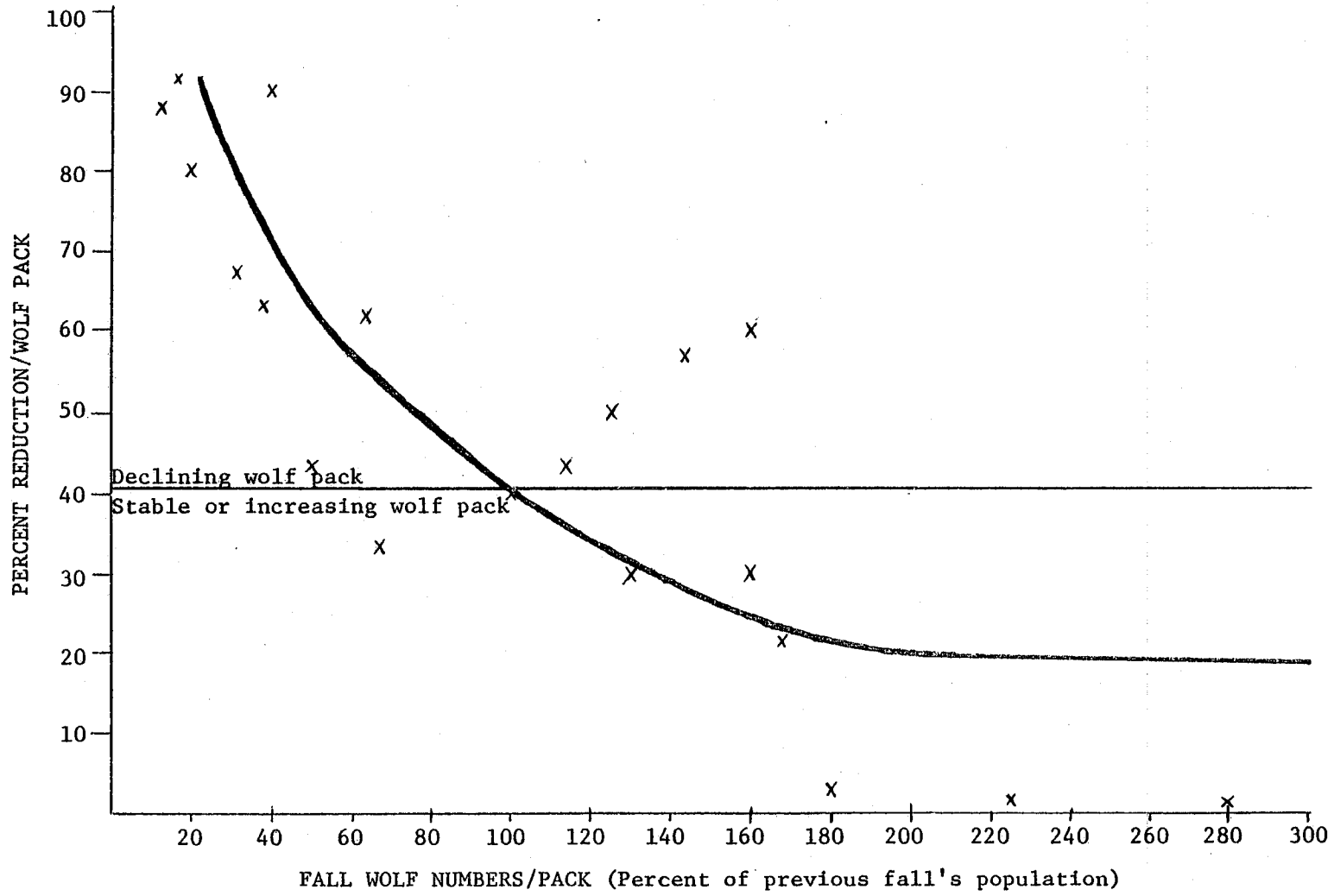


Mech (1970) concluded, based upon data from North America, that wolves can compensate for annual losses of 50 percent and possibly more to animals aged 5-10 months or older. He further he suggested that, in order to control wolf numbers, at least 50 percent of the animals of this age must be killed each year. We compared harvest levels of various radio-collared wolf packs with subsequent pack numbers in an effort to determine the effects of various human harvest levels on GMU 13 wolves (Fig. 10). In this analysis, both dispersal and natural mortality were included and, thus, the comparison is not related to just human induced mortality. Nevertheless, because most pack losses were hunting and trapping related it provides a guideline for harvest strategy. Harvest level (% loss) and subsequent fall pack numbers were significantly correlated ($P<0.01$), indicating that this wolf population was being controlled by human harvest. Wolf packs remained stable or increased at harvest rates of 22 to 60 percent but declined at harvest levels of 33 to 92 percent of the preceeding fall's population. Based upon the equation given in Fig. 10, a harvest level of 41 percent would, in most cases, allow these wolf packs to remain stable. This would not always be the case however, because in this heavily exploited population, packs are often comprised of two to three adults and five to six pups. If annual harvests remove one or two of the adult members, the pack will probably not reproduce even if only 30-40 percent were harvested. Also, the 41 percent figure includes dispersal and natural mortality so the actual level of human harvest that would usually stabilize pack numbers probably lies between 30 and 40 percent.

Hunting and trapping closures in portions of the Nelchina study area in 1978 and 1979 resulted in population increases in the closed areas. Since these packs were used in estimating the Unit's population they inflated this estimate and gave the false impression that the Unit population had increased. Since 1978, the number of public sightings of wolves appears to have declined (Tables 61 through 64). Examination of Figs. 6 through 9 indicates that in many cases packs are being harvested well in excess of 41 percent.

The GMU 13 wolf population has recovered from low densities when restrictive hunting and trapping regulations have been implemented. The Unit wolf population grew from 12 to 300+ individuals in 17 years when given relief from human harvest (Rausch 1967). An equally impressive rate of increase occurred during this study when portions of the Nelchina study area were closed to hunting and trapping over a 2.5-year period. Management of GMU 13 wolves has been guided by policies which state that the Department will manage the resource on the basis of: (a) maximum overall recreational opportunity, (b) maximum sustained harvest, and (c) maximum aesthetic appeal to the user (A.D.F.&G. 1963). A series of hunting-trapping season openings and closures allowing great increases and decreases in wolf numbers may not be consistent with this policy. Alaska's game managers need to determine what constitutes a desirable wolf

Figure 10. Relationship of percent annual reduction per pack to subsequent wolf numbers per pack as expressed by previous fall populations for radio-collared wolf packs studied from April 1975 through June 1980 in Game Management Unit 13 of southcentral Alaska.



density which does not create adverse predation on moose and caribou populations which also are to be managed in most cases on a maximum sustained yield basis. To date no such guidelines have been proposed.

Based upon the downward trend exhibited by this wolf population under the reported harvest levels, we propose that management strive to maintain a post harvest wolf density of approximately 1 wolf/100 mi^2 of habitat, a population of 150 wolves in GMU 13. To achieve this objective without unduly restricting wolf harvests some minor restrictions on hunting and trapping may be necessary. Examination of wolf sealing documents from 1976-80 reveals that successful ground trappers took an average of 1.5 wolves/season (range of 1 to 6). Aerial trappers, however, took an average of 3.4 wolves per season (range of 1 to 23). The upper limit of wolf harvest per trapper could be reduced, preventing further wolf population declines. Wolf numbers and numbers of trappers should continue to be monitored to maintain desired wolf densities.

Table 67 lists the fate of the 103 wolves radio-collared from April 1975 through June 1980. Of that total, 14 (14%) were known to be alive on 30 June 1980 while 26 (25%) were known to have dispersed and were either dead or missing by the same date. Excluding experimental removal (12) and collaring mortality (1 plus 1 not listed), the leading known cause of mortality was human induced (37 of 48, 77%). Ground shooting which involves the use of aircraft, and suspected illegal aerial hunting, accounted for 76 and at least 11 percent, respectively, of the human-caused mortality. Four (11%) wolves were trapped and one (3%) was hit by an auto. Natural forms of mortality (see Appendix V) accounted for 23 percent of the total known wolf mortality and were attributable to the following: 4 killed by other wolves, 1 stepped on by a moose and 5 due to miscellaneous factors such as bear predation, drowning or unknown causes. Illegal aerial hunting was probably underrepresented; we observed buckshot holes in several wolf hides and carcasses presented for sealing which were purportedly taken by ground shooting.

During this study we lost radio contact with 16 of the 103 radio-collared wolves (16%). We suspect that most of the missing radio-collared wolves were either: (1) taken illegally, (2) if taken legally reported as taken elsewhere, (3) properly reported, but no mention made of the radio-collar, (4) lost due to radio failure, or (5) dispersed. Since 26 percent of all radio-collared wolves were known to have dispersed, undoubtedly some of the missing radio-collared wolves are in this category. Toward the latter portion of this study we began receiving unconfirmed reports that radio-collared wolves were being taken but that the radio-collars were being destroyed and not reported. We are certain that some of the rumors were true and some radio-collars were destroyed. Since these animals represent a large financial investment by the State and because

Table 67. Summary of the status of all radio-collared wolves in GMU-13 from 1975 through June 1980.

Original suspected pack affiliation	Accession number	Date radio-collared	Age	Color	Sex	Weight	Number radio-locations	Month contact or mortality occurred	Status as of 6/30/80	Cause of mortality
Brushkana	121983	04/20/75	Adult	Black	♀	90	31	1/76	Dead	Exp. removal
Butte Lake	121984	04/20/75	Adult	Black	♂	102	23	1/76	Dead	Exp. removal
Deadman	121981	04/20/75	Adult	Gray	♂	92	35	3/76	Dead	Exp. removal
	121982	04/20/75	Adult	Gray	♀	108	28	3/76	Dead	Exp. removal
Deep Lake	122067	03/22/76	Adult	Gray	♂	102	46	3/77	Dead	Exp. removal
	121993	03/22/76	Adult	Gray	♀	94	58	10/76	Missing	Prob. dispersed
	122009	10/29/76	Adult	Gray	♀	86	87	2/79	Dead	Killed by Susitna wolves
		11/13/77				90				
		11/19/78				92				
	122096	11/13/77	Adult	Gray	♂	110	11	1/78	Dead	Ground shot
		01/05/78				-				
	122204	04/10/78	Pup	Gray	♂	99	18	7/78	Missing	Dispersed
	122212	11/19/78	Adult	Black	♂	92	10	2/80	Dead	Ground shot
Delta	121997	06/06/75	Adult	Gray	♂	98	21	11/76	Dead	Nat. mortality-cause unknown
	121998	06/06/75	Pup	Gray	♂	50	-	Unk	Dead	Trapped
	122063	03/21/77	Adult	Gray	♂	72	4	3/79	Missing	
	122064	03/21/77	Adult	Gray	♀	104	2	4/77	Dead	Exp. removal in Unit 20A
Ewan	121990	04/15/75	Adult	Gray	♀	87	148	10/76	Missing	? dispersed
	121991	11/04/75	Adult	Gray	♂	85	11	1/76	Dead	Killed by St. Anne wolves
	121992	11/04/75	Pup	Gray	♂	55	17	12/75	Dead	Trapped
	122151	03/16/78	Pup	Gray	♀	65	6	3/78	Dead	Killed by moose
	122219	11/17/78	Pup	Gray	♂	52	4	3/79	Dead	Trapped
		03/15/79								
Gakona	121999	03/18/76	Adult	Gray	♂	110	2	8/76	Dead	Auto collision
	122217	11/16/78	Adult	Gray	♀	100	3	12/78	Dead	Ground shot
	122218	11/16/78	Adult	Black	♂	-	6	2/79	Dead	Ground shot

Table 67 (cont.). Summary of the status of all radio-collared wolves in GMU-13 from 1975 through June 1980.

Original suspected pack affiliation	Accession number	Date radio-collared	Age	Color	Sex	Weight	Number radio-locations	Month contact or mortality occurred	Status as of 6/30/80	Cause of mortality
Hogan Hill	121987	06/06/75	Yrlg.	Gray	♀	69	104	1/79	Dead	Ground shot
	121988	11/05/75	Adult	Gray	♂	88	62	4/77	Missing	Dispersed
	122202	04/08/78	Adult	Gray	♂	108	52	1/79	Dead	Ground shot
	122205	04/09/78	Pup	Gray	♂	82	51	1/79	Dead	Ground shot
	122206	04/09/78	Pup	Gray	♀	79	37	9/78	Missing	? Prob. dispersed.
Keg Creek	121986	04/20/75	Adult	Black	♂	100	101	3/76	Possibly dead	Illegal aerial hunting
	122083	04/20/75 04/27/77	Adult	Gray	♂	94	191	2/78	Dead	Ground shot
	122002	04/20/75	Adult	Black	♀	82	147	7/76	Dead	Exp. removal
	122068	03/21/76	Adult	Black	♀	93	74	3/77	Dead	Exp. removal
	122201	03/21/76	Yrlg.	Gray	♀	74	71	2/79	Suspect dead	Illegal aerial shooting
		04/08/78	Adult			96				
	122010	10/29/76	Pup	Gray	♀	54	23	3/77	Dead	Exp. removal
	122011	10/29/76	Pup	Gray	♂	52	24	3/77	Dead	Exp. removal
	122203	04/09/78	Adult	Gray	♂	104	53	2/79	Suspect dead	Illegal aerial shooting
Maclaren	121985	04/21/75	Adult	Gray	♀	77	51	1/76	Dead	Exp. removal
Mendeltna	122007	10/29/76	Adult	Black	♀	72	124	2/78	Dead	Ground shot
	122008	10/29/76	Pup	Gray	♂	54	119	11/77	Dead	Killed by Tyone wolves
		04/27/77				92				
	122095	10/13/77	Adult	Gray	♀	86	13	2/78	Dead	Ground shot
	122090	10/13/77	Pup	Gray	♂	50	13	2/67	Dead	Ground shot
Middle Fork	121996	03/21/76	1.5	Gray	♀	80	2	5/76	Missing	?
	122062	03/21/76 03/21/77	Pup Yrlg.	Gray	♀	63 -	3	3/77	Dead	Collaring mortality
	122078	03/21/76	Pup	Gray	♂	66	2	2/77	Dead	Ground shot
	122061	03/21/77	Pup	Gray	♂	68	24	1/78	Dead	Ground shot
	122085	04/28/77 11/10/77	Pup Yrlg.	Gray	♀	82 78	18	2/78	Dead	Ground shot

Table 67 (cont.). Summary of the status of all radio-collared wolves in GMU-13 from 1975 through June 1980.

Original suspected pack affiliation	Accession number	Date radio-collared	Age	Color	Sex	Weight	Number radio-locations	Month contact or mortality occurred	Status as of 6/30/80	Cause of mortality
St. Anne	122086	04/28/77	Pup	Gray	♂	91	3	5/77	Missing	Dispersed?
	122088	04/28/77	Adult	Gray	♂	100	37	6/78-3/79	Dead	Drowned
	122087	04/28/77	Pup	Gray	♂	82	4	5/77	Missing	Dispersed
	122093	10/11/77	Adult	Gray	♂	88	8	2/78-9/79	Dead	Natural unknown cause
	122094	10/12/77	Adult	White	♀	72	53		Alive	
	122118	02/10/78	Adult	Gray	♂	92	9	4/78-2/79	Missing	Dispersed
	122209	02/26/78	Pup	Gray	♀	-	26	4/79-12/79	Dead	Starvation
	122207	04/10/78	Pup	Gray	♂	106	10	4/78	Missing	?
	122208	04/10/78	Pup	Gray	♀	84	9	8/78-9/79	Missing	Dispersed
	122292	03/31/79	Pup	Gray	♂	75	13	6/80	Missing	?
	122293	03/31/79	Adult	Gray	♂	92	9	1/80	Missing	Dispersed
Sinona	121989	04/20/75	Adult	Gray	♀	85	85	5/76	Missing	?
	122038	11/05/75	Adult	Gray	♂	106	70	2/77	Dead	Ground shot
	122048	11/05/75	Adult	Gray	♂	87	108	1/79	Missing	
		03/14/77				-				
		10/11/77				-				
	122049	03/14/77	Adult	Gray	♂	-	2	3/77	Dead	Ground shot
	122084	04/28/77	Adult	Gray	♀	112	32	12/78	Dead	Ground shot
		11/10/77				102				
		11/16/78				98				
	122213	11/16/78	Pup	Gray	♀	60	4	12/78	Probably dead	Suspect ground shot
	122214	11/16/78	Pup	Gray	♀	60	3	12/78	Dead	Ground shot
Stephan Lake	122016	02/19/76	Adult	Gray	♀	75	24	10/76	Dead	Killed by bear or wolf

Table 67 (cont.). Summary of the status of all radio-collared wolves in GMU-13 from 1975 through June 1980.

Original suspected pack affiliation	Accession number	Date radio-collared	Age	Color	Sex	Weight	Number radio-locations	Month contact or mortality occurred	Status as of 6/30/80	Cause of mortality
Susitna	122227	02/06/79	Pup	Gray	♂	100	24	4/79	Missing	Prob. radio failure
	122228	02/06/79	Pup	Gray	♂	99	43	4/79	Missing	Prob. radio failure
	122229	02/06/79	Pup	Gray	♂	94	65		Alive	
		04/16/80				105				
	122230	02/06/79	Pup	Gray	♂	100	47	1/80	Missing	?
	122294	03/28/79	Pup	Gray	♀	80	27	4/79	Missing	?
	122295	03/25/79	Adult	Gray	♀	95	103		Alive	
		02/20/80				-				
		04/15/80				-				
	122296	03/25/79	Adult	Gray	♂	108	53	3/80	Dead	Killed by wolves
		02/20/80								
	122302	02/20/80	Pup	Gray	♀	-	40		Alive	
	122303	02/20/80	Yrlg.	Gray	♂	80	10	3/80	Dead	Killed by wolves
	122305	04/13/80	Adult	Gray	♂	100	18		Alive	
	122306	04/13/80	Pup	Gray	♂	86 lbs est	18		Alive	
Tolsona	122210	06/08/78	Adult	Gray	♂	104	29	10/79	Missing	Dispersed
	122220	01/22/79	Pup	Black	♀	70 lbs est	69		Alive	
	1222289	03/28/79	Pup	Gray	♀	-	26	12/79	Missing	Dropped collar
	1222290	03/28/79	Pup	Gray	♂	84	24	10/79	Missing	Prob. dispersed?
	1222291	03/28/79	Pup	Gray	♀	70	5	12/79	Dead	Trapped
Tsusena	121994	02/20/76	Adult	Gray	♂	85	4	5/76	Missing	?
	122199	02/17/76	Adult	Gray	♀	80	59	7/78	Missing	Prob. alive
		03/23/78				-				
	122056	03/19/77	Adult	Gray	♂	92	1	3/77	Missing	Suspect ground shot
	122057	03/19/77	Pup	Gray	♀	72	1	3/77	Missing	Suspect ground shot

Table 67 (cont.). Summary of the status of all radio-collared wolves in GMU-13 from 1975 through June 1980.

Original suspected pack affiliation	Accession number	Date radio-collared	Age	Color	Sex	Weight	Number radio-locations	Month contact or mortality occurred	Status as of 6/30/80	Cause of mortality
Tyone	122001	02/18/76	Adult	Gray	♂	104	37	7/76	Dead	Exp. removal
	121995	02/16/76	Adult	Gray	♀	80	15	3/76	Dead	Exp. removal
	122097	11/15/77	Adult	Gray	♂	112	5	1/78	Dead	Ground shot
	122098	11/15/77	Pup	Gray	♂	92	8	2/78	Dead	Illegal areial hunting
	122099	11/15/77	Adult	Gray	♂	112	5	1/78	Dead	Ground shot
	122115	02/10/78	Adult	Gray	♀	92	2	2/78	Dead	Ground shot
	122116	02/10/78	Adult	Gray	♂	112	20	10/78	Missing	Dispersed
	122117	02/10/78	Adult	Gray	♂	106	2	2/78	Dead	Ground shot
	122215	11/18/78	Adult	Gray	♂	102	81	3/80	Dead	Ground shot
		02/20/78				111				
	122216	11/17/78	Adult	Gray	♀	90	68	3/80	Dead	Ground shot
		02/20/80				95				
	122298	02/20/80	Pup	Gray	♀	84	33		Alive	
	122299	02/20/80	Pup	Gray	♀	82	36		Alive	
	122300	02/20/80	Pup	Gray	♂	93	33		Alive	
	122301	02/20/80	Pup	Gray	♂	100	14	3/80	Dead	Ground shot
Watana	122197	03/20/78	Adult	Gray	♂	-	5	4/78	Missing	?
	122308	04/24/80	Adult	Gray	♀	91	16		Alive	
	122309	04/19/80	Pup	Gray	♀	79	10		Alive	
	122310	04/23/80	Adult	Gray	♂	101	13		Alive	
	122311	04/23/80	Adult	Gray	♂	112	13		Alive	

the ultimate fate of each of them is important to our understanding of population dynamics, it should be mandatory that all tags, tattoos, radio-collars, etc. from tagged big game species be reported. This type of regulation would also aid enforcement officials in enforcing other regulations.

Wolf Dispersal

Table 68 summarizes pertinent data concerning 26 radio-collared wolves known to have dispersed from their original pack area during this study period. Sixty-nine percent of the dispersing wolves were males, of which seven (39%) were under 2 years of age. Females under 2 years of age comprised 50 percent of the dispersing females. Dispersing males averaged 35 months (range of 6 mo. to 92 mo.) of age while females averaged 37 months (range of 15 mos. to 112 mo.).

Wolves dispersed from their original pack territories during all months of the year except December (Fig. 11). Dispersal appeared to be most prevalent during April through June and in September, with 48 percent of all dispersals occurring during these months.

Of the 26 known dispersals, at least 11 (42%) were in the company of one or more wolves when last observed. Five were associated with one other wolf in apparent vacant areas and six were in company of two to four wolves, of which three cases may have been vacant territories. At least three and possibly four wolves were known to have become members of previously established packs. The reasons why wolves left established territories may be related to prey abundance and/or attempts by young wolves to colonize new areas. During the study at least eight dispersing wolves were observed leaving and returning to the original pack before making the final movement. Seven of these wolves were estimated to range in age from 12 to 24 months.

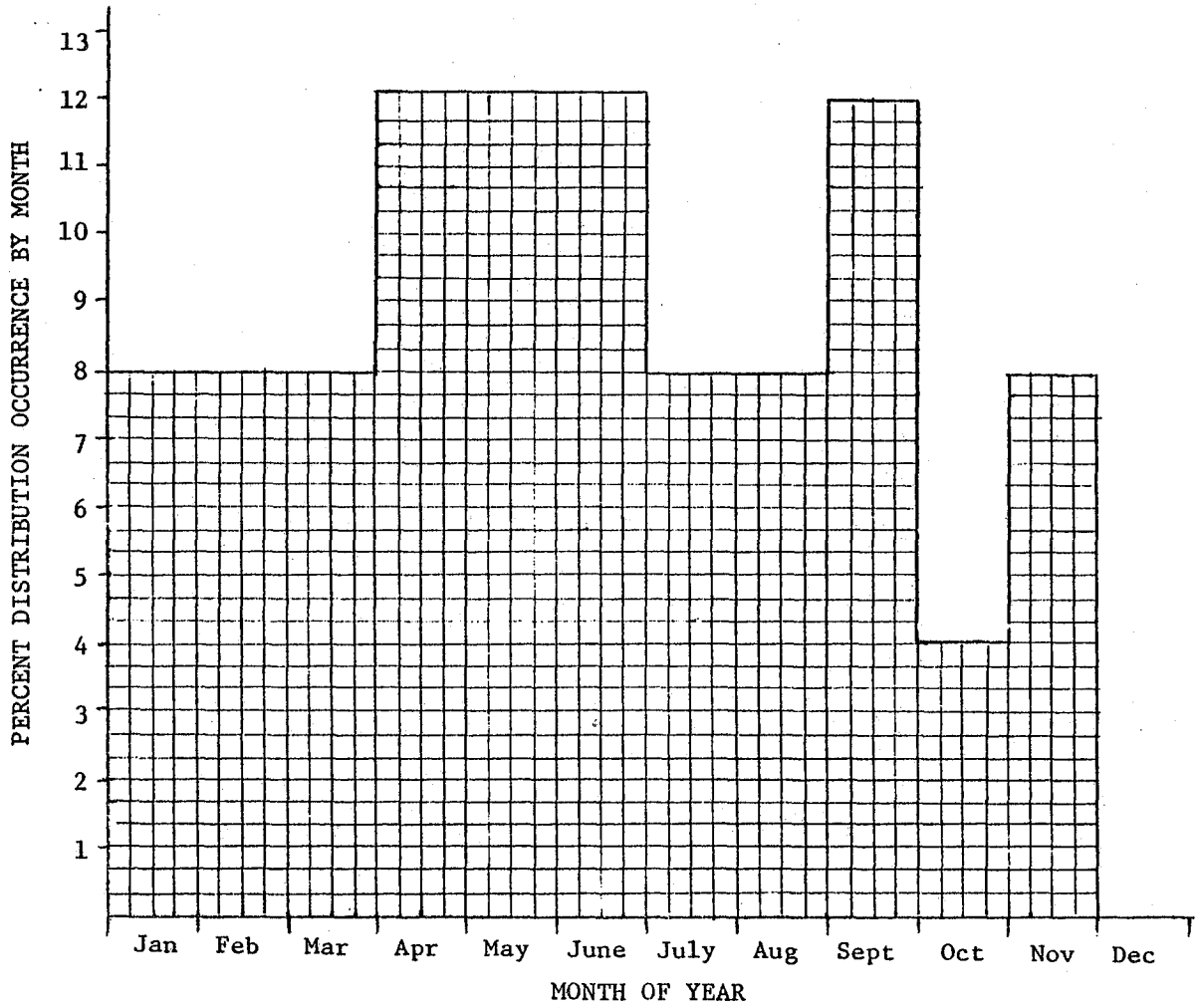
Average distance moved by dispersing wolves prior to loss of radio contact was 67.7 miles (106 km) [range of 14 (22.4 km) to 460 mi (736 km)]. The longest documented movement (736 km) exceeds the longest movement (670 km) recorded in the literature (Van Camp and Gluckie 1979). Excluding this record movement, dispersing wolves moved an average of at least 49.9 mi (76.8 km).

There is a paucity of information in the literature concerning wolf dispersal in populations elsewhere in North America. Recently, Fritts and Mech (In Press) documented a number of instances of wolf dispersal in a newly protected wolf population in northwestern Minnesota. In their study, movements of loners, dispersers and newly formed pairs were greatly influenced by established packs. This appeared to be at least partially true in this study since many dispersers were last observed with one or more wolves in apparently vacant wolf

Table 68. Summary of data pertaining to radio-collared wolf dispersal in GMU 13 of southcentral Alaska from April 1975 through June 1980.

Original pack affiliation	Accession number	Color/sex	Estimated age at capture	Date captured	Distance last observed from original territory mi	km	Date movement occurred	Status 6/80
Deep Lake	121993	Gray ♀	9 yr	03/22/76	20		9/76	Missing 10/78
	122067	Gray ♂	3 yr	03/22/76	30		8/76	Shot on 3/77 with Keg Creek pack
	122204	Gray ♂	11 mo	04/10/78	62		6-7/78	Missing 11/18/78
	122212	Black ♂	2 yr	11/19/78	35		3/79-2/80	Shot 2/80
Delta	122063	Gray ♀	2-3 yr	03/21/77	120		4/77-3/79	Shot 3/79 on Wood River
Ewan	121990	Gray ♀	2 yr	04/15/75	40		2-4/76	Missing from Mendeltna pack 10/76
	121991	Gray ♂	7 yr	11/04/75	20+		1/76	Killed by St. Anne's wolves
	122219	Gray ♂	6 mo	11/17/78	80		11/78-3/79	Trapped
Hogan Hill	121988	Gray ♂	2.5 yr	11/05/75	40		9/76-3/77	Missing 3/77
	122206	Gray ♀	11 mo	04/10/78	?		9/78	Missing 9/78
Keg Creek	122002	Black ♀	1-2 yr	04/20/75	25		5/76	Shot 7/76
	122083	Gray ♂	3 yr	04/20/75	45		3-10/76	Shot from Mendeltna pack 1978
Mendeltna	122008	Gray ♂	5 mo	10/29/76	14		11/77	Killed by Tyone wolves
St. Anne	122086	Gray ♂	11 mo	04/28/77	?		5/77	Missing 5/77
	122087	Gray ♂	11 mo	04/28/77	30		5/77	Missing 5/77
	122088	Gray ♂	4-5 yr	04/18/77	32		6/78-3/79	Drowned 1979
	122093	Gray ♂	2-3 yr	10/11/77	80		2/78-9/79	Dead, unknown causes
	122118	Gray ♂	2 yr	02/10/78	460		4/78-2/79	Missing in Brooks Range 3/79
	122209	Gray ♀	9 mo	02/26/78	80		4/79-12/79	Dead, starvation prob.
	122208	Gray ♀	11 mo	04/10/78	88		8/78-9/79	Missing 9/79
	122293	Gray ♂	3 yr	03/31/79	28		10/79	Missing 1/80
Susitna	122229	Gray ♂	9 mo	02/06/79	48		1/80	Alive
Tolsona	122210	Gray ♂	1 yr	06/08/78	60		10/79	Missing
	122290	Gray ♂	10 mo	03/28/79	?		10/79	Lost contact
Tsusena	122199	Gray ♀	2 yr	02/17/76	60		7/76	Missing 7/78
Tyone	122116	Gray ♂	6 yr	02/10/78	60+		6-10/78	Lost contact 10/78

Figure 11. Percent frequency distribution of radio-collared wolf dispersals from pack territories in Game Management Unit 13 of southcentral Alaska from April 1975 through June 1980.



territories. Fritts and Mech (In Press) documented one case, and suspected three other cases in which a lone wolf was accepted into an established pack. They suspected that these "loners" may have previously dispersed from the pack they had joined. They concluded that acceptance of lone wolves by established packs helps to maintain pack structure in populations with high mortality which in turn results in a stable social system and higher productivity. This statement seems particularly pertinent to this study since the lone wolves that were accepted into established packs were sexually mature (average age 37 mo.). This could be particularly important in a heavily exploited wolf population where pack size is often very small and mortality is high. Whether these new pack members eventually become socially dominant in the pack structure is not known but our observations suggest that in some cases they do.

Experimental Wolf Removal

From January 1976 through July 1978, 60 wolves were shot from helicopter or fixed-wing aircraft by Department personnel as part of the experimental wolf removal program (Table 69). Thirteen of these were killed outside the Susitna study area. These included seven from the Keg Creek pack and six believed to be from the Tyone Creek pack. Although only small portions of the territories of these packs overlapped the Susitna study area, a substantial number of study area moose migrated out of the area and wintered and calved in the two pack areas (Ballard and Taylor 1980). As a consequence, moose originally thought to be inhabiting areas of low wolf density were spending half the year in areas where wolf densities approached one wolf per 50 mi^2. Therefore, between January 1976 through March 1977, attempts were made to remove wolves occupying the western Alphabet Hills and lower Tyone Creek floodplains. In addition to the wolves harvested by Department personnel, 24 wolves may have been harvested in the Susitna study area by the public from September 1975 through June 1980 (Table 70).

Based on track counts, wolf removal and radio telemetry, we were able to estimate wolf population densities within the Susitna River study area from spring 1975 through spring 1980. During this period wolf populations were surveyed after fresh snowfall; once in late fall and once in spring. Attempts to remove wolves from the southern portion of the study area were terminated in December 1978 while removal effort in the northern portions of the area north of the Denali Highway were discontinued in spring 1979.

Prior to initiation of Department wolf removal in 1976, wolf densities in the Susitna River study were estimated at 1 wolf/148 mi^2 (383 km^2) in spring 1975 to 1 wolf/78 mi^2 (202 km^2) in fall 1975 (Table 71). Densities were higher if mi^2 of actual wolf habitat were utilized (98 - 52 mi^2) instead of the entire study area. Comparison of these density figures with those presented for the remainder of GMU 13 during the same time

Table 69. Summary of wolves taken by Department personnel in the Susitna River study. Area as part of an experimental wolf removal program from January 1976 through June 1980 in GMU 13 of southcentral Alaska.

Wolf ID number	Suspected pack affiliation	Color	Sex	Long-bone age	Date of harvest	Location
61324	Oshetna	Gray	M	A	3/20/76	SE Lone Butte
121995	Oshetna	Gray	F	A	3/20/76	Clarence Lake
61322	Oshetna	Gray	F	A	3/19/76	Clarence Lake
61321	Oshetna	Gray	M	A	3/19/76	Clarence Lake
61319	Oshetna	Gray	M	A	3/19/76	Clarence Lake
61320	Pack association unknown	Gray	M	A	3/19/76	Western Alphabet Hills
121984	Butte Creek	Black	M	A	1/17/76	Butte Creek
61311	Butte Creek	Black	M	A	1/17/76	Butte Creek
--	Butte Creek	Gray	M	A	1/17176	Butte Creek
61300	Deadman pack	Black	M	P	1/17/76	Watana Creek
61301	Deadman pack	Black	M	P	1/17/76	Watana Creek
61316	Deadman pack	Gray	F	P	1/17/76	Watana Creek
121981	Deadman pack	Gray	M	A	3/19/76	Watana Creek
121982	Deadman pack	Gray-black	F	A	3/19/76	Watana Creek
61302	Maclaren pack	Gray	M	P	1/17/76	Maclaren River
61303	Maclaren pack	Gray	M	P	1/17/76	Maclaren River
--	Maclaren pack	Gray		P	1/17/76	Maclaren River
--	Maclaren pack	Gray	M	A	1/17/76	Maclaren River
121985	Maclaren pack	Gray	F	A	1/17/76	Maclaren River
61304	Possible Brushkana pack	Black	M	A	1/17/76	Butte Creek
61307	Brushkana pack	Black	F	A	1/17/76	Butte Creek
121983	Brushkana pack	Black	F	A	1/17/76	Butte Creek
61312	Brushkana pack	Black	F	Yrlg	1/17/76	Butte Creek
61306	Brushkana pack	Black	F	P	1/17/76	Butte Creek
61308	Brushkana pack	Black	F	P	1/17/76	Butte Creek
61310	Brushkana pack	Black	F	P	1/17/76	Butte Creek
61315	Brushkana pack	Black	F	P	1/17/76	Butte Creek
61309	Brushkana pack	Black	M	P	1/17/76	Butte Creek
61313	Brushkana pack	Black	M	P	1/17/76	Butte Creek
122001	Clearwater	Gray	M	A	7/29/76	Upper Valdez Creek
122002	Coal Creek	Black	F	A	7/29/76	Upper Coal Creek
122003	Coal Creek	Gray	M	A	7/29/76	Upper Coal Creek
122012	Clearwater	Black	F	A	10/28/76	Upper Clearwater Creek
122013	Clearwater	Gray	M	A	10/28/76	Upper Clearwater Creek
122017	Brushkana	Gray	M	A	12/30/76	Brushkana Creek
122018	Brushkana	Gray	F	P	12/30/76	Brushkana Creek
122019	Brushkana	Black	F	P	12/30/76	Brushkana Creek
122020	Brushkana	Black	F	A	12/30/76	Brushkana Creek
122021	Brushkana	Black	M	P	12/30/76	Brushkana Creek
122022	Brushkana	Black	M	P	12/30/76	Brushkana Creek
122058	Unknown	Gray	F	A	3/20/77	Middle Maclaren River

Table 69 (cont.). Summary of wolves taken by Department personnel the Susitna River study area as part of an experimental wolf removal program from January 1976 through June 1980 in GMU 13 of southcentral Alaska.

Wolf ID number	Suspected pack affiliation	Color	Sex	Long-bone age	Date of harvest	Location
122059	Clearwater	Black	F	P	3/20/77	Lower Clearwater Creek
122060	Watana	Gray	M	A	3/19/77	Delusion Creek
122010	Keg Creek	Gray	F	P	3/22/77	Keg Creek
122011	Keg Creek	Gray	M	P	3/22/77	Keg Creek
122067	Keg Creek	Gray	M	A	3/22/77	Keg Creek
122068	Keg Creek	Black	F	A	3/22/77	Keg Creek
122069	Keg Creek	Black	F	P	3/22/77	Keg Creek
122070	Keg Creek	Black	F	P	3/22/77	Keg Creek
122071	Keg Creek	Gray	F	A	3/22/77	Keg Creek
122072	Clearwater	Black	F	P	3/23/77	Valdez Creek
122089	Clearwater	Black	M	P	5/28/77	Valdez Creek
122192	Jay Creek	Gray	M	P	3/23/78	Clarence Lake
122193	Jay Creek	Gray	M	A	3/23/78	Clarence Lake
122194	Jay Creek	Gray	M	P	3/23/78	Clarence Lake
122195	Clearwater	Black	F	A	3/21/78	Middle Clearwater Creek
122196	Watana	Gray	M	A	3/20/78	Fog Creek
122198	Watana	Gray	M	P	3/22/78	Fog Creek
122200	Watana	Gray	F	A	3/22/78	Fog Creek
122211	Clearwater	Gray	F	Yrlg	7/08/78	Clearwater Creek

Table 70. Summary of number of wolves harvested by public which possibly could have been located in the Susitna River study area 1975-1980.

Possible pack association	Sex	Age	Color	Date	Comments
Brushkana pack	M	A	Black	10/24/75	
Valdez Creek	M	?	?	10/75	
Mouth Maclaren River	M	A	Gray	2/25/77	
Mouth Maclaren River	F	A	Gray	2/25/77	
Mouth Maclaren River	M	A	Black	10/8/76	
Susitna River	F	P	Gray	3/7/77	
Denali Highway	Unk	Unk	Gray	9/18/77	
Susitna River	F	A	Black	2/3/78	
Susitna-Watana	M	A	Gray	2/12/78	
Mouth Maclaren River	M	P	Black	9/10/77	
Mile 122 Denali Highway	M	P	Gray	2/22/79	
Denali Highway	M	P	Gray	3/13/79	
Denali Highway	M	P	Gray	4/13/79	
Denali Highway	M	A?	Gray	9/29/79	
Susitna River	M	?	?	4/20/80	
Susitna River	F	?	?	4/20/80	
Susitna River	F	A	Gray	3/17/80	
Coal Creek	F	?	Gray	2/13/80	
Coal Creek	M	?	Gray	2/13/80	
Coal Creek	F	?	Gray	2/13/80	
Coal Creek	F	?	Gray	2/13/80	
Butte Lake	F	A?	Gray	2/25/80	
Butte Lake	F	A?	Gray	2/25/80	
Butte Lake	F	A?	Gray	2/25/80	

Table 71. Numbers and density of wolves estimated to occupy the Susitna River study area from spring 1975 through June 1980.

Possible or Known Pack Affiliation	Spring 1975	Fall 1975	Spring 1976	Fall 1976	Spring 1977	Fall 1977	Spring 1978	Fall 1978	Spring 1979	Fall 1979	Spring 1980
Brushkana River-Butte Creek	7	12	2	7	1	2	2	2	3-4	3-4	?
Coal Creek	6?	10?	2	0	0	0	0	0	0	0	0
Clearwater Creek			3	3	2	0	1	2	0	?	2
Jay Creek			0	2	2	4	1	4	3-4	10	6
Maclaren River	2	6	?	?	1	0	0	0	0	5	?
Middle Fork of Susitna River			1	2	0	2	2	0	0	0	2
Watana-Deadman Creeks	2	5	2	4	2	6	1	3	2+	7	5
Subtotal	17	33	10	18	8	14	7	11	10	26	15
Lone Wolves (10% of subtotal)	2	3	1	2	1	1	1	1	1	3	2
Total	19	36	11	20	9	15	8	12	11	29	17
Sq. miles/wolf											
Total area (2804 sq. mi.)	148	78	255	140	312	187	351	234	255	97	165
Habitat area (1858 sq. mi.)	98	52	169	93	206	124	232	155	169	64	109

period (Table 60) suggests that wolf densities in the Susitna River study area were slightly lower than those elsewhere in the Unit. This was probably attributable to the fact that topography, vegetation, and snow cover in the Susitna study area make wolves more vulnerable to hunting and trapping.

For purposes of evaluating the effects of wolf removal on moose calf survival, spring wolf densities were used since they would represent the number of adult wolves which could potentially prey upon moose calves. Newborn pups would have low food demands for a few weeks following birth, but their demands would increase and probably approach those of an adult by late November. Our estimates of wolf numbers in the study area indicate that density was lower than the spring 1975 level by 42 percent, 53 percent, 58 percent, 42 percent, and 11 percent for springs 1976, 1977, 1978, 1979, and 1980, respectively. If the two large packs outside the study area were included for the years that removal was maintained, reductions in wolf density from 1976 through 1978 would have been 37, 54, and 69 percent, respectively. In either case, wolf numbers averaged less than 50 percent of the spring 1975 level from 1976 until removal was terminated in spring 1979.

Wolf Repopulation of Removal Area

In spite of continuing public harvests, wolf populations in the Susitna River study area had increased to within at least 89 percent of the spring 1975 population by spring 1980. In all likelihood, the spring 1980 wolf population is even higher than that presented in Table 71 because we lack data for two previously occupied areas which we suspect are now occupied by an unknown number of wolves.

The rapid repopulation of this study area can be attributed to both immigration and to high reproductive rates for the few remaining wolves which were not removed by either the Department or the public. Immigration of wolves into the study area was significant. Dispersal and movement of individual radio-collared wolves such as number's 067, 204, 219, 002, 001, 199 and 116 (described under Pack Histories) demonstrate how rapidly areas void of wolves can be repopulated.

During this study, annual rates of wolf population increase were extremely high: 89.5 percent in 1975, 81.8 percent in 1976, 66.7 percent in 1977, 50.0 percent in 1978, and 163.6 percent in 1979. For the 5-year period, the average annual rate of increase was 93 percent. We suspect that this rate will decline as the habitat becomes saturated and wolf harvests increase.

Evaluation of Wolf Removal on Moose

Initially we planned to evaluate the effect of wolf removal on moose calf survival by comparing fall calf:cow ratios as

determined by standard moose sex and age composition counts. Pre and post wolf removal ratios within specific count units were to be compared. Also, ratios in low wolf density count units could be compared with those in medium to high wolf density count units. This approach presented certain problems, however. Calf:cow ratios in a count unit normally fluctuate from year to year and factors such as moose density, climate and habitat vary between count units. Therefore, results of direct comparisons between count units or between years could be obscured or exaggerated by these factors. Also, wolf densities in these comparison areas were never constant and fluctuated widely from year to year in response to hunting and trapping (Table 60).

In an effort to minimize some of these problems, we selected combinations of count units in which calf:cow ratios had historically fluctuated in phase. We assumed that when calf:cow ratios were positively correlated between groups of count units over a period of years, there was a high likelihood that factors influencing ratios in those units were similar. We expected these units to continue to exhibit similar trends unless some factor was altered in one group of units but not the other. If wolf densities strongly influenced moose calf survival, we expected a divergence in trends between a group of count units in which wolf densities were substantially reduced and another group of units in which densities remained "normal."

We selected combinations of composition count units in which fluctuations in calf:cow ratios, yearling bull percentages and number of moose seen per hour were similar prior to wolf reduction (Figs. 12 through 14). Count units 3, 6 and 7 were within the Susitna River study area (wolf removal area) while count units 10, 13, 15, 16, and 17 were in areas of "normal" wolf density (Fig. 15). Count areas 2, 5, and 14 were adjacent to the Susitna River study area and wolf densities in those areas were occasionally influenced by removal activities. Not all count units were surveyed each year. The strongest correlation of calf:100 cow ratios prior to wolf control was between comparison areas 1 and 4 ($P<0.05$, $r=0.86$).

Trends in calf:cow ratios between comparison areas 1 and 3 and 1 and 4 (Fig. 12) diverged in 1976 and 1977 but not in 1978 or 1979. Prior to wolf reductions, calf;cow ratios in the Susitna River study area fluctuated considerably and exceeded 30:100 in 4 of 7 years. Therefore, the changes observed in 1976 and 1977 could have resulted from either reduced wolf predation or normal variation in other factors. Because yearling cow moose cannot be accurately identified from fixed-wing aircraft, the number of cows older than 2 years of age was calculated by subtracting the number of yearling bulls observed (representing a minimum estimate of the number of yearling cows) from the total number of cows observed (Ballard et al. 1980). This method assumes an equal sex ratio at birth and does not include yearling bulls taken by hunters prior to the survey. Therefore,

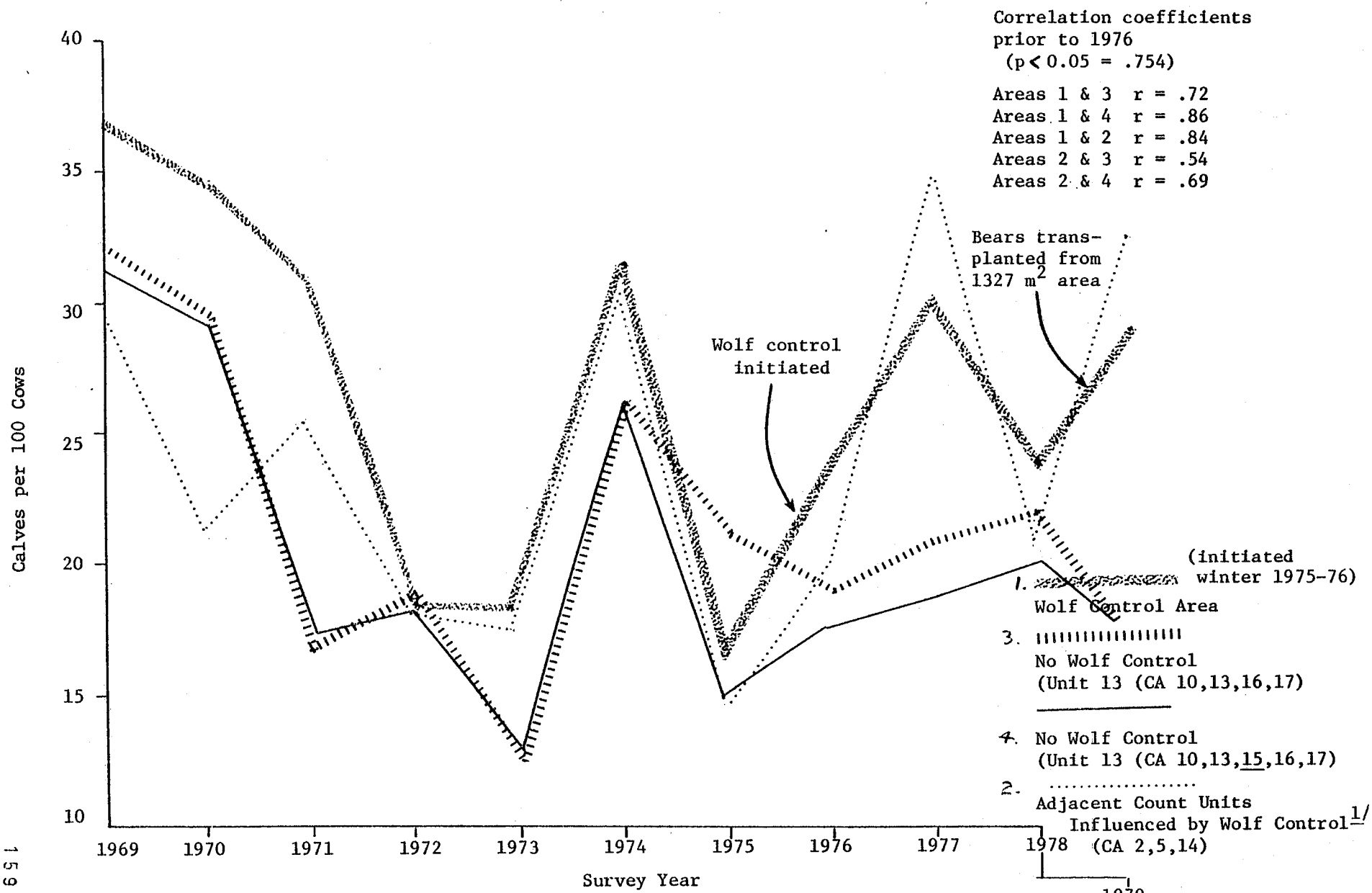


Figure 12. Calf per 100 cow moose ratios from selected moose sex and age composition count areas within Game Management Unit 13 of Southcentral Alaska from 1969 through 1979. 1/ Only CA-5 surveyed in 1979.

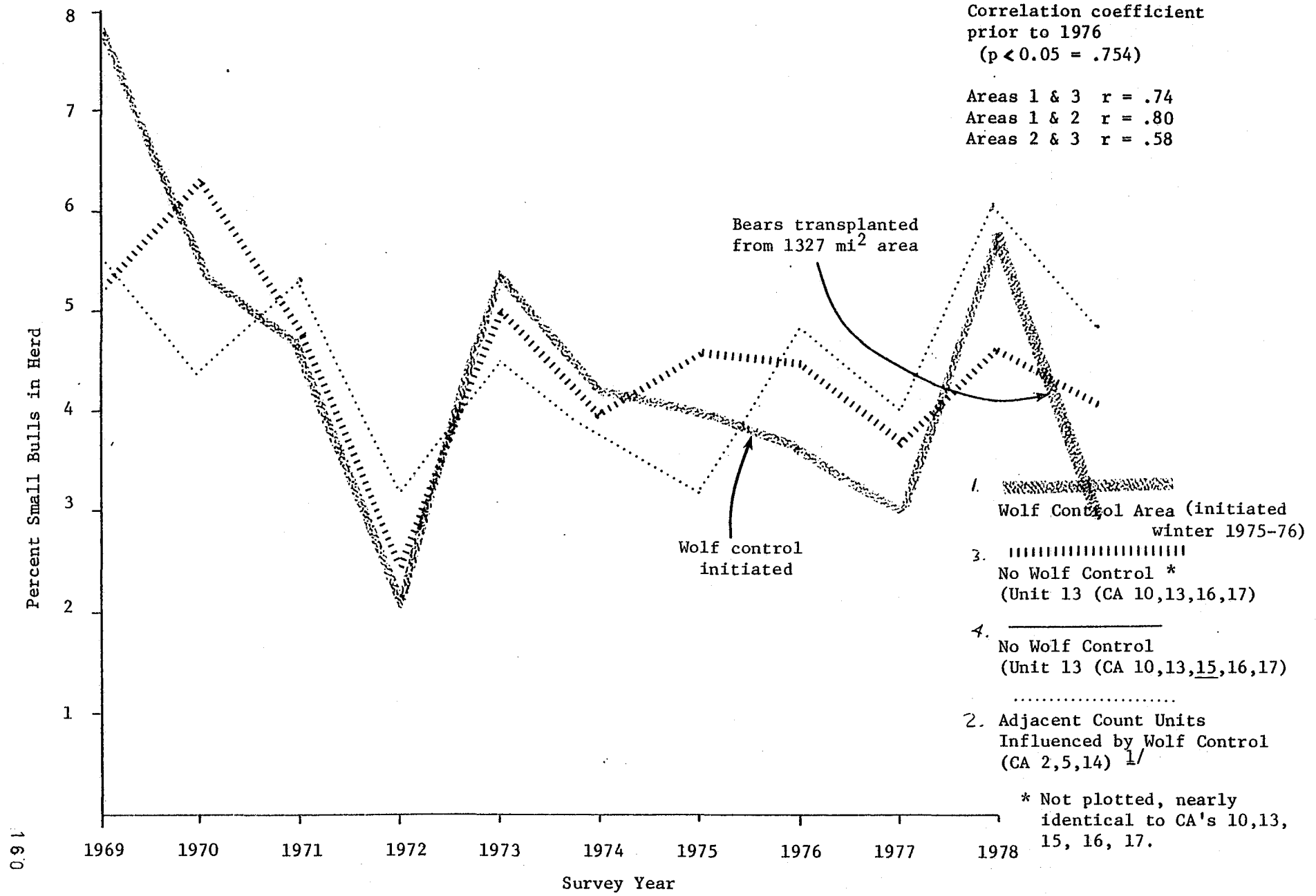


Figure 13. Percent small bulls within selected moose sex and age composition count areas within Game Management Unit 13 of Southcentral Alaska from 1969 to 1978. 1/ Only CA-5 survey in 1979.

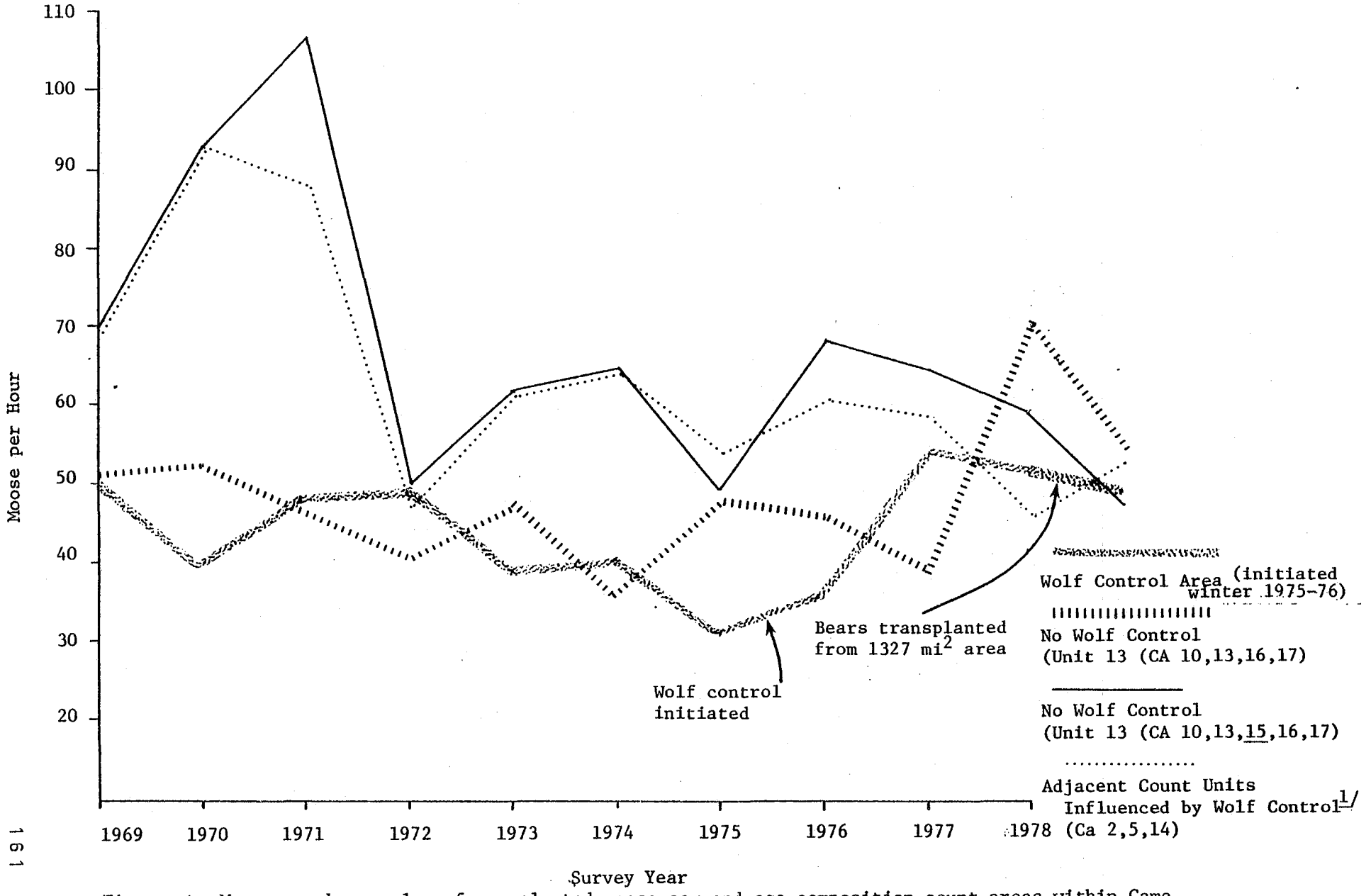
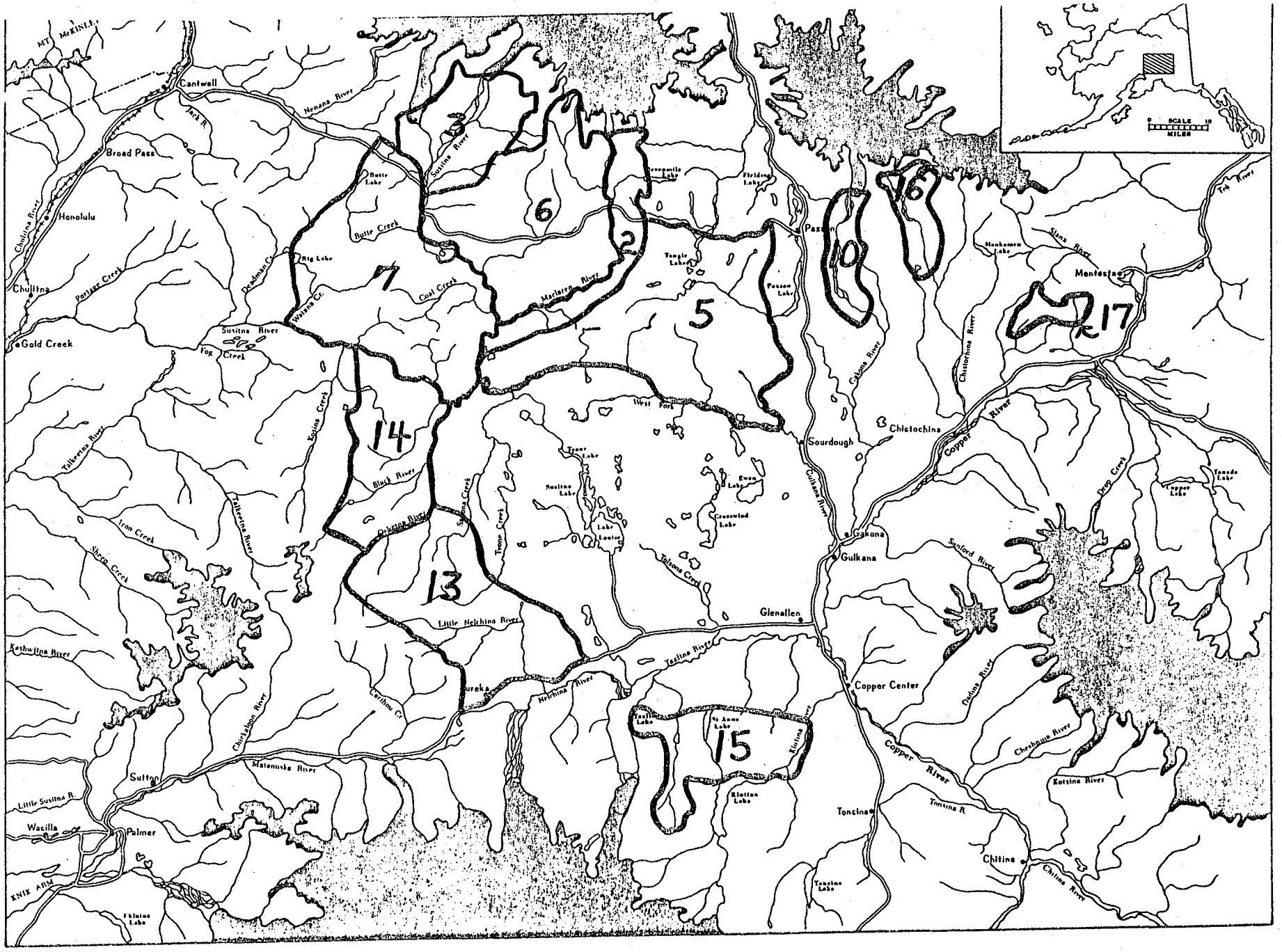


Figure 14. Moose per hour values from selected moose sex and age composition count areas within Game Management Unit 13 of Southcentral Alaska from 1969 through 1978, 1/ Only CA-5 survey in 1979.

Figure 15. Boundaries of fall moose sex and age composition count areas within GMU-13 of Southcentral Alaska.



the estimate of the number of cows older than yearlings is exaggerated. Nevertheless, calf:cow ratios generated from these estimates are more meaningful because they exclude some of the sexually immature cows.

Using the above described method of computing calf:cow ratios we analyzed statistical differences in ratios between comparison areas 1 and 3 and 1 and 4 using an analysis of residuals (Everith 1977:46) to determine which cells of a chi-square table were significant in rejection of the null hypothesis (Table 72). There were no significant ($P>0.05$) deviations for the years Department wolf removal was in effect, suggesting that reductions in wolf density did not increase moose calf survival. Significant ($P<0.05$) deviations did occur in 1971 which might be explained by differences in winter severity. This might also explain the significant ($P<0.05$) deviation of numbers of calves observed in the comparison count area during 1975.

Percentages of yearling bulls (Fig. 13) observed in fall composition counts were compared between the wolf removal area and the comparison areas. We would have anticipated a divergence in trends for percent yearling bulls beginning in 1977, had the 1976 and succeeding calf crops experienced greater survival due to wolf control. This was not the case and, although there was an increase in 1978, all of the comparison areas continued to fluctuate in phase suggesting again that Departmental wolf control had not resulted in increased calf or short yearling survival.

We also would have anticipated an increase in moose harvests in the wolf removal area if wolf reductions had increased the survival of bull calves, short yearlings and adults. Numbers of bull moose harvested in the Susitna River study area were compared with harvests in the remainder of GMU 13 (Table 73). Significant deviations ($P<0.10$) in numbers of moose harvested in the Susitna River study area occurred in 1976 and 1979 (Table 73B). In 1976, following the first year of wolf removal, the bull harvest was lower than expected while in 1979, after both wolf removal and the transplanting of brown bears (discussed below), the harvest was higher than expected. This analysis again suggests that moose survival was not enhanced by reductions in wolf density.

The only evidence which suggested that wolf reductions had increased moose calf survival in the Susitna study area was a positive but nonsignificant correlation ($P>0.05$, $df = 3$, $r^2 = 0.70$) between fall calf:cow ratios (corrected) and the preceeding spring wolf density. This relationship was not evident ($P>0.05$, 4db, $r^2 = 0.53$) for comparative count areas outside the Susitna River study area. We tend to discount the former relationship because of only four data points and because calf:cow ratios in the comparative areas had similar trends in ratios.

Table 72. Adjusted residuals (d) of number of calves and cows (≧2 yr old) observed in fall moose sex and age composition surveys conducted in the Nelchina and Susitna River Basin of southcentral Alaska from 1969-1979.

Year	Deviations from expected value[1/] Comparison area	Cows	Calves	Deviations from expected value[1/] Comparison area	Cows	Calves
1969	1	0.160	-0.240	1	0.276	-0.409
	3	-0.095	0.163	4	-0.147	0.253
1970	1	0.331	-0.527	1	0.448	-0.708
	3	-0.361	0.655	4	-0.487	0.892
1971	1	-1.237	2.352*	1	-1.039	1.943
	3	1.083	-2.346*	4	0.855	-1.855
1972	1	0.540	-1.181	1	0.618	-1.342
	3	-0.581	1.448	4	-0.605	1.521
1973	1	-0.198	0.457	1	-0.080	0.181
	3	0.203	-0.533	4	0.077	-0.203
1974	1	0.286	-0.487	1	0.407	-0.688
	3	-0.270	0.524	4	-0.383	0.750
1975	1	0.523	-1.185	1	0.287	-0.668
	3	-0.988	2.552*	4	-0.42	1.136
1976	1	0.151	-0.300	1	0.062	-0.123
	3	-0.142	0.322	4	-0.055	0.128
1977	1	-0.293	0.535	1	-0.533	0.989
	3	0.296	-0.616	4	0.508	-1.094
1978	1	0.511	-0.970	1	0.343	-0.659
	3	-0.518	1.119	4	-0.329	0.733
1979	1	-0.620	1.174	1	-0.541	1.018
	3	0.671	1.448	4	0.567	-1.237

[1/] Significant deviations ($|d|>1.96$, $P<0.05$) denoted by *.

Table 73. Numbers of moose reportedly harvested in the Susitna River study area in comparison to the remainder of Game Management Unit 13 for harvest years 1974 through 1979.

Area	Number of moose harvested					
	1974	1975	1976	1977	1978	1979
Susitna River study area	145	103	83	104	148	163
Remainder of GMU 13	562	479	462	502	612	588

Table 73B. Adjusted residuals (d) of moose harvests from the Susitna River study area and the remainder of Game Management Unit 13 for harvest years 1974-1979.

Area	Deviations from expected value[1/]					
	1974	1975	1976	1977	1978	1979
Susitna River study area	0.996	-0.657	-1.962*	-0.974	0.376	1.780*
Remainder of GMU 13	-0.481	0.317	0.947	0.470	-0.181	-0.859

[1/] Significant deviation ($|d| > 1.67$, $P < 0.10$) denoted by *.

Analyses presented thus far in this report indicate that wolf predation was not a major cause of moose calf mortality in GMU 13 during this study. Winter food habits and rates of predation on short yearling and adult moose, however, suggest that wolf predation might constitute an important mortality factor for these age classes. Experimental wolf removal also provided an opportunity to test this thesis. If it were true, the effects of wolf removal would be manifested by an increase in adult moose survival. To test this possibility we compared ratios of adult cow (≧2 yr old) and calf (<6 mos.) moose observed per hour of survey in comparison areas 1 and 3 to those ratios observed in comparison areas 1 and 4 (Table 74). For all comparisons no significant ($P>0.05$) deviations in ratios of cow and calf moose observed per hour of survey were evident following reductions in wolf density initiated in 1976. This analysis suggests that adult and short yearling moose survival was not significantly improved as a result of wolf control.

This evaluation of wolf removal was based on the premise that one factor, wolf predation, was responsible for low calf survival. If this assumption were correct, removal of this factor should have produced substantial increases in calf:cow ratios, particularly since moose pregnancy rates were high (Ballard and Taylor 1980). Prior to the study, we did not select a calf:cow ratio at which we would have concluded calf survival had definitely improved as a result of wolf control. However, a value of 50 calves to 100 cows appeared to be reasonable if wolf predation were indeed primarily responsible for low calf survival. Obviously the reported ratios were considerably less. If, however, wolf predation were only one of several factors a smaller increase would be expected. Composition counts, as currently conducted, are probably not precise enough to measure such small changes.

Calf:cow ratios for the study area were compared with those in other moose populations in the State (Fig. 16). Of particular interest were the data from Mt. McKinley National Park (Troyer 1976, 1977 and 1978). Wolf densities in the Park have been estimated at approximately one wolf per 50 mi^2 (Murie 1944 and Haber 1977). Wolf populations in the Park are for the most part unexploited, and thus we would expect the moose population to be characteristic of a population subjected to high levels of wolf predaton. The study area, the remainder of Unit 13 excluding the Susitna River study area, and McKinley Park have all exhibited the same trends in calf:cow ratios since 1974 even though wolf densities differed greatly among these areas. In contrast, however, Unit 20A calf:cow ratios have increased tremendously following wolf removal in 1976 (Gasaway et al. 1977).

Another, more direct method of evaluating the effects of wolf removal on moose calf survival was initiated in late spring 1977. Newborn moose calves were captured and fitted with special transmitters which alerted biologists that mortality had

Table 74. Adjusted residuals (d) of cow (≧2 yr old) and calf (≦6 mo) moose observed per hour of survey during moose sex and age composition counts conducted in the Susitna River study area in comparison to comparative areas in the remainder of Game Management Unit 13 from 1969-1979.

	Deviations from expected value[1/]			Deviations from expected value[1/]		
Year	Comparison area	Cows	Calves	Comparison area	Cows	Calves
1969	1	-0.793	1.133	1	-3.025*	-0.412
	3	-0.403	1.174	4	2.065*	2.415*
1970	1	-1.889	0.054	1	0.266	1.272
	3	0.693	1.579	4	-1.171	0.476
1971	1	-1.728	-0.200	1	-0.765	0.221
	3	1.737	-0.573	4	0.856	-0.376
1972	1	1.614	0.149	1	0.848	-0.299
	3	-0.806	-1.076	4	-0.234	-0.932
1973	1	0.447	-0.549	1	0.584	-0.581
	3	0.507	-1.294	4	0.164	-0.901
1974	1	-0.304	0.440	1	-0.506	0.213
	3	-0.107	0.350	4	0.246	0.314
1975	1	-0.417	-0.539	1	1.947	0.014
	3	-0.068	-0.100	4	-1.514	-0.936
1976	1	-0.494	-0.324	1	-0.095	-0.228
	3	0.649	-0.257	4	0.487	-0.537
1977	1	0.719	1.092	1	0.138	0.633
	3	-0.645	-0.721	4	-0.163	-0.599
1978	1	0.365	0.382	1	0.437	0.297
	3	-0.223	-0.439	4	-0.261	-0.665
1979	1	0.651		1	0.534	0.902
	3	-0.473	-0.960	4	-0.584	-0.839

[1/] Significant deviations ($|d| > 1.96$, $P < 0.05$) denoted by *.

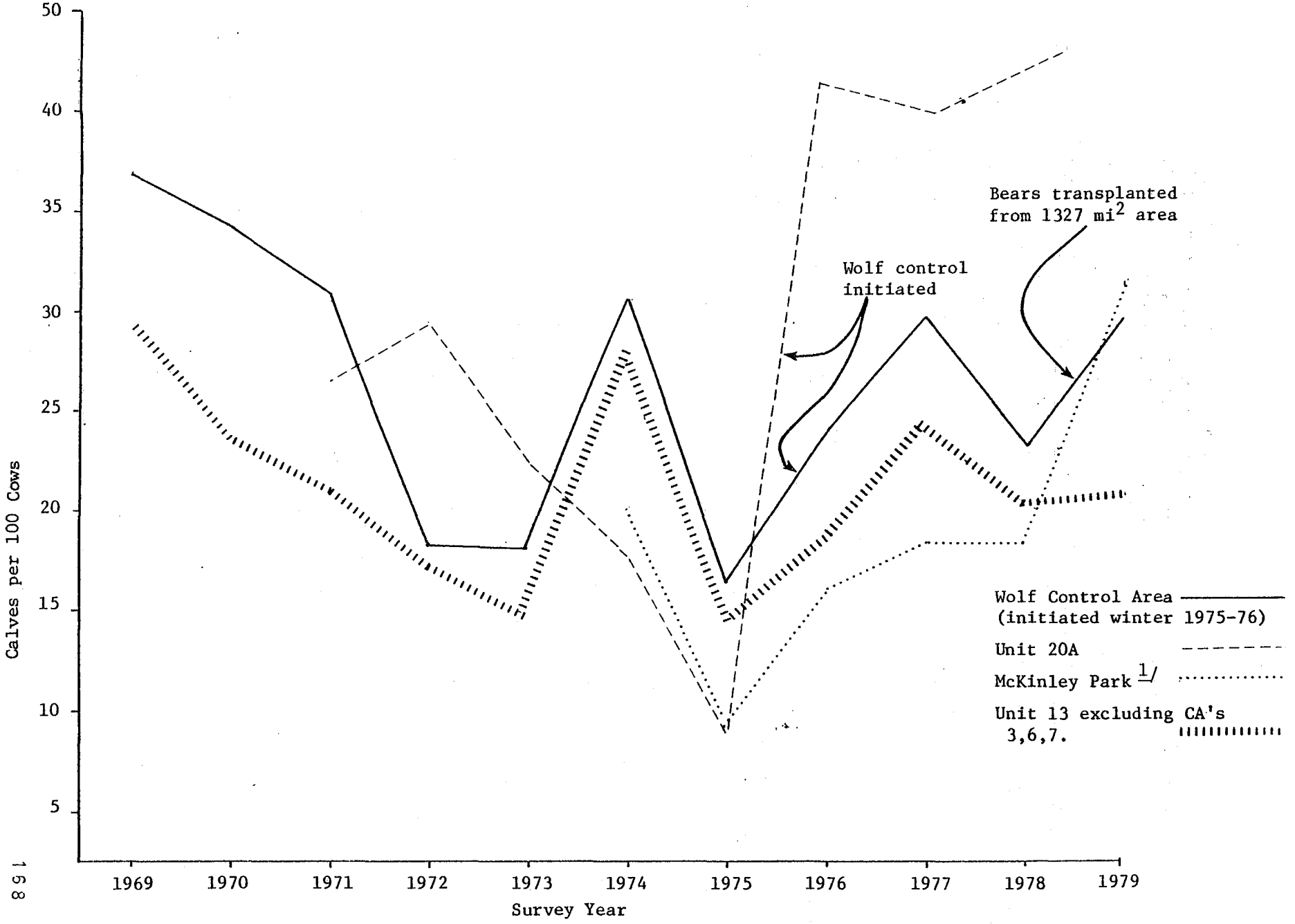


Figure 16. Comparison of calf per 100 cow moose ratios between Susitna River Study Area and other moose populations within Alaska from 1969 through 1978.
1/Only small portion of Park survey in 1979, sample size of 103 (Troyer, pers. comm.).

occurred (Ballard et al. 1979). During 1977 and 1978, 136 calves were radio-collared. Fifty-four percent of the calves died of natural causes, with predation by brown bears accounting for 79 percent of those deaths (Ballard et al. 1981). Causes of calf moose mortality were compared between the wolf removal area and two comparative areas; no significant differences ($P>0.05$) in causes of mortality were detected, indicating that differences in wolf density were not an important factor influencing calf survival. Further, only 3 percent of the radio-collared calf mortality was attributable to wolf predation.

Results of moose calf mortality studies in 1977 prompted initiation of a brown bear food habits study (Spraker et al. 1981; Ballard et al. 1981). This study confirmed the findings of the moose calf mortality study in that adult bears (≧3 yr. old) were preying upon ungulates (predominately moose calves) at the rate of 1 kill/6.1 days. Subsequently, in spring and summer 1979, 48 brown bears were transplanted from a 1,327 mi^2 (3,437 km^2) portion of the Susitna River study area, partially in an attempt to determine if the moose population would respond to a decrease in bear density. Details of the transplant and resulting bear population estimates were provided by Miller and Ballard (1980). Moose calf survival in the bear removal area increased by 24 calves:100 cows (≧2 yr. old) over 1978 levels (Ballard et al. 1980). Comparative moose count areas did not demonstrate increases in calf survival during the same period. High calf survival continued through winter 1979-80 as evidenced by the high survival of radio-collared yearlings and a spring calf:100 cow (uncorrected) ratio of 56 (Ballard and Gardner, unpub. data). This large increase in calf survival was the result of a temporary reduction in bear density of approximately 58 percent (Ballard et al. 1980; Miller and Ballard 1980). During this year of increased calf survival, wolf densities ranged from 1 wolf/169 mi^2 (438 km^2) in spring 1979 when the bear transplant was in progress to 1 wolf/64 mi^2 (166 km^2) by fall 1979. By spring 1980, wolf densities had increased to 1 wolf/109 mi^2 (282 km^2); within 89 percent of the spring 1975 pre-control wolf density. Thus, even though wolf densities increased, calf and short yearling moose survival remained high in the study area.

During 1976 and 1977, we grossly estimated the GMU 13 fall moose population at 11,000 to 19,000 animals based upon sightings of tagged moose (Ballard and Taylor 1980). Using this estimate we attempted to grossly model the dynamics of this moose population based upon our findings. Assuming a stable moose population of approximately 15,000 moose, over 10,000 moose calves are produced annually in GMU 13 based upon a pregnancy rate of 88 percent (Ballard and Taylor 1980) and a parturition rate of 1.15 calves/cow (Ballard and Cornelius, unpubl. data). According to predation rate data based on sightings of radio-collared bears (Spraker et al. 1981; Ballard et al. 1981) and wolf scat analyses from den and

rendezvous sites (this report), we calculated that brown bears were annually killing over 4,000 moose calves from mid-May to mid-July, while wolf predation was responsible for 434 to 1,013 calves annually during the same time period. Based upon the 15,000 moose population estimate and fall calf percentages derived from fall composition counts (ADF&G files), approximately 3,000 calves could not be accounted for by our simple model. Similar types of problems existed for adult moose mortality.

Application of observed wolf and bear predation rate data to the adult moose population estimate resulted in an estimate that roughly 25 percent of the adults succumbed to predation alone. This crude modeling attempt indicates that our predation rate and composition data are in error, and/or that adult moose population estimates are too low, and/or that our understanding of moose population dynamics are inadequate. Obviously more sophisticated modeling techniques could solve some of these problems. However, it is apparent that the lack of adequate moose population estimates will hinder attempts to quantify the effects of wolf and bear predation on moose. Attempts to quantify moose populations will be attempted in fall 1980 in conjunction with studies on the impacts of Susitna River hydroelectric development on moose. Perhaps these estimates will allow us to better quantify the effects of predation on moose.

Ballard et al. (1981) reviewed the causes of newborn moose calf mortality in three separate Alaskan moose populations: Kenai Peninsula, Tanana Flats, and this study. In all three studies predation was the leading cause of summer calf mortality: by black bears on the Kenai (Franzmann et al. 1980); wolves on the Tanana Flats (Gasaway et al. 1977); and brown bears in the Nelchina Basin (Ballard et al. 1981). Although predation by brown bears was especially significant in the Nelchina Basin, the GMU 13 moose population is probably receiving predation pressure from all three predator species in addition to human harvest.

In summary, data collected in this study do not support the hypothesis that wolves are responsible for the low calf moose survival reflected in fall moose composition counts in GMU 13. These data also appear to partially refute the hypothesis that at the observed densities wolves are responsible for high rates of adult moose mortality. If wolf control increased moose survival, the increases were not of sufficient magnitude to be reflected in fall moose counts or calf mortality studies. Predation rate studies, however, indicate that wolf predation may be an important cause of yearling and adult moose mortality. If moose survival increased as a result of lowered wolf densities it was certainly overshadowed by the increases in calf and probably adult moose survival resulting from the removal of brown bears.

RECOMMENDATIONS

1. To quantify the effects of both wolf and bear predation on GMU 13 moose; data from this and other related predator-prey studies should be used to model the moose population. This analysis would aid game managers in formulating strategies for managing predators and prey.

2. We should continue to annually monitor wolf numbers in GMU's 11 and 13 by both aerial survey and radio telemetry to determine changes in density, and aid in assessing the potential impact of wolf predation on moose.

3. For GMU's 11 and 13, we propose that game managers consider instituting a season bag limit of seven wolves in an effort to stabilize wolf numbers at a post hunting density of approximately 1 wolf/100 mi^2 of habitat. We speculate that establishment of this objective would maximize sustained wolf harvests and yet not allow predation on moose to become excessive.

4. Hunters and trappers should be required by regulation to return all tags, radio-collars, etc. from all species of wildlife marked for scientific study. Although implementation of this regulation will not guarantee compliance it will at least aid in informing the public that the information is needed.

5. Further research is needed to determine desirable predator-prey ratios for moose management. Both predator and prey densities should continue to be manipulated in the Susitna study area and the effects monitored to achieve this goal.

6. Wolf repopulation of the Susitna study should be monitored for at least 1 more year to gather additional data on population dynamics and rates of increase.

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Appendix I. Blood values of wolves sampled in Game Management Unit-13 of southcentral Alaska from July 1976 through May 1977.

Wolf Accession Number	Carbon dioxide (meg/L)	BUN (mg/dl)	Creatinine (mg/dl)	Bilirubin (mg/dl)	Uric Acid (mg/dl)	Total Protein (gm %)	Albumin (gm %)	Globulins (gm %)	Alpha 1 (gm %)	Alpha 2 (gm %)	Beta % (gm %)	Gama % (gm %)	A/G Ratio	Packed Cell Volume	% Hemoglobin
122001	4	47	1.3	0.0	3.6	7.90	3.72	4.18	0.25	0.21	1.86	1.86	0.89	-	-
122002	0	47	1.3	0.0	2.5	6.90	3.31	3.59	0.17	0.21	1.71	1.50	0.92	-	-
122003	11	42	1.2	0.0	2.6	7.30	3.23	4.07	0.28	0.23	2.01	1.55	0.79	-	-
122004	0	50	1.2	B	0.3	7.30	2.86	4.44	0.30	0.18	2.45	1.51	0.64	-	-
122007	14	71	0.7	0.5	-	6.95	3.36	3.59	0.47	0.47	1.90	0.60	0.95	-	-
122008	13	45	0.7	0.1	-	6.10	3.12	2.98	0.45	0.53	1.55	0.45	1.05	-	-
122009	11	59	1.0	0.2	-	6.20	3.40	2.80	0.24	0.57	1.37	0.62	1.21	-	-
122010	13	21	0.2	0.0	-	5.70	3.19	2.51	0.43	0.23	1.52	0.32	1.27	-	-
122011	14	24	0.8	0.1	-	5.50	3.08	2.42	0.25	0.48	1.32	0.36	1.27	-	-
122012	3	70	1.7	1.5	-	8.3g/dl	G	-	-	-	-	-	-	-	-
122017	11	54	1.5	0.6	3.2	8.00	3.60	4.40	0.23	0.12	3.37	0.68	0.82	-	-
122018	12	27	1.2	0.4	2.2	6.50	3.41	2.09	0.29	0.44	2.07	0.29	1.11	-	-
122019	10	16	1.1	0.1	1.3	2.80	1.85	0.95	0.12	0.12	0.64	0.06	1.94	-	-
122021	10	20	0.9	0.2	2.6	5.50	2.99	2.51	0.33	0.28	1.57	0.33	1.19	-	-
122022	10	29	0.8	0.2	2.6	6.70	3.23	3.47	0.39	0.76	1.95	0.37	0.93	-	-
122048	15	108	1.6	0.3	1.8	9.10	4.55	4.55	0.33	0.91	2.48	0.82	1.00	-	-
122049	14	89	1.5	0.2	2.1	9.50	5.60	3.90	0.52	0.69	2.36	0.33	1.43	-	-
122056	-	-	-	-	-	7.00	4.16	2.84	0.27	0.75	1.04	0.77	1.46	51	-
122057	12	36	1.1	0.0	0.9	6.70	3.30	3.40	0.25	1.00	1.96	0.20	0.97	-	-
122058	10	18	1.3	0.1	1.4	7.00	3.35	3.65	0.34	0.26	2.12	0.92	0.92	56	-
122061	12	23	1.1	0.0	1.1	5.50	2.87	2.63	0.39	0.52	0.85	0.87	1.09	-	-
122062	14	26	1.1	0.0	1.0	6.30	3.50	2.80	0.28	0.72	1.25	0.56	1.25	55	19.5
122063	15	52	0.8	0.0	0.5	4.70	2.44	2.26	0.33	0.31	0.99	0.63	1.08	49	20
122064	14	68	1.1	0.0	0.8	5.40	3.22	2.18	0.28	0.67	0.59	0.64	1.47	49	19.8
122067	13	25	1.3	0.0	1.3	5.50	2.40	3.10	0.27	0.95	1.64	0.24	0.77	43	-
122069	8	27	1.3	0.0	1.6	5.60	2.94	2.66	0.40	0.28	1.24	0.74	1.11	45	-
122070	18	48	0.9	0.0	2.1	5.30	2.92	2.38	0.33	0.42	1.27	0.36	1.23	37	-
122072	9	36	1.3	0.1	5.1	5.60	3.49	2.11	0.19	0.61	0.38	0.93	1.66	50	-
122083	12	60	1.3	0.1	1.4	7.60	4.18	3.42	0.40	0.54	1.31	1.17	1.23	58	-
122084	12	67	0.9	0.0	1.6	6.70	2.85	3.85	0.49	0.41	2.49	0.45	0.74	39	-
122085	12	79	0.8	0.0	1.9	6.20	3.21	2.99	0.43	0.37	1.80	0.40	1.07	-	-
122086	17	28	1.2	0.0	1.1	6.30	3.23	3.07	0.43	0.35	1.97	0.32	1.05	46	-
122087	12	28	1.2	0.1	0.4	6.80	3.45	3.35	0.46	0.26	2.08	0.55	1.03	40	-
122089	8	39	1.1	0.3	5.5	7.20	3.01	4.19	0.28	0.45	3.14	0.31	0.72	-	-

Appendix I (cont.).

Wolf Accession Number	Glucose (mg/dl)	Cholesterol (mg/dl/)	Triglycerides (mg/dl)		LDH (U/L)	SGOT (U/L)	SGPT (U/L)	Alkaline Phosphatase (U/L)	Phosphorus (mg/dl)	Calcium (mg/dl)	Iron (ug/dl)	Sodium (meg/L)	Potassium (meg/L)	Chloride (meg/L)
122001	9	207	18	G	89	D	247	-	12.2	198	157	G	125	
122002	266	227	86	G	D	D	67	G	13.3	295	153	G	118	
122003	79	217	7	G	63	57	119	G	11.7	259	G	G	130	
122004	0	194	87	G	T	T	38	G	12.9	359	158	G	114	
122007	70	113	73	323	300	T	28	4.3	8.8	188	G	6.4	124	
122008	104	117	22	94	41	75	109	7.5	9.9	165	145	6.1	114	
122009	79	163	23	232	238	229	64	2.7	8.1	189	G	6.1	130	
122010	102	180	6	137	108	103	176	8.7	12.3	98	159	6.4	122	
122011	106	161	25	127	96	86	182	6.8	9.9	112	155	5.7	122	
122012	-	241	145	G	T	T	69	G	8.0	231	148	G	94	
122017	11	262	110	G	20	T	130	G	12.8	250	151	G	104	
122018	154	241	30	G	D	D	358	G	13.8	195	148	G	105	
122019	479	110	20	165	138	64	113	4.0	6.6	73	110	6.5	82	
122021	73	216	29	G	-	307	161	10.0	11.3	173	132	G	95	
122022	56	221	35	G	-	308	162	G	12.5	148	143	G	102	
122048	51	232	152	262	220	101	69	5.7	13.4	317	G	6.3	G	
122049	50	268	78	389	157	121	76	5.8	G	353	G	6.6	G	
122056	-	-	-	-	-	-	-	-	-	-	-	-	-	
122057	137	222	15	177	336	384	163	3.6	10.4	186	146	4.4	123	
122058	133	180	18	1070	1070	830	30	3.6	9.6	196	149	7.2	118	
122061	274	145	31	95	50	38	78	2.9	10.2	112	147	4.4	121	
122062	95	140	27	163	93	65	35	1.5	10.3	154	148	4.8	119	
122063	176	125	54	128	134	111	64	2.8	8.7	121	147	4.5	119	
122064	132	116	57	109	157	127	24	2.1	9.3	150	148	4.2	121	
122067	106	128	37	3500	2780	892	114	6.9	8.9	184	142	9.9	110	
122069	58	135	82	1222	1250	400	131	13.0	13.6	150	142	14	107	
122070	59	148	229	510	486	208	134	9.6	11.6	110	147	8.6	105	
122072	334	140	52	213	126	63	32	7.4	10.6	88	148	9.6	115	
122083	32	177	18	444	182	112	38	4.1	9.8	269	153	5.4	123	
122084	110	255	62	234	121	71	78	3.9	9.3	148	145	5.9	119	
122085	83	152	126	214	264	118	33	2.8	8.0	139	148	5.2	115	
122086	92	191	11	206	92	76	86	3.3	10.6	128	150	5.1	117	
122087	53	185	30	G	161	88	38	2.3	11.0	79	148	5.0	120	
122089	102	239	240	G	T	T	252	G	11.1	178	148	G	111	

Appendix II. Hair mineral element values (ppm) from wolves harvested and radio-collared in GMU's 11 and 13 of southcentral Alaska from June 1976 through May 1977.

Accession Number	Zn	Cu	Ca	Mg	K	Na	Cd	Co	Fe	Pb	Mn	Cr
122001	237	28	1540	185	1460	6030	0.9	0.10	112	6	0.8	0.1
122002	178	15	690	95	540	5770	1.2	0.16	45	2	0.3	0.1
122003	164	19	1210	120	1030	5960	1.1	0.14	144	8	0.8	0.2
122004	160	11	870	95	580	5770	1.1	0.14	74	6	0.6	0.5
122008	171	14	400	60	610	5700	1.0	0.13	59	<1	0.3	0.3
122009	222	14	680	120	790	5720	1.3	0.16	58	6	0.4	0.8
122010	172	10	380	60	820	5790	1.1	0.15	59	<1	0.3	0.3
122011	223	17	520	95	1120	5820	1.3	0.14	63	4	0.4	0.1
122012	169	10	480	40	390	5670	1.1	0.27	61	<1	0.4	<0.1
122013	175	17	580	70	490	5300	0.8	0.17	80	4	0.2	<0.1
122014	202	10	770	110	1470	6320	1.1	0.19	76	<1	0.4	0.6
122015	85	10	250	45	4690	6120	1.0	0.15	74	<1	0.7	<0.1
122016	272	35	850	100	1920	5930	1.2	0.14	87	<1	0.8	0.3
122017	165	13	420	65	410	5520	1.3	0.14	64	<1	0.6	0.3
122018	175	10	390	30	1200	5720	1.3	0.21	65	3	0.2	0.2
122019	150	16	740	85	1960	5790	1.3	0.18	71	<1	0.6	<0.1
122020	142	18	620	95	790	5870	0.9	0.13	76	14	0.3	0.1
122021	177	32	1140	125	2800	5910	1.4	0.20	105	8	0.6	0.4
122022	151	14	650	55	2030	5860	1.0	0.18	74	16	0.4	<0.1
122023	193	12	335	145	1585	2470	1.2	0.21	50	1	1.3	0.4
122024	149	20	700	95	1270	5220	IS	IS	IS	IS	IS	IS
122025	169	6	630	125	965	1350	1.4	0.19	7	<1.0	1.1	0.2
122027	195	9	465	95	445	730	1.5	0.25	20	2	0.9	0.4
122028	196	13	1285	235	470	1715	1.4	0.24	53	6	1.3	0.2
122029	180	6	275	80	525	1390	1.5	0.16	17	8	1.0	0.3
122030	168	8	365	125	915	2090	1.7	0.25	35	<1.0	1.2	0.2
122031	188	16	395	200	1940	2970	1.4	0.19	121	12	1.0	0.4
122032	213	13	215	110	585	880	1.5	0.14	30	7	0.9	<0.1
122033	194	8	200	120	1090	860	1.3	0.19	15	<1.0	0.9	<0.1

Appendix II (cont.). Hair mineral element values (ppm) from wolves harvested and radio-collared in GMU's 11 and 13 of southcentral Alaska from June 1976 through May 1977.

Accession Number	Zn	Cu	Ca	Mg	K	Na	Cd	Co	Fe	Pb	Mn	Cr
122075	168	9	220	55	430	815	1.4	0.21	20	9	1.2	0.7
122076	172	8	220	90	855	3235	1.4	0.27	29	9	1.4	1.0
122077	174	8	255	95	1245	3175	1.6	0.25	31	8	1.1	0.8
122078	133	7	230	70	470	3275	1.6	0.26	25	13	1.1	0.9
122081	155	<1.0	465	115	600	910	1.1	0.19	23	<1.0	0.6	<0.1
122083	241	1	1170	285	700	1600	1.5	0.30	98	9	1.1	0.4
122084	197	<1.0	665	125	300	780	1.1	0.10	179	8	0.8	0.1
122085	183	4	450	115	345	555	1.5	0.19	52	9	0.5	0.3
122086	206	5	1185	165	720	1610	1.1	0.21	69	14	0.7	<0.1
122087	161	<1.0	890	200	715	490	1.1	0.17	49	<1.0	1.0	<0.1
122088	194	3	760	215	845	550	1.0	0.20	50	9	0.6	<0.1
122089	171	<1.0	895	185	495	1385	1.3	<0.1	170	13	0.5	<0.1

Appendix III. Copy of paper presented at Portland Wolf Symposium, held in Portland, Oregon in August 1979 (J. O. Sullivan and P. C. Paquet, co. eds.

GRAY WOLF - BROWN BEAR RELATIONSHIPS IN THE NELCHINA BASIN OF SOUTHCENTRAL ALASKA

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ABSTRACT: From June 1976 through June 1978, 16 wolf (*Canis lupus*) packs were observed at 130 kills in the Nelchina Basin. Seventeen of these kills were contested by brown bears (*Ursus arctos*). Nine of the 17 kills contested by both bears and wolves were observed in conjunction with studies of the Mendeltna wolf pack. Comparisons of predation rates, predator densities and prey densities were made between two packs which were intensively studied during late May and June 1977 and 1978. It was suggested that the disproportionate number of bear-wolf encounters at kill sites for the Mendeltna pack was primarily the result of a lower moose (*Alces alces gigas*) density in the Mendeltna area. Descriptions of bear-wolf encounters are given. Mortality of each predator species as a result of encounters is also described. Possible significance of these observations to predator-prey relations is discussed.

INTRODUCTION

The wolves of southcentral Alaska have been the focus of interest and study for over 30 years. From 1948 to 1953 poisoning by the Federal Government reduced populations of wolves to low levels. In 1953 only 12 wolves were estimated to survive in the Nelchina study area described by Rausch (1969). Bears, wolverines (*Gulo gulo*), other carnivores and some omnivores were probably reduced by these Federal poisoning efforts. The wolf population gradually increased and reached a peak of 400 to 450 animals in 1965. Rausch (1969) summarized the status of wolves in this region from 1957 through 1968.

Rausch (1969), Bishop and Rausch (1975), and McIlroy (1974) described the history of the Nelchina Basin moose population. The moose population began declining after the severe winter of 1961-62. The decline continued with severe winters occurring in 1965-66 and 1971-72. Although wolf predation was not suggested as the main reason for the population decline, it was thought to have at least accentuated the decline, and perhaps more importantly, prevented recovery during mild winters (Bishop and Rausch

1975). This trend of thought, coupled with the findings of Stephenson and Johnson (1972, 1973), which revealed high percentages of calf moose in wolf scats, suggested that wolf predation on moose calves was preventing the moose population from recovering. Consequently, in 1975 a series of studies on wolf-moose relationships were initiated. These studies were later expanded to include brown bear-moose relationships. Information pertaining to these studies was reported by Stephenson (1978), Ballard and Taylor (1978a,b), Ballard and Spraker (1979), Spraker and Ballard (1979) and Ballard et al. (in press). Considerable attention was focused on gathering wolf food habits information during the late spring and summer when most moose calf mortality occurred. The purpose of this paper is to report on observed encounters between bears and wolves during these studies, and to discuss the significance of such interactions.

MATERIALS AND METHODS

Radio-collared wolves were tracked and visually observed, when possible, from fixed-wing aircraft. These methods were similar to those described by Mech (1974). Monitoring intensity varied seasonally and from pack to pack but consisted of at least bimonthly efforts during winter months. Two wolf packs were intensively studied during the summers of 1977 and 1978 and were located either once or twice daily from late May to mid-July in 1977 and to late June in 1978.

Ages of captured wolves were determined on the basis of tooth eruption and wear. During radio-tracking, ages of unmarked wolves were occasionally estimated on the basis of relative sizes and also by the criteria described by Jordan et al. (cited in Mech 1970). The age-sex structure of certain packs was not ascertained until the animals had been killed by hunters and trappers. Hunters and trappers were encouraged to provide us with wolf carcasses taken in the study area by offering $10.00 per carcass. Ages of harvested wolves were determined by examining epiphyseal cartilage of the longbone according to methods described by Rausch (1967).

Moose kills were classified as calf, yearling or adult from fixed-wing aircraft based on combinations of size, pelage, and antler growth. When practical, wolf kills were examined on the ground. Cause of death was determined according to methods described by Stephenson and Johnson (1973) and Ballard et al. (in press).

Observations of circumstances surrounding bear-wolf encounters were recorded, as they occurred, in a notebook and then elaborated upon after the flight ended. When it became apparent that more than two or three observations

would be collected, notes were recorded on a Sony tape recorder (Model TC-55) and transcribed after the flight had terminated.

Wolf summer home ranges were determined by plotting all radio locations for individual packs and then connecting the outermost observations. Sizes of home ranges were determined with a compensating polar planimeter.

Study Areas and Wolf Pack History

The study was conducted in Game Management Unit 13 of southcentral Alaska. The area, commonly referred to as the Nelchina Basin, consists of approximately 61,595 km^2 of which 18,798 km^2 is over 1,200 m elevation.

The study was conducted primarily in those portions of the unit lying north of the Chugach Mountain Range and east of the Talkeetna Mountains. Year-round studies involved up to 16 wolf packs. Only data pertaining to wolf-bear relationships and their implication to wolf summer food habits will be presented here.

Mendeltna Wolf Pack

The Mendeltna wolf pack occupied the Lake Louise and Oshetna River Range Units described by Skoog (1968). Boundaries of its year-round territory are depicted in Figure 1.

Generally, the area consists of a level plateau of wet muskeg interspersed with numerous ponds and lakes. Drier, rolling hills on the western portion of the area comprise the foothills of the Talkeetna Mountains. Elevations range from about 600 m to 1,170 m on the western edge in the Talkeetna Mountains. Much of the lowland areas is vegetated with sparse to dense stands of black spruce (*Picea mariana*) and white spruce (*P. glauca*) interspersed with wet muskegs containing several species of sedges (*Carex* sp.), grasses, willow (*Salix* sp.), and birches (*Betula* sp.). Drier, better drained sites contain a mixture of white spruce, willow and shrub birch (*Betula glandulosa*). In the higher, western portion of the area spruce densities decline and the area is a transition between spruce-muskeg and subalpine-tundra. All stream courses are vegetated with willows and birch. Sparse stands of spruce occur on southerly exposures. Well-drained, sandy sites on the lowlands often contain homogenous stands of aspen (*Populus tremuloides*). Understory vegetation is comprised of varying densities of low bush cranberry (*Vaccinium vitis-idaea*); high bush cranberry (*Viburnum edule*) and two species of blueberry (*Vaccinium ovalifolium* and *V. uliginosum*). Lichens are found in varying density throughout the area. All study areas contain old burns which are more than 30 years old.

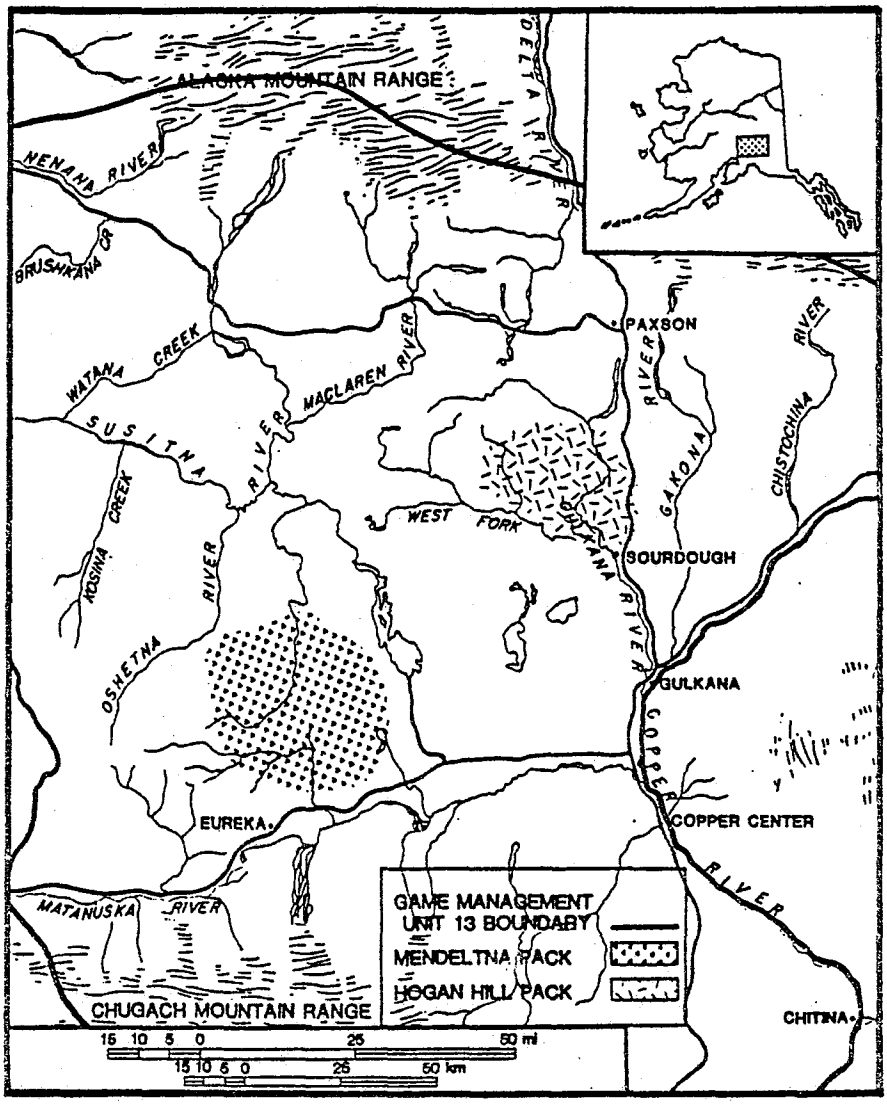

Fig. 1. Map of Game Management Unit 13 and year-round territories of two wolf packs intensively studied during summers 1977 and 1978 in the Nelchina River Basin of southcentral Alaska.

During the 1977 season, the Mendeltna pack numbered seven adults of which two to four were yearlings. Two adults and one yearling were radio-collared. This pack occupied a summer home range of approximately 829 km^2. During the 1977 season the pack had two den sites at which two litters, totaling at least eight pups, were raised.

Hogan Hill Wolf Pack

This pack was located in the Alphabet Hills (Fig. 1). The area comprised portions of Skoog's (1968) Lake Louise and Alphabet Hills Range Units. The northern two-thirds of the area is comprised of "low rounded hills" with elevations reaching about 1600 m. Higher elevations are characteristic of subalpine tundra. Lower elevations are thickly vegetated with white and black spruce. Several creeks bisect the area, draining primarily into the Gulkana River. The southern slopes of the Alphabet Hills, which were predominantly utilized by the Hogan Hill pack during summer 1978, are thickly vegetated with spruce and willow along stream bottoms and adjacent to ponds. As the area levels out, vegetation becomes similar to that of the Lake Louise Flats although spruce, willow and birch densities appear greater.

During 1978 the Hogan Hill pack was comprised of eight adults of which at least two were yearlings. One adult and two yearlings were radio-collared. In 1978 the pack maintained one den site at which at least five pups were raised. They ranged over an area of approximately 570 km^2 during early summer 1978. Boundaries of the year-round territory are shown in Fig. 1.

RESULTS AND DISCUSSION

From June 1976 through June 1978, 16 study wolf packs were observed on 130 kills, of which approximately 75 percent were moose (Ballard and Spraker 1979). Of that total, 17 (13.1%) were contested by brown bears. In most instances I was unable to determine which predator species had made the kill. During the summers of 1977 and 1978 I intensively studied one different wolf pack each year and was able to document some of the circumstances surrounding bear-wolf encounters at, and away from, kill sites. Because such observations are rarely witnessed, my notes and interpretations of bear-wolf encounters for the Mendeltna Pack during summer 1977 are summarized chronologically below.

On 11 June, at 2500 hr., adult gray-black female wolf 07 was observed being chased by a cow moose which was exhibiting aggressive behavior (mane ruffed-up and ears down). Wolf would veer off a straight line in what appeared to be an attempt to lose the pursuing cow. When wolf appeared

to lose cow by crouching in brush, the cow would search for the wolf and in three instances was able to find it. The cow gained ground on the wolf which appeared to tire. On one occasion the wolf stopped and crouched in the brush. The cow ran over to the area and appeared to trample the wolf. Wolf then continued running but at a much slower pace and with a limp. The chase lasted approximately 15 minutes, at which time the wolf appeared to head for den site, while the cow began traveling back the direction from which it had come. Cow continued to exhibit aggressive behavior. Cow began swimming a pond on the other side of which I observed a brown bear sow with three yearling cubs. The cubs were huddling over and dragging around a calf moose carcass. Cow ran around the bears within a 40-50 m radius. Wolf 08, a yearling male, was present in dense spruce some 150-175 m away from the bears, but was not observable. I returned to the calf kill at 2230 hr. via helicopter and frightened the bears, which were huddled over the calf carcass, away from the site. Examination of kill revealed puncture marks on the neck and either puncture or claw marks on the anus. Only the head had been fed on. The skull was cleaned out so that all that remained was skin casing. Tongue, eyes and ears had been eaten which was characteristic of bear-killed calves (Ballard et al., in press). Imprints were noted in area and bear hair was noticeably evident on surrounding brush. Interpretation: Bears made the kill and wolves were attempting to scavenge, but were chased away by cow or bears or both.

On 12 June, at 0910 hr., wolf 83, an adult gray male, and a smaller, drabber gray adult of unknown sex were observed chasing and harassing same bears observed the previous evening. The wolves stayed fairly close to each other while chasing the fleeing bears. When the bears stopped running one wolf would crouch and approach the sow. The sow would charge the approaching wolf at which time the other wolf would would charge and chase the yearling cubs causing the sow to charge the second intruding wolf. On one occasion the wolves treed all three cubs. The wolves appeared to press their charge when the bears' direction of movement was towards den #2 which was less than 2 km away to the east. On one occasion the radio-collared wolf was observed sneaking around and crouching down in front of the bears' direction of movement. Apparently the sow detected this action because when she was approximately 10 m away, she charged the crouched wolf and almost caught it by the hind quarters. It appeared that when the bears finally established a trend of movement away from the den, the wolves no longer pursued and began heading back towards the den. These activities lasted 15 minutes and covered 0.6 km from where we first observed the bears. Interpretation: Wolves discouraged bear movement towards wolf den.

On 14 June, at 1720 hr., wolf 08 (yearling gray male) was observed alone resting on sand bar. Approximately 60 m away a single adult brown bear was feeding on an adult moose kill estimated to be 80 percent consumed. Wolf appeared to have swollen abdomen, indicating it also had fed on the kill. Interpretation: Kill made by wolves and wolves displaced by bear.

On 15 June, at 0850 hr., wolves 83 (adult gray male), 08 (yearling gray male), and one black yearling were observed approaching moose calf kill which had one sow and one yearling brown bear feeding on it. Kill was estimated to be 80 percent consumed with guts and hide remaining. Approach of airplane and perhaps wolves frightened bears causing them to run from kill. Wolves went directly to kill and began feeding. Interpretation: Kill made by bears, observer approach and/or wolves caused bears to leave kill which was taken over by wolves.

On 16 June, at 1945 hr., wolves 83 (adult gray male), 08 (yearling gray male), a small gray adult of unknown sex, and one black yearling of unknown sex were observed attacking an adult brown bear which possessed an adult moose kill. Initially three wolves were observed equally spaced surrounding the bear. One of the wolves was observed attempting to nip the bear in rump. Bear made several short charges at wolves which were approaching to within 3-5 m. Wolves easily out manuevered the bear and three of the wolves appeared to keep the bear away from the kill as a fourth wolf fed on it. The bear's direction of movement was toward the kill and after 15 minutes of encountering the wolves, the kill was reached. When the bear reached the kill the wolves stopped harassing the bear and began traveling in the direction of the main den. Kill was estimated to be 50 percent consumed. Interpretation: Either bear or wolves made kill and wolves were attempting to displace bear.

On 22 June, at 0829 hr., wolves 83 (adult gray male) and one adult gray were observed feeding on what I identified as a moose calf. Ground inspection of the kill site at 1200 hr. revealed the kill had been misidentified. Instead of a calf moose, the wolves had been feeding on a yearling brown bear. A portion of the carcass had been buried, but most had been consumed. The kill site contained tracks of a small bear and wolf. Interpretation: Yearling bear was killed by wolves.

On 24 June, at 1655 hr., wolf 83 (adult gray male) was observed alone resting approximately 10 m from an adult moose kill with one adult brown bear on it. Head, rear quarters, guts and skin were all that remained. Interpretation: Kill was made by either wolves or bear. Wolf may have been attempting to scavenge and/or displace

bear. On 29 June three wolves were observed feeding at kill site.

On 27 June, at 2200 hr., wolves 83 (adult gray male), one gray adult and one black yearling were observed resting close to one adult brown bear which was feeding on calf moose kill. Estimated kill to be 50 percent consumed with head and front quarters missing. Bear seemed unconcerned by presence of wolves. Bear was still present on 28 June at 1000 hr. and had carcass almost consumed. Interpretation: Kill made by either bears or wolves. Wolves attempting to scavenge and displace bear.

On 8 August, at 0730 hr., wolves 83 (adult gray male), one gray adult, one gray yearling and one black yearling observed scattered around an adult moose kill with one brown bear on it. Two grays and one black were observed huddled together touching noses and wagging tails before separating and charging bear, running it away from kill. A third gray hidden by a large spruce ran to the kill and tore off a large chunk of flesh as the returning bear charged. Another gray followed carrying the meat into the dense spruce. Several bear charges were observed. Bear remained in possession of kill. Interpretation: Either bear or wolves made kill. Wolves attempted to scavenge and/or displace bear.

Aggressive behavior between the two predator species occasionally results in mortality to the participants. Joslin (1966) reported that an adult female wolf was killed close to a den by a black bear (*Ursus americanus*). In September 1976, a member of the Mendeltna pack was killed by a brown bear probably as a result of competition over an adult moose kill. Details of this particular observation were presented in Ballard (in press). Mech (1970) thought that occasionally wolves killed bears, but that the victims were probably cubs, young bears, or older weakened bears. Murie (1944) suggested that bear-wolf encounters were more intense on the part of wolves when they occurred close to wolf dens. The Mendeltna wolves exhibited agonistic behavior towards bears both at kills and in areas close to den sites. Observations recorded during this study substantiate that wolves do occasionally kill bears. The result of brown bear-gray wolf encounters, therefore, may at times be an additional source of natural mortality not previously documented for either predator species. Whether it is a significant source of mortality for either species is unknown.

Reasons for Contested Kills

During summer 1977 the Mendeltna pack had six contested kills in addition to several bear encounters away from kill sites. In contrast, during a similar study period in 1978

when the Hogan Hill pack was studied, none of six kills were contested and no bear encounters away from kills were observed. Reasons for the larger number of contested kills for the Mendeltna pack may be related to a number of factors including: (1) observability, (2) predator density and (3) prey density.

If there was a difference in observability between the areas, it was not detectable. During summer 1977, the three radio-collared members of the Mendeltna pack were observed on 188 of 224 (83.9%) occasions they were located. In comparison, the three radio-collared members of the Hogan Hill pack were observed on 97 of 114 (85.1%) occasions.

Differences in bear density are unlikely to have caused the disproportionate number of contested kills in the Mendeltna area. Although no accurate estimates of bear density exist, tagging data and sightings of bears (Ballard and Taylor 1978a, Spraker and Ballard 1979) suggest the study areas had similar densities, approaching one bear per 39 km^2. There were, however, differences in wolf densities (Table 1). Based upon areas occupied during summer, wolf densities ranged from one wolf/ 73 km^2 for the Hogan Hill pack to one wolf/119 km^2 for the Mendeltna pack. Thus the area with the lowest wolf density had the largest number of kills contested by bears. Differences in wolf density may have been partially related to the maintenance of two den sites, 8 km apart, by the Mendeltna pack, but was more likely related to differences in prey density.

Numbers of moose counted in fall sex and age composition surveys from 1976 through 1978 were utilized to calculate a crude approximation of moose density (Table 1). The number of moose per 2.6 km^2 counted in the Alphabet Hills count unit containing the Hogan Hill wolf pack territory was 1.10, while .88 moose per 2.6 km^2 was counted in two count units containing the Mendeltna wolf pack territory. Therefore, the area with the highest wolf density also had the highest moose density.

I speculate that the bear-wolf encounters observed while studying the Mendeltna wolf pack were due primarily to lower moose densities in that area. This speculation was supported by predation data collected by monitoring radio-collared bears. These data indicate that bears took substantial numbers of moose in all of the areas studied (Ballard and Spraker, in prep.). Thus, for the Hogan Hill area, where moose were more abundant, no kills were contested, because, I suspect, sufficient moose were available for each predator during the study period.

Speculation that low prey densities were responsible for the disproportionate number of contested kills for the Mendeltna wolf pack was also supported by data on the

Table 1. Summary of predator-prey statistics for two wolf pack areas intensively studied during early summer 1977 and 1978 in the Nelchina Basin in southcentral Alaska.[1/]

Pack Name	Study Period	Wolf Density Within Summer Range ($Wolf/km^2$)	Moose Density ($Moose/2.6\ km^2$)	# of Kills Wolves Present	No. and % of Bear-Wolf Contested Kills	Known Kill Rate (Days/Kill)	Feeding Rate (Days/Feed)	Available Prey Biomass (kg)	Kg. Prey Biomass Per Adult Wolf/Day
Hogan Hill	28 May - 21 June 1978	1/73	1.10	6	0 = 0%	4.0	4.0	841	4.4
Mendeltna	27 May - 15 July 1977	1/119	.88	11	6 = 55%	10.0	4.6	2,173	6.2/4.7

1/ Biomass of available food based upon following assumptions: Weight of adult moose = 427.5 kg (from Franzmann and Bailey 1977) and yearling moose = 197.5 kg. (from Franzmann and Arneson 1973, 1975) of which approximately 75% (from Peterson 1977) available as food yielding 321 kg. and 148 kg., respectively.

Newborn calf moose weights 13.3 kg. (from Ballard and Taylor 1978) and gains weight at rate of 1.3 kg/day (from Franzmann and Arneson 1973). Therefore, 15 day old calf weighs 32.8 kg., of which 90% is consumable yielding 29.5 kg.

Yearling brown bear weighs 45 kg. (from Spraker and Ballard 1979) of which 75% is consumable yielding 34 kg.

Snowshoe hare weighs 1.4 kg. (from Burt and Grossenheider 1964) of which all is consumable yielding 1.4 kg.

chronology of calf moose mortalities. During 1977 and 1978, 79 percent of radio-collared calf mortality was attributed to predation by brown bears (Ballard et al., in review). During 1977, when the Mendeltna pack was being intensively monitored, 53 percent of all calf mortalities had occurred by 11 June. These data correspond with the date of the first observed contested kill between the Mendeltna wolf pack and brown bears. This suggests that ample moose were available for both predator species until mid-June but not afterwards. If correct, then bear-wolf encounters at kills for the Hogan Hill wolf pack would be expected to occur at a later date had a declining prey base influenced its occurrence. Although daily contact with the Hogan Hill pack terminated on 21 June, two and possibly three of four kills observed between 1 July and mid-November were contested by bears with the first contested kill occurring on 4 August. Therefore, I suspect that had I continued intensively monitoring the Hogan Hill Pack beyond 21 June, I would have observed contested kills before 4 August.

Significance of Contested Kills to Predator Ecology

During this study I was unable to quantify how much was eaten by each predator species at a particular kill site because the observation periods were too short and in some cases, my presence may have interfered. In many cases, however, it it was apparent that both species were able to feed at many of the kills for varying lengths of time. The amount consumed by wolves at a particular kill site could alter kill rates and influence how kill data are interpreted.

From 27 May through 15 July 1977, during intensive monitoring of the Mendeltna wolf pack's activities, all or some, Mendeltna wolves were observed on 11 kills. The kills included 6 adult moose, 3 calf moose, 1 yearling moose and 1 yearling brown bear. In comparison, from 28 May through 21 June 1978 members of the Hogan Hill Pack were observed on 6 kills comprised of 2 adult moose, 2 calf moose, 1 yearling moose and 1 of unknown species. Based upon these data, wolf kill rates were calculated for kills which were known to have been made by wolves and for kills when bears were involved (Table 1). The latter rates are referred to as feeding rates. For known wolf kills there was a large difference in kill rates: one kill every 4.0 days for the Hogan Hill Pack which numbered eight adults versus 10.0 days for the Mendeltna Pack which numbered seven adults. However, when bear contested kills were added the Mendeltna Pack rate increased to one kill every 4.6 days while the Hogan Hill Pack rate remained unchanged.

The amount of prey biomass available per adult wolf was calculated for both study packs (Table 1). Two values were calculated for the Mendeltna Pack: the first value assumed

that all of the prey biomass was available to wolves even though bears were present on some kills while for the second value I arbitrarily assumed that only 50 percent of the biomass on bear contested kills was available to wolves. Although I could not determine how much was eaten by either predator at a kill site, I did observe that both usually fed on some quantity. Regardless, the range of 4.7 to 6.2 kg/wolf/day of available food for the Mendeltna Pack was greater than the rate of 4.4 kg/wolf/day calculated for the Hogan Hill Pack.

Both the kill and consumption rates during summer for the Mendeltna and Hogan Hill wolf packs fall within the range of values reported in the literature for the winter season. Mech (1970) reported that a pack of 15 to 16 wolves had a kill rate of one moose per 3.0 days to one moose per 3.7 days on Isle Royale. Fuller and Keith (in press) reported a kill rate of one moose per 4.7 days for a pack of nine wolves in northern Alberta. Peterson (1977) reported food availability of 4.4 to 10.0 kg/wolf/day for Isle Royale wolves from 1971 through 1974 which was considerably less than the average consumption rate of 22 kg/wolf/day derived by Mech (1970). Mech (cited in Peterson 1977) determined that one Minnesota wolf pack declined after a winter when only 3.0 to 3.4 kg/ wolf/day of food was available, increased at 5.8 kg/wolf/day, and remained stable at 3.6 kg/wolf/day. Mech (1970) reported that a higher kill rate occurred when calf moose comprised a larger percentage of the prey taken. The same appeared to be true during this study.

Stephenson (1978) speculated that competition from bears at wolf kills could result in an increase in the wolf predation rate. Data presented from this study indicate that, if true, the increase may not be detectable with the study methods used. Competition at kill sites could increase bear predation rates, however, no data were collected on this aspect.

Within recent years, scat analyses have been used to determine wolf food habits. Although most such studies have acknowledged that the derived data represent what was eaten rather than what was actually killed, the observations of wolf-bear encounters further emphasize the need for caution when analyzing both wolf and bear scat data and interpreting their significance to predator-prey relationships. If both species were feeding on the same kill, the resulting food data could only be viewed as that obtained by scavenging.

Only within recent years have both black and brown bears been identified as significant predators of cervids (Schlegel 1976, Franzmann and Schwartz 1978, Ballard and Taylor 1978, and Ballard et al. In Press). The fact that both predator species have potential to not only prey upon

ungulate species, but also to scavenge and interact with one another could greatly complicate our attempts to understand predator-prey relationships.

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Appendix IV. Copy of manuscript submitted to Canadian Field Naturalist

Surplus Killing of Caribou by Wolves

STERLING H. EIDE AND WARREN B. BALLARD Alaska Department of Fish and Game, P.O. Box 47, Glennallen, Alaska 99588

Eide, S. H. and W. B. Ballard. 1981. Surplus Killing of Caribou by Gray Wolves. Canadian Field-Naturalist.

Seven apparently healthy adult caribou were killed and only partially consumed by a pack of two to four Gray Wolves in late March 1979 along the Copper River in southcentral Alaska. Deep snow contributed to the vulnerability of the Caribou.

Key Words: Gray Wolf, *Canis lupus*, Caribou, *Rangifer tarandus*, surplus killing.

Several investigators have documented instances in which Gray Wolves (*Canis lupus*) have killed more prey than they consumed. Most of these incidents of surplus killing (Kruuk 1972) occurred during winter months. Mech et al. (1971) reported surplus killing of White-tailed Deer (*Odocoileus virginianus*) in Minnesota; in Sweden, Bjarvall and Nilsson (1976) reported surplus killing of eight domestic Reindeer. Miller and Broughton (1974) observed surplus killing of Caribou (*Rangifer tarandus*) calves during summer 1970. All of these observations, although of interest to students of predator/prey relationships, represent the exception to generally accepted predation principles. To better interpret their significance to both predator and prey, further explanation of circumstances surrounding such observations is needed. We describe what appeared to be surplus killing of Caribou by Gray Wolves during winter 1979 in the Nelchina Basin of southcentral Alaska and provide an interpretation of the events leading to this phenomenon.

On 31 March 1979, seven Caribou carcasses were observed within a 1 km radius along the Copper River near its confluence with the Indian River. On the basis of tracks, puncture marks and subcutaneous hemorrhaging, we inferred that these Caribou had been killed by a pack of two to four Gray Wolves. The amount of flesh taken from these carcasses was subjectively estimated as follows: 1 - 90%, 5 - 50%, 1 - 20%. Because all carcasses had been scavenged by Bald Eagles (*Haliaeetus leucocephalus*), Ravens (*Corvus corax*) and Red Foxes (*Vulpes fulva*), it was difficult to estimate the amount consumed by Wolves.

Ages of Caribou were estimated on the basis of mandible wear (Skoog 1968). Percent of fat of the femur was used as

an indicator of physical condition using methods described by Neiland (1970). Ages ranged from 2 to 5 years and the percentage of fat in femurs ranged from 52 to 88 percent, and averaged 74 percent (Table 1). All would have been placed in Cheatum's (1949) visual index classification 3 or 4, indicating that based on femur marrow the animals were in relatively fair physical condition. Neiland (pers. comm.) considered Caribou with less than 25 percent fat to be in relatively poor physical condition.

Mech (1970) discussed the likelihood of deep snow contributing to excessive killing by Wolves. On 29 March 1979 (U.S. Geological Survey 1979) snow depth at a snow course near the Sanford River was 92 cm. This was 44% above the 12-year average of 64 cm. Only during the severe winter of 1971-72 have snow depths exceeded those recorded on 29 March 1979. Therefore, deep snow possibly made these Caribou especially vulnerable to Wolves. Four of the Caribou were killed on the Copper River where snowpack was hard and footing good, but tracks indicated they were chased through deep snow before reaching the river and likely were exhausted. The other carcasses were located in deep snow which clearly had impeded their movements.

During relatively mild winters, Wolves completely consume most Caribou killed (Ballard and Spraker 1979). However, during relatively severe winters, trappers, guides and others have reported the occurrence of multiple, simultaneous killings of Caribou and subsequent failure to consume large percentages of the flesh. Perhaps during severe winters surplus killing by Wolves may be more common than previously suspected. If this were true, predation by Wolves could be considered an important factor contributing to the decline of Caribou herds during severe winters.

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Appendix V. Copy note published in Canadian Field Naturalist.

Brown Bear Kills Gray Wolf

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Ballard, W. B. 1980. Brown Bear Kills Gray Wolf. Canadian Field-Naturalist 94(1):000-000.

Ground examination indicated a Brown Bear (*Ursus arctos*) had killed a Gray Wolf (*Canis lupus*) at an adult Moose (*Alces alces gigas*) carcass in southcentral Alaska. The observation represents first published evidence of a Gray Wolf mortality inflicted by a Brown Bear.

Key Words: Gray Wolf, *Canis lupus*, Brown Bear, *Ursus arctos*, mortality, Moose kill, *Alces alces gigas*, interspecific relationships.

Several known and potential natural mortality factors have been described for Gray Wolves, *Canis lupus* (Mech 1970). This report describes a cause of mortality not previously documented.

On 25 September 1976, while conducting wolf ecology studies in the Nelchina Basin of southcentral Alaska, I aerially tracked a wolf pack (6 gray and 3 black wolves) to an adult Moose (*Alces alces gigas*) kill. The Moose kill appeared to be less than 2 days old, on the basis of both color of exposed flesh and degree of consumption (50%).

The next day Alfred Lee, Lee's Air Taxi Service, found a dead Gray Wolf close to the kill and observed a Brown Bear (*Ursus arctos*) running from the site. The site was examined from the ground the following day. The dead adult male Gray Wolf was at the base of a White Spruce tree (*Picea glauca*) approximately 10 m from the Moose, and the Moose had been buried. Tracks, plus extensively disturbed vegetation and soil indicated a fight had occurred.

The wolf had numerous punctures on its throat and around its anus. At least three cervical vertebrae and the rear portion of the occipital condyle were crushed. The left rear femur was fractured.

Evidence indicated that the Brown Bear had killed the Gray Wolf. An alternate explanation is that other wolves had killed the animal. Because the victim had been a regular pack member, and the bone damage was not typical of other wolf-killed wolves examined, it seems unlikely that the wolf was killed by pack members.

Murie (1944) mentioned that it was not infrequent for bears to discover kills made by wolves and disposess the wolf to assume ownership. This observation, however, is the first published evidence of Gray Wolf mortality inflicted by a Brown Bear. The importance of this type of mortality to Gray Wolf populations is unknown.

I am grateful to Thomas Balland for assisting with field observations.

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