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UNIT 13 WOLF STUDIES

By

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Volume I

Project Progress Report
Federal Aid in Wildlife Restoration
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PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Robert O. Stephenson and Victor VanBallenberghe

Project No.: W-17-8 Project Title: Big Game Investigations

Job No.: 14.8 Job Title: Wolf Populations and Movements in Relation to Those of Prey Species

Job No.: 14.9 Job Title: Wolf Food Habits

Job No.: 14.10 Job Title: Impact of Wolf Predation Upon Ungulate Populations

Period Covered: July 1, 1975 to June 30, 1976

SUMMARY

Between April 1975 and June 1976, 31 wolves were radio-marked in Game Management Unit 13. These included members of 14 discrete packs inhabiting an area of about 6500 mi^2. Radio-marked wolves were relocated 1,167 times and visually observed on 670 occasions. Average pack size for nine intensively studied packs was 8.5 in October 1975 with pups comprising 43.4 percent of the population. Estimated wolf population densities were one wolf per 110 mi^2, 59 mi^2, and 124 mi^2 in May 1975, October 1975, and May 1976, respectively. Observations of mortality within the radio-marked population and in GMU 13 as a whole suggest that during 1975-76 mortality, primarily from hunting and trapping, approached recruitment and negated most of the increase from reproduction. The territories of nine denning packs averaged 452 mi^2 in size. Radio-marked packs inhabited territories that were for the most part used exclusively by pack members with occasional overlap in movements occurring during winter and to a lesser extent during summer. The activities of dispersing wolves and instances in which members of different packs were associated are discussed. The analysis of 1532 scats collected at dens used in 1975 indicated that during summer adult moose were the most important source of food for wolves in terms of volume consumed but that calf moose were more important in terms of number of individuals taken. Beaver and/or snowshoe hares were also important sources of food for six radio-marked packs. The carcasses of 100 ungulates judged to have been killed by wolves were located; 75 of these were moose and 25 were caribou. Although moose were the most important winter food caribou were taken by wolves as they became available during migration. Twelve instances of predation on moose by grizzly bears were noted and the possible significance of predation by bears on moose is discussed. An effort to evaluate the impact of wolf predation on moose calf survival through the removal of wolves from a portion of the study area is discussed.

CONTENTS

BACKGROUND

Alaska is inhabited by the largest population of timber wolves *(Canis lupus)* remaining in the United States. Various aspects of the status and management of this animal have been discussed by Rausch and Winters (1964), Rausch(1967, 1971), Harper (1970), Rausch and Hinman (1977), and Stephenson and Johnson (1972, 1973), Stephenson and Sexton (1974), and Stephenson (1975). Research conducted throughout North America during the last 30 years has dispelled much of the fantasy that for so long dominated human thinking about wolves, but these studies have raised equally complex questions regarding the behavior of wolves and the interrelationships between wolves and their prey. The present study was initiated in an effort to better evaluate various aspects of the ecology of wolves in Southcentral Alaska including the nature and extent of wolf movements and territories, population density, productivity, food habits, and the impact of wolf predation upon ungulate populations in Game Management Unit (GMU) 13. The effect of wolf predation on moose *(Alces alces gigas)* calf survival during the first six months of life was of particular interest.

OBJECTIVES

To delineate wolf pack territorys, seasonal movements, and wolf food habits in experimental and control areas in Game Management Unit 13.

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

PROCEDURES

Wolves were anesthetized with intramuscular injections of phencyclidine hydrochloride (Sernylan, Parke-Davis Co.) and promazine hydrochloride (Sparine, Wyeth Laboratories). Drugs were administered with Cap-Chur darts (Palmer Chemical and Equipment Co.) administered from a Bell 206B helicopter using techniques described by VanBallenberghe and Stephenson (in prep.). Immobilized wolves were weighed, measured and ear-tagged and radio collars constructed of machine belting and acrylic by AVM Instrument Co. were applied. Blood samples were taken and wolves were examined for sex, age, general physical condition and nutritional status, and the presence of infirmities. Pups and adults were separated on the basis of tooth eruption and wear. Instrumented wolves were radio-located with Piper PA-18-150 STOL or Cessna 180 STOL aircraft equipped with two 3-element Yagi antennae. An attempt was made to locate each radioed wolf from two to three times per week. Radioed wolves were circled repeatedly until seen and their apparent activity noted. When it was determined that wolves were resting (unchanging signal location and character) in heavy cover, only a brief effort was made to actually see them. Occasionally dense vegetation, poor light conditions or air turbulence precluded sightings. Data recorded for each radio location included date, time, location, weather conditions, habitat type, the activity of the radioed wolf and any associates, and the presence of other large mammals in the vicinity. When wolves were observed in close proximity to prey animals or in the act of pursuing them the area was circled widely and observations made until the outcome of the chase or potential chase was evident. When possible the carcasses of wolf-killed ungulates were examined on the ground. During summer, monitoring flights were undertaken during the late evening and early morning hours when wolves were most active and flying conditions were optimal.

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 plastic bags, then autoclaved and analyzed using previously described techniques (Stephenson and Johnson 1972). Scats smaller than about 20 mm in diameter were considered to be those of pups.

In order to measure the effect of wolf predation on survival of moose calves during their first six months of life, a portion of GMU 13 was designated as an experimental area in which wolf numbers would be reduced by 90 percent or more. The experimental area includes the upper Susitna River basin and is bounded as follows: the Maclaren River on the east; the Alaska Range on the north; the upper Nenana River, Brushkana Creek and Deadman Creek on the west and the Susitna River upstream to its confluence with the Maclaren River on the south. Five wolves in four packs were radio-collared in the experimental area in April 1975 and their movements monitored until January 1976 when they were killed by Department personnel.

Moose calf survival in and out of the experimental area will be measured in November composition counts and the results will be compared. Radio-marked packs outside the area will continue to be monitored, providing basic population data to aid in assessing the results of the experimental removal of wolves. The portion of Unit 13 lying outside the experimental area will be referred to in this report as the control area.

The carcasses of wolves removed from the experimental area were necropsied and age, 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 northwest Alaska have been presented by Nielson (1977), and additional results are being prepared for presentation (Stephenson in prep.). Blood serum samples from radio-collared wolves and from some nonradioed wolves removed from the experimental area were sent to various laboratories for serological and disease analyses. However, only results of tests for infectious canine hepatitis and canine distemper are available and these are being prepared for publication (Ritter, Nielsen and Stephenson, in prep.). Tissue samples of wolves from various parts of the state including GMU 13 have also been radio-assayed for radiocesium (cesium-137)by Dan Holleman of the Institute of Arctic Biology, University of Alaska, Fairbanks in an effort to further elucidate the relative importance of moose and caribou *(Rangifer tarandus)* in the diet of wolves in various portions of the area. The results of these analyses are also being prepared for publication (Holleman and Stephenson, in prep.).

FINDINGS

Between April 1975 and June 1976, a total of 31 wolves were radio-collared in GMU 13. These included members of 14 discrete packs and one lone wolf which were found to occupy an area of about 6,507 mi^2 (16,853km^2) Radio-marked wolves were relocated 1,167 times and visually observed on 670 (57.4%) of these occasions. Table 1 includes data on the frequency of relocation for each radioed wolf and other data reflecting characteristics of monitoring coverage for each pack. The column heading "number of times one or more wolves seen" indicates the number of relocations where at least one wolf was actually seen while the next column "combined number of wolves seen" indicates the total number of wolves observed during relocations of each pack. As shown, 2,509 resightings of individual pack members were made on 757 pack days. The intensity of coverage varied due to varying logistical problems; i.e. packs inhabiting more mountainous terrain were farthest from the base of operations near Glennallen and were monitored only once on each flight whereas packs in the intervening areas were more accessible and could often be monitored on both outgoing and incoming routes. Turbulence more often precluded radio-tracking in mountainous terrain as well. Table 2 gives basic data for radioed wolves including weight, estimated age and collaring and transmitter expiration dates.

Table 1. Number of radio locations for each radio-marked pack in Unit 13, April 1975-June 1976.

	Radioed wolf and pack association	Color	No. times located	(Combined) no. times one or more wolves seen	(Combined) no. of wolves seen	(Combined) Number different locations	(Combined) Number different days	October 1975 pack size
1.	Deadman male (ad)	gy	35	30	67	47	38	5
2.	Deadman female (ad)	gy	28					
3.	Brushkana female (ad)	bk	31	20	109	31	34	9
4.	Butte Lake male (ad)	bk	23	18	41	23	31	3
5.	Maclaren female (ad)	gy	51	37	119	51	52	6
6.	Keg Creek male (ad)	bk	101	134	650	210	137	13
7.	Keg Creek male (ad)	gy	94					
8.	Keg Creek female (adI)	bk	128					
9.	Keg Creek female (adII)	bk	26					
10.	Keg Creek female (pup)	gy	16					
11.	Hogan Hill female (ad)	gy	103	114	494	135	115	9
12.	Hogan Hill male (ad)	gy	52					
13.	Sinona Creek female (ad)	gy	85	88	432	110	95	11
14.	Sinona Creek male (adI)	gy	43					
15.	Sinona Creek male (adII)	gy	40					
16.	Ewan female (ad)	gy	123	108	338	142	121	11
17.	Ewan male (ad)	gy	11					
18.	Ewan male (pup)	gy	17					
19.	Tyone male (ad)	gy	20	18	22	20	26	
20.	Deep Lake male (ad)	gy	32	51	127	70	47	7?
21.	Deep Lake female (ad)	gy	38					
22.	Tsusena male (ad)	gy	4	12	30	14	16	8
23.	Tsusena female (ad)	gy	12					
24.	Stephan Lake female (ad)	gy	10	9	15	10	11	2?
25.	Oshetna female (ad)	gy	15	13	15	15	13	2?
26.	Middle Fork female (ad)	gy	2	1	9	4	2	9
27.	Middle Fork female (pup)	gy	2	1				
28.	Middle Fork male (pup)	gy	2	1				
29.	Delta River male (ad)	gy	21	13	37	21	17	8
30.	Delta River male (pup)	gy						
31.	Gakona male (ad)	gy	2	2	4	2	2	
Totals			1167	670	2509	905	757	
			Average = 37.6 locations per wolf					

Table 2. Basic data for wolves radioed in GMU 13, 1975-1976.

	Wolf	Color	wt. lbs.	Estimated or cem. age if available	Date collared	Date radio failed or wolf died	Location and remarks
1	Deadman male	gray-tan	92	3	4/20/75	3/22/76	
2	Deadman female	blue-gray	108	4	4/20/75	3/22/76	
3	Brushkana female	black	90	4	4/20/75	1/16/76	
4	Butte Lake male	black	102	3	4/20/75	1/16/76	
5	Maclaren female	gray-tan	77	4	4/21/75	1/16/76	
6	Keg Creek male	black	100	3	4/20/75	3/9/76	
7	Keg Creek male	gray	94	3	4/20/75	3/9/76	
8	Keg Creek female	black	82	1or2	4/20/75		
9	Keg Creek female	black	93	4	3/21/76		
10	Keg Creek female	gray-tan	74	1	3/21/76	5/15/76	
11	Hogan Hill female	gray	69	1	6/6/75		
12	Hogan Hill male	gray-tan	88	2.5	11/5/75		
13	Delta River male	gray-tan	98	3	6/6/75	11/12/75	died of natural causes
14	Delta River male	gray-tan	50	.5			
15	Sinona Creek female	gray-tan	85	1or2	4/20/75	4/21/76	
16	Sinona Creek male	gray	106	4	11/5/75		
17	Sinona Creek male	gray-tan	87	3	11/5/75		
18	Ewan Lake female	gray-tan	87	2	4/15/75		
19	Ewan Lake male	gray	85	7	11/4/75	1/7/76	killed and eaten by large pack while trespassing
20	Ewan Lake male	gray-tan	55	.5	11/4/75	12/27/75	
21	Tyone male	gray-tan	104	2	2/18/76		
22	Deep Lake male	gray-tan	102	3	3/22/76		
23	Deep Lake female	gray-tan	94	9	3/22/76		
24	Tsusena male	gray-tan	85	2	2/20/76		
25	Tsusena female	gray-tan	80	2	2/17/76		
26	Stephan Lake female	gray	75	2	2/19/76		
27	Oshetna female	gray-tan	80	2	2/16/76		
28	Middle Fork female	gray-tan	80	1.5	3/21/76	4/6/76	collar chewed off by pack members
29	Middle Fork female	gray-tan	63	.5	3/21/76	4/6/76	collar chewed off by pack members
30	Middle Fork male	gray-tan	66	.5	3/21/76	4/6/76	collar chewed off by pack members
31	Gakona male	gray-tan	110		3/18/76	3/22/76	radio failed shortly after 3/22

A brief outline of the history of each radio-marked wolf and pack associates is given below, followed by sections detailing summer food habits based on scats and winter food habits based on observations of kills. Figure 1 shows the general location of radio-marked packs as indicated by the first 14 months of monitoring and also shows the location of the experimental and control areas.

The territories shown are pack territories, i.e. they are derived from the locations at which most or all members of a pack were located, as opposed to the individual territories of radio-marked wolves. The latter would to a large degree conform to the pack territories shown, but a few more extensive movements of solitary radioed wolves occurred. These would give a misleading picture of territories if included. These "extraterritorial" movements of individuals are discussed in a separate section of the report. The characteristics of wolf territories observed are summarized in Table 3. The tables giving information on kills are brief chronological records of kills found and do not include data on other circumstances surrounding each kill.

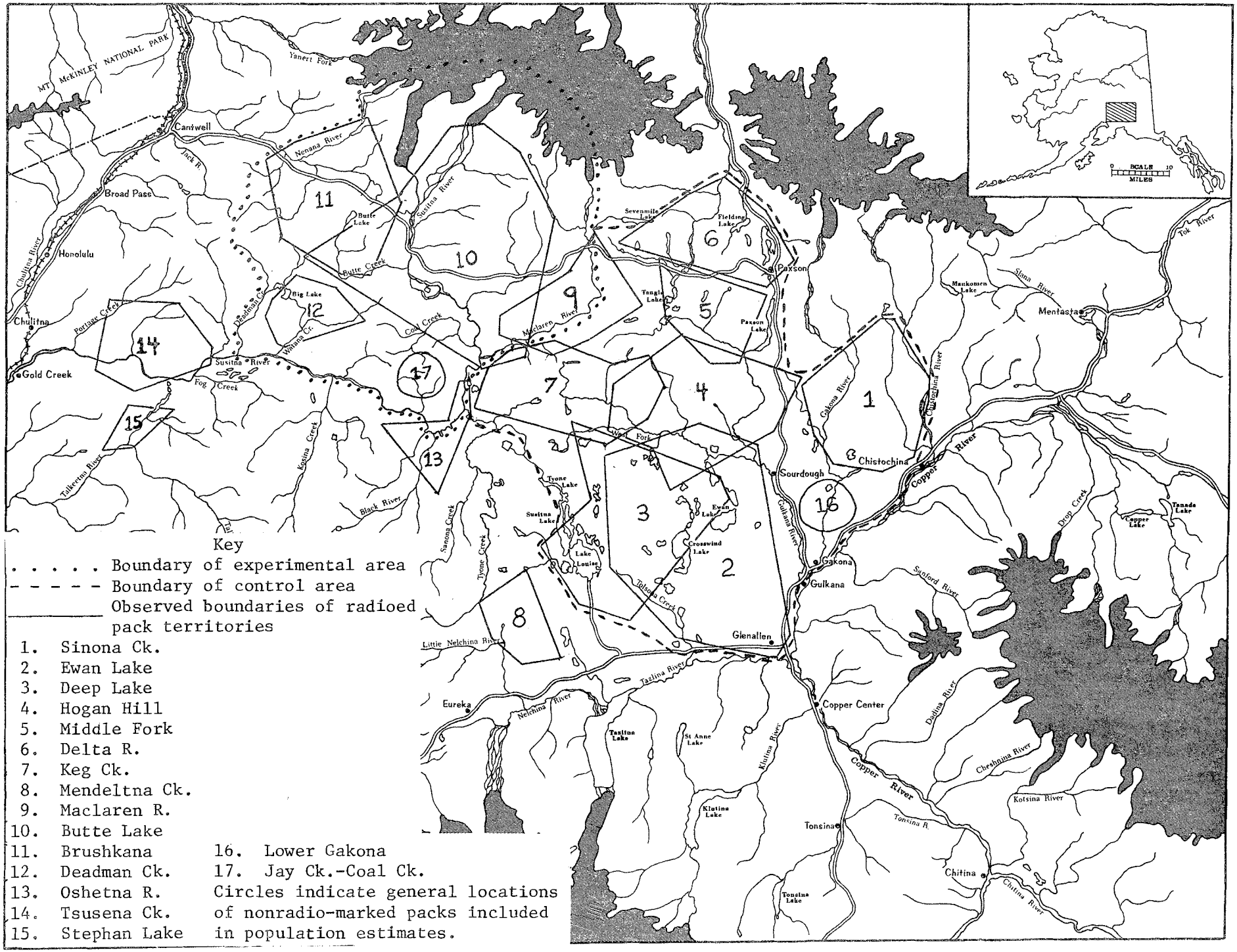
Review of Pertinent Data from Radioed Packs

Control Area

Ewan Lake Pack - Only one radioed wolf, a young female collared in April 1975, was present in this pack during most of the period of study. An old adult male and a male pup were collared in November 1975 and provided additional information although the pup was trapped in late December and the adult male was killed by a pack of wolves in an adjacent pack territory in early January 1976. The Ewan pack included at least seven adults and four pups during most of the summer, but one pup was apparently lost in late August to unknown causes. The chronology of den and rendezvous site use is given in Table 4.

This pack inhabited an area of relatively low moose density, and caribou were not present in large numbers until late October when the pack shifted much of its activity to the north of the den area. Caribou moved into the area along the West Fork of the Gulkana River and the pack subsisted primarily on caribou during the winter months (Table 5). During summer moose, beaver *(Castor canadensis)*, and snowshoe hares *(Lepus americanus)* were primary foods (Tables 6 and 7). During summer the radioed wolf and as many as four associates were found on several occasions in areas where signs of recent beaver activity were apparent and they were observed hunting along lake edges near beaver lodges. Only three moose kills attributable to this pack were located during the summer months, but the presence of only one radioed wolf having relatively solitary habits during that period greatly lessened the likelihood of detecting kills. There were indications of relatively poor nutrition in this pack; throughout the summer the Ewan pups appeared smaller than those in other packs (with the exception of the Delta River pack discussed below) and the male pup collared in November was small and extremely thin while the old adult male was in only fair nutritional condition.

Figure 1. Boundaries of radio-marked pack territories in the control and experimental areas in Unit 13, 1975-76.



Key

. . . . . Boundary of experimental area

- - - - - Boundary of control area

_____ Observed boundaries of radioed pack territories

1. Sinona Ck.
2. Ewan Lake
3. Deep Lake
4. Hogan Hill
5. Middle Fork
6. Delta R.
7. Keg Ck.
8. Mendeltna Ck.
9. Maclaren R.
10. Butte Lake
11. Brushkana
12. Deadman Ck.
13. Oshetna R.
14. Tsusena Ck.
15. Stephan Lake
16. Lower Gakona
17. Jay Ck.-Coal Ck.

Circles indicate general locations of nonradio-marked packs included in population estimates.

Table 3. Characteristics of radio-marked pack territories, GMU 13, 1975-76.

Pack	No. and sex of radio-marked members	Pack size (Sept, 1975)	Year-round pack home range(mi^2)	Summer home range	Density within year-round home range (mi^2/wolf)	Remarks
Ewan Lake	1 female 2 males	11	864	378*	78.5	* Includes all locations of radio-marked female, April 24 - Sept 1.
Deep Lake	1 male	7	630		90	
Sinona Ck.	1 female 2 males	11	432	191*	39.3	* Includes all locations of radio-marked female, April 20 - Sept 1, 1975
Hogan Hill	1 female 1 male	8	567	119*	70.9	* Includes all locations of radio-marked female, June 6 - Sept 1, 1975.
Keg Creek	3 females 2 males	13	432	180	33.2	Includes all locations, April 20 - Sept 1.
Delta River	2 males	8	288		36	
Maclaren River	1 female	6	279		46.5	
Butte Lake	1 male	3	1188		--	
Brushkana Ck.	1 female	9(11)	468		42.5	Although 9 was the largest number observed together, at least two other wolves were found in this territory.
Deadman Lake	1 female 1 male	5	108		21.6	
Lone Wolves						
Tyone River	1 male	1	1400			
Deep Lake	1 female	1	324			

$\bar{x}$ year-round home range for 9 breeding packs = 452 mi^2

Table 4. Chronology of den and rendezvous site use, GMU 13, 1975-76.

Pack	Wolves first found at natal den 1975	1976	Date pups first seen outside of den 1975	1976	Largest no. pups seen 1975	1976	Date moved to first rendezvous site 1975	1976	Date moved to second rendezvous 1975	1976	Date pups appeared to be traveling with adults 1975	1976	Remarks
Keg Creek	5/23	4/13* 5/1	6/13		6		7/2		8/25		9/23-30		* First located at den. Constant presence at den noted after 5/1.
Ewan Lake	6/13	5/25*		7/2	4	3	7/30	Between 6/26-7/2	9/8		9/23?		* 1976 dates are derived from activities of pack joined by Ewan female.
Deep Lake													Information not obtained in either year.
Sinona Creek	5/22	5/6	7/22		4						9/25-10/4 ?		No rendezvous sites detected.
Hogan Hill	5/14		6/13		2		7/23		9/8		?		
Delta River	6/3		6/6		4		7/29*				9/12?		* On 8/1 pups were again seen at den, having been moved from rendezvous site.
Deadman Lake	6/26	3/9*			3		7/10		8/18		11/12		* Den started in trees, pups were not seen at the 1975 den due to thick vegetation.
Butte Lake	5/21		6/19		6		8/1*				9/26-10/6		* Apparently the pups were split up with 3 still at natal den and 3 with female 4 1/2 mi. SW of den on moraine.
Maclaren River	5/21				4		6/16*		8/18		10/4		* Wolf observed twice in new area, may have moved pups to rendezvous site at early date.
Tyone Male		6/20		6/20		2		6/28					Radio-collared male was not associated with den until June 20.
Stephan Lake		4/28*											* Den site never confirmed but existence likely.

Table 5. Record of carcasses of prey animals at which Ewan Lake pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
5/20/75	Moose	n/a	adult	recent kill
7/30/75	Moose	n/a	yrlg.	fresh kill
9/10/75	Moose	n/a	adult	remains of old kill at rendezvous site
9/30/75	Red fox	n/a	n/a	fresh kill
11/7/75	Caribou	F	adult	fresh kill
11/13/75	Caribou	F	adult	recent kill
11/14/75	Caribou	n/a	n/a	recent kill
12/3/75	Moose	n/a	n/a	recent kill
12/3/75	Caribou	n/a	calf	recent kill
12/9/75	Caribou	n/a	n/a	recent kill
12/18/75	Caribou	n/a	n/a	recent kill
12/26/75	Moose	n/a	n/a	recent kill
1/8/76	Caribou	n/a	adult	recent kill
1/16/76	Caribou	n/a	adult	recent kill
2/3/76	Caribou	n/a	adult	recent kill
2/25/76	Moose	n/a	adult	old kill
5/3/76	Caribou	F	adult	fresh kill, Mendeltna pack
6/14/76	Moose	n/a	calf	fresh kill, Mendeltna pack

Table 6. Incidence of food items in 58 adult wolf scats and 89 pup wolf scats collected 6 September 1975 at a wolf den near Ewan Lake, Southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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	1	0.6
Bird	1	1.4	0	0	2	1.1
Total	70		107		177	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	58	32.8
Small mammals	115	65.0
Other	4	2.3
Total	177	

Food Remains: a) femur and tibia of one adult moose

Table 7. Incidence of food remains in 35 adult wolf scats and 84 pup wolf scats collected 6 September 1975 at a rendezvous site near Ewan Lake, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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	11	8.0
Vegetation	1	2.5	10	10.4	2	1.4
Unidentified	0	0	2	2.1	2	1.4
Total	40		98		138	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	72	52.2
Small mammal	51	37.0
Other	15	10.9
Total	138	

Food Remains: a) partial skeleton of one adult moose

During winter the young radioed female 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 by two wolves. These were last located in the Ewan territory on 25 February after which contact was lost until 30 April when a wider search found the female associated with three other adult wolves in an area 40 miles (64km) 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 five adults), raised six pups at a den in the area during 1976. The Ewan radio-marked female 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 radioed 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. While the loss of three and possibly four pack members from the original pack (2 mortalities, 1 or 2 dispersals) is known, the remaining members of the pack, except for possibly one wolf, are unaccounted for but may have disappeared through dispersal and/or mortality.

As indicated in Table 3, the Ewan pack territory encompassed 864 mi^2 (2,238km^2). This is a relatively large territory and probably reflects the low food abundance in much of the area. It appears that the Ewan pack subsisted in a much smaller area during most of the year, however, with the northern and western portions of the territory shown in Fig. 1 being used for relatively short periods during winter.

Deep Lake Pack - Information on the numbers and movements of the Deep Lake pack was not obtained until March 1976 when two adult wolves 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 midwinter. For unknown reasons the adult female collared at the same place as the adult male 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 Ewan pack territory as shown in Fig. 1.

The remainder of the Deep Lake pack inhabited an area of 630 mi^2 (1,631km^2) as indicated by movements of the radio-marked male. This territory lay west of, but partly overlapped the year around range of the Ewan pack. Analysis of scats collected at the den (Table 8) suggested that calf and adult moose were the most important food during summer with snowshoe hares and beaver comprising a smaller but significant portion of the diet. During late winter, both moose and caribou were taken but the number of kills located was small (Table 9). No active den was found in 1976.

Table 8. Incidence of food remains in 34 adult wolf scats and 72 pup wolf scats collected 6 August 1975 at a wolf den near Deep Lake, Alaska.

	34 Items in adult scats		72 Items in pup scats		106 Total items	
	No.	%	No.	%	No.	%
Adult moose	5	14.7	14	19.4	19	17.9
Calf moose	15	44.1	31	43.1	46	43.4
Caribou	1	2.9	2	2.3	3	2.8
Snowshoe hare	3	8.8	13	18.1	16	15.1
Beaver	11	32.4	8	11.1	19	17.9
Microtine	0	0	2	2.8	2	1.9
Lynx	0	0	3	4.2	3	2.8
Vegetation	0	0	8	11.1	8	7.5
Fish	0	0	1	1.4	1	0.9
Eggshells	2	5.9	0	0	2	1.9
Unidentified	0	0	3	4.2	3	2.8
Total	37		85		122	

Grouped Data n = 106

Food Item	Number of Items	Percent
Ungulate	68	64.2
Small mammal	40	37.7
Other	13	12.3
Total	121	

Food Remains

Scapula, femur and mandible from calf moose
4 skulls and several long bones from snowshoe hares
Portions of skull of 4 to 5 week old wolf pup (from previous summer)

Table 9. Record of carcasses at which Deep Lake pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
4/19/77	Moose	F	adult	recent kill
4/22/77	Caribou	n/a	n/a	recent kill
5/6/77	Caribou	n/a	n/a	recent kill
6/6/77	Moose	n/a	calf	fresh kill

Sinona Creek Pack - A young female collared in April 1975 provided all radio-tracking data until November 1975 when two males 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 9 pups were reared in 1976 at two dens 11 miles (18km) apart. The Sinona pack inhabited a year round range of 432 mi^2 (1,119km^2)(Table 3) lying between the Gakona and Chistochina Rivers. Moose density was relatively high in this area and moose comprised the bulk of the summer diet with beaver being an important supplement (Table 10). No ungulate carcasses other than moose were found (Table 11), but it is possible that a small number of caribou were taken but not detected since small numbers of caribou were present in the territory during the period of study.

Hogan Hill Pack - The Hogan Hill pack included seven adults (although two additional adults were seen on one occasion) and reared only two pups during 1975. No clear explanation for the small litter size is available although canine distemper could have been involved (Ritter, Nielsen, and Stephenson, in prep.). The year round home range of this pack (567 mi^2 [1,469km^2]) included the eastern half of the Alphabet Hills. A yearling female was collared in June 1975 and a young male was collared in November. The only known mortality included a male pup which was snared in February. As indicated in Table 12, adult and calf moose were the predominant item in the summer diet with snowshoe hares and caribou being important supplements. The caribou remains may have originated from kills made prior to summer since no caribou were observed in the territory during summer. During winter, moose were the predominant prey although two caribou kills were located (Table 13). 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. The Hogan Hill den used in 1975 was within 2.5 miles (4km) of the TransAlaska pipeline.

Keg Creek Pack - The Keg Creek pack was the largest pack studied and included seven adults and six pups by autumn 1975. Three adult wolves, two adult males and one adult female were radio-collared in April 1975 and were present during most of the study period. Two additional wolves, an adult female and a female pup, were collared in March 1976. The Keg Creek wolves inhabited a year round range of 432 mi^2 (1,119km^2) with the summer territory (based on all locations from 20 April to 1 September) encompassing 180 mi^2 (466km^2) (Table 3). Mortality in this pack was high during winter with indications that four wolves were taken with the aid of an aircraft in early December. An additional five were known to have been taken illegally by an aerial hunter in mid-March, leaving four wolves, including two adult females and a female pup. The adult female radio-collared in March appeared to have been the mother of the 1975 litter and produced another litter in 1976. Analysis of scats collected at the 1975 den, and also at a rendezvous site, suggested that adult and calf moose were the major items in the diet with snowshoe hares also important (Tables 14 and 15). Moose were the predominant item in the winter diet (Table 16) but several caribou were taken in early winter when they became available in considerable numbers.

Table 10. Incidence of food items in 18 adult wolf scats and 110 pup wolf scats collected 6 September 1975 at a wolf den near Sinona Creek, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
Adult moose	7	31.8	32	27.4	39	28.1
Calf moose	10	45.5	67	57.3	77	55.4
Caribou	0	0	1	0.9	1	0.7
Beaver	3	13.6	10	8.5	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	2	1.4
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		117		139	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	117	84.2
Small mammals	16	11.5
Other	6	4.3
Total	139	

Food Remains: a) vertebrae and scapula of adult moose

Table 11. Record of carcasses of prey animals at which Sinona Creek pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
7/14/75	Moose	n/a	adult	grizzly on kill, probably bear kill
7/30/75	Moose	n/a	adult	carcass covered by bear, possible bear kill
8/11/75	Moose	n/a	adult	old kill
10/2/75	Moose	n/a	n/a	old kill covered by bear, possible bear kill
10/9/75	Moose	n/a	n/a	grizzly on kill, probable bear kill
11/2/75	Moose	n/a	n/a	recent kill
11/7/75	Moose	n/a	n/a	old kill
11/20/75	Moose	n/a	adult	recent kill
11/21/75	Moose	n/a	calf	fresh kill
11/26/75	Moose	n/a	adult	fresh kill
12/2/75	Moose	n/a	adult	recent kill
1/8/76	Moose	n/a	adult	recent kill
1/14/76	Moose	n/a	adult	recent kill
1/20/76	Moose	n/a	calf	recent kill
1/28/76	Moose	n/a	calf	fresh kill
2/10/76	Moose	n/a	calf	recent kill
2/22/76	Moose	n/a	adult	recent kill
2/24/76	Moose	n/a	adult	recent kill
3/16/76	Moose	n/a	n/a	recent kill
4/13/76	Moose	n/a	n/a	recent kill
4/28/76	Moose	n/a	n/a	recent kill
5/1/76	Moose	n/a	n/a	wolves at kill found 4/28, grizzly on kill
5/6/76	Moose	n/a	n/a	recent kill
6/20/76	Moose	M	yrlg.	radioed moose killed by wolves, possibly by Sinona Creek pack members

Table 12. Incidence of food remains in 39 adult wolf scats and 96 pup wolf scats collected 13 August 1975 at a wolf den near Hogan Hill, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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	4	2.5
Vegetation	1	2.0	3	2.7	2	1.3
Eggshells	1	2.0	1	1.0	1	0.6
Total	48		111		159	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	78	49.1
Small mammal	64	40.3
Other	17	10.7
Total	159	

Food Remains:
a) 1-2 adult moose long bones
b) 2-3 calf moose long bones and mandible (one)
c) 3, 3" x 4" patches of grizzly hair with skin attached
d) 1 adult beaver, hair and lower jaw
e) snowshoe hare hair (6-10 old bones; a few new bones)

Table 13. Record of carcasses of prey animals at which Hogan Hill pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
5/20/75	Moose	F	adult	recent kill found prior to radio collaring
8/8/75	Moose	n/a	adult	carcass covered by grizzly, possible bear kill
8/29/75	Moose	F	adult	fresh kill, collared moose
10/2/75	Moose	n/a	n/a	grizzly on buried carcass, probable bear kill
10/16/75	Moose	M	adult	grizzly on recent kill, probable bear kill
10/20/75	Moose	M	adult	grizzly on kill, 1-1/2 mi from wolf, probable bear kill
10/22/75	Moose	n/a	n/a	old kill
10/25/75	Moose	n/a	n/a	recent kill
11/2/75	n/a	n/a	n/a	wolves bloody and gorged probable kill but not found
11/7/75	Moose	n/a	n/a	kill covered by grizzly, possible bear kill
11/20/75	Moose	n/a	calf	recent kill
12/11/75	Moose	F	adult	recent kill
12/18/75	Moose	n/a	adult	possible winter kill
1/8/76	Moose	n/a	adult	possible winter kill
1/13/76	Moose	n/a	calf	recent kill
2/10/76	Caribou	n/a	adult	recent kill
3/18/76	Moose	n/a	n/a	old kill
4/8/76	Moose	F	adult	fresh kill, collared moose
5/17/76	Moose	n/a	adult	fresh kill
5/25/76	Moose	n/a	n/a	kill covered by grizzly, possible bear kill

Table 14. Incidence of food remains in 17 adult wolf scats and 65 pup wolf scats collected 3 September 1975 at a wolf den near Keg Creek, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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		69		88	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	59	67.0
Small mammal	25	28.4
Other	4	4.5
Total	88	

Food Remains:
a) mandible of beaver kit
b) maxilla of young canid
c) jaws and bones of calf moose
d) old caribou bones
e) pelvis and hoof sheaths of adult moose

Table 15. Incidence of food remains in 12 adult wolf scats and 114 pup wolf scats collected 3 August 1975 at a rendezvous site near Keg Creek, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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		124		138	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	125	90.6
Small mammal	10	6.8
Other	3	2.0
Total	138	

Food Remains: a) pelvis of adult moose

Table 16. Record of carcasses of prey animals at which Keg Creek pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
7/2/75	Moose	n/a	adult	one grizzly at kill site, probable bear kill
7/2/75	Moose	n/a	calf	fresh kill
7/16/75	Moose	n/a	adult	large grizzly on kill, probable bear kill
8/15/75	Moose	n/a	adult	kill covered by grizzly, possible bear kill
9/12 and 9/13/75 - Radioed wolves located in same area near grizzly. Possible bear or wolf kill				
10/16/75	Moose	M	adult	fresh kill
10/19/75	Caribou	n/a	n/a	old kill
11/3/75	Caribou	n/a	n/a	recent kill
11/12/75	Caribou	n/a	n/a	recent kill
11/25/75	Caribou	n/a	adult	fresh kill
12/3/75	Moose	n/a	adult	recent kill
1/15/76	Moose	n/a	adult	recent kill
1/29/76	Moose	n/a	adult	recent kill
3/22/76	Moose	n/a	adult	remains of very old kill
4/19/76	Caribou	n/a	n/a	recent kill
4/21/76	Caribou	n/a	adult	fresh kill
6/22/76	Moose	n/a	adult	old kill covered by grizzly

Delta River Pack - The Delta pack included only one collared wolf, an adult male, during most of the study period. The pack inhabited an area of about 288 mi^2 (746km^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, but an adult lactating female was killed by an automobile near Summit Lake in late June and a yearling male wolf was shot in defense of life and property at the same location in early July. These two wolves and another had often been seen near a lodge on Summit Lake during a period of three 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 but which subsequently disappeared. Four pups were successfully reared at the den, however, and four adults were seen with the pups in early winter. In mid-November the collared adult male 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. 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. As Tables 17 and 18 indicate, the summer diet of the pack in 1975 included a relatively high proportion of small mammals including beaver, snowshoe hares, and ground squirrels *(Spermophilus undulatus)* with ungulates being relied upon relatively little. Only two ungulate carcasses were located in the course of radio tracking (Table 19) and both of these were being used by grizzly bears *(Ursus arctos)* when found. The pack inhabited an area which appeared to have the lowest abundance of big game prey of any pack studied. The four 1975 pups appeared small throughout the summer, and examination of the carcasses 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 the winter of 1975-76, leaving the territory without a denning pack.

In addition to the dens located through telemetry, an active den was located near St. Anne Lake south of the Glenn Highway in 1975. The results of scat analysis are presented in Table 20. This pack is hereinafter referred to as the St. Anne pack.

Experimental Area

Maclaren Pack - The Maclaren pack included one collared adult female. Other pack members included an adult male and four pups reared in 1975. This pack inhabited an area of 279 mi^2 (723km^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, none was seen from the air or found in searches on the ground after the area was vacated. A rendezvous site one mile from the probable

Table 17. Incidence of food remains in 24 adult wolf scats and 113 pup wolf scats collected 4 September 1975 at a wolf den on the Delta River, Alaska.

	24		113		137	
	Items in adult scats		Items in pup scats		Total items	
Food item	No.	%	No.	%	No.	%
Adult moose	10	41.6	10	8.8	20	14.6
Calf moose	4	16.7	35	40.0	39	28.5
Snowshoe hare	16	66.7	51	45.1	67	48.9
Beaver	3	12.5	21	18.6	24	17.5
Muskrat	0	0	1	0.9	1	0.7
Sciurids	2	8.3	1	0.9	3	2.2
Eggshells	0	0	1	0.9	1	0.7
Bird	4	16.6	2	1.8	6	4.4
Insecta	0	0	1	0.9	1	0.7
Fish	1	4.2	0	0	1	0.7
Total	40		123		163	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	59	43.1
Small mammals	94	68.6
Other	9	6.6
Total	162	

Food Remains:

1 Beaver skull (fresh)
1 Otter skull (fresh)
1 Adult moose pelvis (fresh)
1 Otter mandible (old)
1 Caribou mandible
1 Adult moose pelvis
From previous years - several moose long bones

Table 18. Incidence of food remains in 13 adult wolf scats and 67 pup scats collected 4 September 1975 at an area 200m from a den on the Delta River, Alaska. This site was used as a rest area by some adults throughout the summer and by pups from the end of June until the den was vacated in early August.

	13 Items in adult scats		67 Items in pup scats		80 Total items	
	No.	%	No.	%	No.	%
Adult moose	2	15.4	2	3.0	4	5.0
Calf moose	4	30.8	5	7.5	9	11.3
Snowshoe hare	2	15.4	3	4.5	5	6.3
Beaver	0	0	45	67.2	45	56.3
Ground squirrel	6	46.2	15	22.4	21	26.3
Eggshells	0	0	1	1.5	1	1.3
Insecta	0	0	1	1.5	1	1.3
Fish	0	0	0	0	0	0
Microtine	0	0	6	9.0	6	7.5
Total	14		78		92	

Grouped Data n = 80

Food Item	Number of Items	Percent
Ungulate	13	16.3
Small mammals	71	88.8
Other	4	5.0
Total	88	

Table 19. Record of carcasses at which Delta River pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
7/8/75	Moose	n/a	adult	large grizzly on kill, probable bear kill
7/12/75	Moose	n/a	adult	sow and cub grizzly on kill, probable bear kill

Table 20. Incidence of food remains in 106 adult wolf scats and 126 pup wolf scats collected 17 August 1975 at a wolf den near St. Anne Lake, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
Adult moose	9	8.4	15	11.9	24	7.3
Calf moose	30	28.3	31	24.6	61	18.5
Beaver	1	0.9	8	6.3	9	2.7
Muskrat	5	4.7	5	3.9	10	3.0
Snowshoe hare	92	86.7	103	81.7	195	59.1
Red squirrel	2	1.8	0	0	2	0.6
Microtine	3	2.8	13	10.3	16	4.8
Fish	2	1.8	1	0.7	3	0.9
Bird	6	5.6	1	0.7	7	2.1
Vegetation	0	0	3	2.3	3	0.9
Total	150		180		330	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	85	25.8
Small mammal	232	70.3
Other	13	3.9
Total	330	

Food Remains: a) skull, leg bones etc. of about 10 snowshoe hares

den area was located, however, and the small number of scats collected (Table 20) suggested that moose were an important summer food resource with snowshoe hares being used also. Based on ungulate carcasses found through radio-tracking (Table 21), moose were the predominant large mammal taken on a year round basis with caribou being taken to some extent during late winter. Despite the presence of only two adult wolves, the pack was able to kill adult moose during winter. One pup was lost (possibly trapped) in mid-November prior to the removal of the pack in January in connection with the experiment.

Butte Lake Pack - The Butte Lake pack included one collared wolf that was captured while traveling alone near Butte Lake in late April 1975. An adult female member (Brushkana female) of a group of six wolves was collared the same day three miles (5km) from the Butte Lake male and tracks suggested that both wolves had been feeding on an old moose kill in the area. Subsequently, the male was accompanied first by three black wolves and later by one black and one gray wolf and inhabited an area of 1,188 mi^2 (3,077km^2) almost totally exclusive of the range of the Brushkana female. The associates of the Butte Lake male included no female wolves and no den was located. The movements of the group were much more extensive than those of denning packs during summer. No scats representing the summer diet were collected, but the small number of carcasses located (Table 22) suggested that both moose and caribou were used by the pack. Relatively few radio locations were obtained during early summer due to poor weather and the mountainous terrain inhabited by the pack during part of the study period. The three males were removed in January in conjunction with the wolf control experiment.

Brushkana Creek Pack - The Brushkana pack included only one radioed member, an adult female, during the study period. 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 January 1976 in connection with the wolf control experiment. The analysis of scats collected at the 1975 den (Table 23) suggested that calf moose were the predominant item in the diet with adult moose, adult and calf caribou, sheep *(Ovis dalli)*, and beaver comprising a significant portion of the diet. Ungulate carcasses located through radio-tracking (Table 24) also indicated that moose comprised the major portion of the diet during winter. Based on the movements of the collared female, the pack inhabited an area of at least 468 mi^2 (1,212km^2).

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 and female 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 collected at one of these (Table 25) indicated that moose were the primary source of food; the small number of kills located during winter (Table 26) suggested that moose were the primary winter food as well. Caribou were available in

Table 21. Incidence of food remains in 6 adult wolf scats and 20 pup wolf scats collected 25 August 1975 at a rendezvous site near the Maclaren River, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
Adult moose	5	83.3	3	11.5	3	9.4
Calf moose	0	0	14	53.8	19	59.4
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		26		32	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	22	68.8
Small mammals	7	21.9
Other	3	9.4
Total	32	

Food Remains: a) adult moose hair

Table 22. Record of carcasses of prey animals at which Maclaren River pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
4/24/75	Moose	F	adult	fresh kill
4/29/75	Caribou	F	adult	cow and calf killed simultaneously, fresh kills
	Caribou	n/a	calf	
5/7/75	Moose	F	adult	recent kill covered by brush, possible bear kill
5/9/75	Moose	n/a	adult	possible winter kill
6/7/75	Moose	n/a	yrlg.	fresh kill
10/16/75	Moose	F	adult	recent kill
10/18/75	Moose	M	yrlg.	wounded and later died, 40% consumed within 2 days
10/28/75	Moose	F	adult	recent kill
11/1/75	Moose	n/a	n/a	recent kill
11/7/75	Moose	F	adult	fresh kill
1/16/76	Moose	n/a	adult	recent kill

Table 23. Record of carcasses at which Butte Lake pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
4/24/75	Caribou	n/a	n/a	recent kill
5/21/75	Moose	n/a	n/a	recent kill
5/29/75	Moose	n/a	adult	fresh kill
12/11/75	Moose	n/a	adult	old kill
1/17/76	Moose	n/a	adult	old kill

Table 24. Incidence of food remains in 40 adult wolf scats and 144 pup wolf scats collected 7 August 1975 at a wolf den near Brushkana Creek, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
Adult moose	2	4.8	12	8.3	14	7.6
Calf moose	17	41.4	77	53.8	94	51.0
Adult caribou	12	29.2	22	15.3	34	18.4
Calf caribou	2	4.8	9	6.2	11	5.9
Dall sheep	2	4.8	6	4.1	8	4.3
Beaver	3	7.3	9	6.2	12	6.5
Muskrat	0	0	1	0.6	1	0.05
Unident. furbearer	0	0	2	1.3	2	1.0
Wolf	0	0	1	0.6	1	1.0
Vegetation	0	0	3	2.0	3	1.6
Unidentified	2	4.8	4	2.7	6	3.2
Total	40		146		186	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	161	86.5
Small mammal	13	7.0
Other	12	6.5
Total	186	

Food Remains:
a) carpals, leg bones and hoof sheath of adult moose
b) rib from calf caribou
c) calf moose hair, caribou hair, and possibly sheep hair in scats
d) long bones of adult caribou
e) calf caribou radius/ulna

Table 25. Record of carcasses at which Brushkana River pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
4/20/75	Moose	n/a	adult	recent kill
5/29/75	Moose	n/a	n/a	old kill
6/17/75	Moose	n/a	n/a	old kill
10/16/75	Moose	F	adult	wounded and later died, partly consumed on 10/18
11/13/75	n/a	n/a	n/a	old carcass dug out of snow

Table 26. Incidence of food items in 1 adult wolf scat and 29 pup wolf scats collected 8 August 1975 at a wolf rendezvous site near Deadman Lake, southcentral Alaska.

Food item	Items in adult scats No.	%	Items in pup scats No.	%	Total items No.	%
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		31		32	

Grouped Data

Food Item	Number of Items	Percent
Ungulate	26	81.3
Small mammal	3	9.4
Lynx	3	9.4
Total	32	

Food Remains: a) lynx skull, kitten
b) femur, adult moose (recent kill)

Table 27. Record of carcasses at which Deadman Lake pack members were observed, GMU 13, 1975-76.

Date	Species	Sex	Age	Remarks
6/19/75	Moose	n/a	calf	fresh kill
8/14/75	Moose	n/a	n/a	old kill
11/12/75	Moose	F	adult	recent kill

limited numbers during much of the year and may also have been taken but not detected during the study. The three pups were removed in January and the two adults in March in connection with the wolf control experiment. The home range suggested by radio locations, comprised only 108 mi^2 ($280km^2$). The small range indicated may be a result of the relatively small number of radio locations obtained due to the mountainous terrain and turbulent weather often encountered. However, the pack was small and inhabited an area with relatively abundant and varied food resources and the small range is probably representative of the area used by the pack.

Other Radioed Wolves - During February 1976, five additional wolves were radio-marked along the southern and western boundaries of the experimental area to further measure the movement of wolves in the vicinity of the area and determine whether packs other than those previously removed used parts of the area. One of these was a young adult male collared at the west end of the Alphabet Hills and referred to as the Tyone male. During the subsequent five months, this wolf traveled alone over a wide area including 1,400 mi^2 ($3,626km^2$), traversing parts of at least four of the radio-marked pack territories described above. This wolf 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 drainages and the West Fork of the Gulkana River, the Tyone male was found at an active den near Clearwater Creek in the experimental area on 20 June 1976. Only one other adult wolf, a female, and two pups were observed at this den. Although it is possible that the female and male were not previously associated, they could have been since the male was radio-collared only 14 miles (23km) 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.

Also collared in February 1976, was a young adult female which inhabited an area along the Susitna River in the vicinity of Tyone and Goose Creeks and as far as six miles (10km) above the mouth of the Tyone River. This wolf was seen in association with only one other wolf, an adult male, and was found near the remains of five different moose carcasses, some of which were old kills, during the one month period in which her movements were monitored. This wolf was removed by Department personnel in late March after it was determined that its range included parts of the experimental area. Five other wolves that may have been members of this pack were removed, but the pack association of two, both males, is only conjectural.

Two wolves, a young male and a young female, were collared in mid-February in the area north of the Susitna River between Tsusena and Portage Creeks. These were members of a pack that at the time included at least nine wolves and appeared to occupy a territory to the west of and adjacent to the Deadman Lake pack. These wolves were located a relatively small number of times during the study period and were found near two old and one recent moose kills, one recent caribou kill, and

one carcass of undeterminable species. A den was not located during the low intensity monitoring of the pack in 1976 although it is likely that one existed. As discussed in the following section, the collared female dispersed from the pack's range in early June.

An adult female was collared in mid-February in the vicinity of the Tsusena pack. This wolf was seen with only one associate during the ensuing months, and although the existence of a den was suggested by the movements of the pair, none was found. The carcasses of two moose were observed during monitoring of this pack.

In late March three members of a pack of nine wolves were radio-marked in the vicinity of the Middle Fork of the Gulkana River. These included a male and female pup and a yearling female. However, all three wolves lost their collars within two weeks. The territorial boundary shown in Fig. 1 is based on a few radio locations made prior to the loss of the collars and observations of these wolves and their tracks made in the course of flights over the area during winter 1975-76. These observations indicated that the home range of this pack was adjacent to the areas occupied by the Hogan Hill, Delta River, and Maclaren packs.

Den and Rendezvous Site Use

The earliest dates at which dens and rendezvous sites were known to be in use in 1975 and 1976 are given in Table 4. Although wolves were found as early as 13 April near excavations that were eventually used as natal dens, the presence of wolves at dens was not consistently observed until early or mid-May. The range of dates observed suggests that most litters were born during the third and fourth weeks of May with dens being visited as much as several weeks prior to parturition. Pups were observed outside of dens as early as 6 June and in most cases, by mid-June. Mech (1970) indicated that wolf pups are commonly seen outside of dens when three weeks old, and Clark (1971) observed 10-day-old pups outside dens on Baffin Island. This corroborates other indications that parturition in Southcentral Alaska was occurring in mid to late May. Natal dens were, in most cases, vacated during July with dates ranging from mid-June to late July. Distances between natal dens and first rendezvous sites ranged from one-half mile to nine miles (1 to 14km). In some cases a move to a second rendezvous site was noted during August or early September, but these sites were used only briefly and in most cases, pups appeared to be traveling with adult pack members by late September.

Most dens were either roughly centered or well within the observed territorial boundaries, but the Hogan Hill and Maclaren dens were located along observed territorial boundaries. The average distance between eight natal dens used in 1975 was 22.8 air miles (37km) and ranged from 16 to 28.5 air miles (25 to 46km). 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 north-central Brooks Range (Stephenson and Johnson 1973) where the minimum average distance between dens was about 25 miles (40km). The physical

characteristics of wolf den sites located in this study were studied by Brian Lawhead of the Alaska Cooperative Wildlife Research Unit and a M.S. thesis covering this subject is in preparation.

Wolf Population Density

As shown in Table 3, wolf density within territories was as high as one wolf per 21.6 mi^2 ($56km^2$), with densities of one wolf per 30 to 50 mi^2 (78 to $130km^2$) being common.

The following discussion describes population density within the Unit 13 study areas. As noted earlier, radio-marked packs inhabited what are referred to as "experimental" and "control" areas, the former being an area in which wolves were eventually removed, and the latter, an area in which monitoring of radio-marked packs continued. The observed boundaries of radio-marked pack territories were used as the outer boundaries of an area for which estimates of wolf density were derived. This method resulted in parts of Unit 13 near the northern boundary of the unit being eliminated from consideration since wolves appeared to use these areas only rarely. Included are the higher elevations of the Alaska Range near the headwaters of the Susitna and Maclaren Rivers and lying primarily in the experimental area. The experimental area lies at a generally higher elevation, and radio-marked packs there inhabited areas adjacent to more rugged, glaciated portions of the Alaska Range.

Radio-marked packs and other wolves were known to inhabit 2,673 mi^2 ($6,923km^2$) of the 3,200 mi^2 ($8,288km^2$) experimental area during 1975-76. In the control area, where boundaries were defined by the movements of radio-marked packs, wolves inhabited an area of 3,834 mi^2 ($9,930km^2$). This gives an area of 6,507 mi^2 ($16,853km^2$) for which relatively accurate wolf population data are available. Figure 1 shows the approximate boundaries of the experimental and control areas, and also the boundaries of radioed pack territories and general locations of other packs considered in making the population estimate. The number of wolves in each pack in May 1975, October 1975 and May 1976 and resulting density figures are given in Table 28. To allow for the existence of lone wolves and possibly other small groups that would probably not be detected in conjunction with telemetry studies, a number equal to 10 percent of the population of wolves accounted for in packs has been added. This is approximately the proportion of lone wolves observed in other population studies in Minnesota (Mech 1973) and Alaska (Stephenson 1977).

Although we have the greatest confidence in the October 1975 figures, we think the May estimates are also relatively close approximations of the status of wolf numbers in the areas in question. The figures indicate that wolf numbers fluctuated significantly during the first year of study due to reproduction and mortality. The areawide population nearly doubled following the denning season in 1975 and then roughly halved during the winter months due to mortality and dispersal. The loss of pups during summer appeared to be small, at least after the

Table 28. Numbers of wolves in packs included in population estimates derived for Unit 13, 1975-76.

Pack Name	May 1975	Oct 1975	May 1976
Experimental Area - 2673 mi^2			
Deadman Lake	2	5	0
Brushkana River	3	9	0
Butte Lake	4	3	0
Maclaren River	2	6	0
Jay Creek-Coal Creek	6?	10?	2?
Subtotal	17	33	2
Lone wolves	1.7	3.3	-
Total	19	36.3	2
Square miles per wolf	141	74	1337
Control Area - 3834 mi^2			
Delta River	4	8	1?
Keg Creek	7	13	5
Hogan Hill	7	9	7
Ewan Lake	7	11	?
Sinona Creek	7	11	11
Deep Lake	?	?	8
Lower Gakona River	5	5	5
Middle Fork	?	11	9
Subtotal	37	68	46
Lone wolves	3.7	6.8	4.6
Total	40.7	74.8	50.6
Square miles per wolf	94	51.2	75.8
Total estimated population including experimental and control areas	59.4	111.1	52.6
Square miles/wolf, total area 6507mi^2	110	59	124

first few weeks of life, with the loss of one pup from the Ewan Pack in August being noted. In addition, the remains of a four- to five-week-old pup that probably died in 1974 of unknown causes, were found at the Deep Lake den (Table 8).

Data reflecting the 1975 reproductive success of nine radioed packs for which accurate information is available, are given in Table 29. As indicated, the population in the experimental area contained a higher percentage of pups with a lower average pack size than the population in the control area. Pups comprised 43.4 percent of the total radio-marked population. Because all radio-marked packs in the experimental area were removed in midwinter, only data from the control area can be used to evaluate mortality. At least 17 wolves are known to have been lost from the 5 packs in the control area with all but 3 being due to hunting or trapping by man. This loss amounts to 32.7 percent of the autumn 1975 pack population and represents a minimal figure. It appears then, that between May 1975 and May 1976 mortality approached recruitment and negated most of the increase from reproduction.

Some assessment of the status of wolves in Game Management Unit 13 can be made using the data from radio-marked packs given in Tables 28 and 29. Sightings of wolves and wolf tracks in portions of Unit 13 outside the telemetry study area suggest that wolf abundance in much of the unit is roughly comparable to that observed in the study area. Unit 13 includes 25,000 square miles (64,750km^2) of land area of which most is roughly similar to the study area in terms of habitat characteristics. As noted in the above discussion, the highest portions of mountain ranges adjacent to glaciers are little used by wolves, and to allow for this we have eliminated 3,000 mi^2 (7,770km^2) from consideration in making a population estimate. Assuming that the average autumn density (1 wolf per 59mi^2 or 153km^2) and the mortality rate observed in the control area held over 22,000 mi^2 (56,980km^2) of wolf habitat, the October 1975 population would have numbered an estimated 373 wolves with the May 1976 population numbering about 252 wolves, a preparturition density of one wolf per 87 mi^2 (260km^2). The reported 1975-76 harvest of wolves in Unit 13 totalled 110 or 29.4 percent of the estimated October 1975 population. This is comparable to the 32.7 percent mortality observed in the control area and suggests that roughly 75 percent of the 1975 increment was removed by humans, with an additional number of wolves being lost to natural mortality, dispersal, and unreported harvest. Mortality from all causes appears to closely approximate the current reproductive rate of the population. Although the 1975-76 harvest included 29 wolves taken by the Department, harvests in recent years have been similar numbering 75, 103 and 102 in 1973-74, 1974-75 and 1976-77, respectively. It would appear that the population would be nearly stable with present harvest levels but that in any given year an increase or a decrease could occur. If prey availability remains near current levels, changes in harvest intensity are most likely to alter the present relationship. However, from the standpoint of assessing the effect of wolf predation, changes in actual numbers of wolves are probably not as important as are changes in the number of functioning packs. The

Table 29. Numbers of adult and yearling wolves and wolf pups in radio-marked packs in October 1975 and known losses to mortality and dispersal from May 1975 to May 1976.

Pack	No. ad-yg	No. pups	Total	Known* mortality	Number dispersing wolves
Experimental Area					
Deadman Lake	2	3	5	0	0
Brushkana River	3	6	9	2	0
Butte Lake	4	0	4	0	0
Maclaren River	2	4	6	1	0
Subtotal	11	13	24	3	0
Percent pups = 54.1					
Average pack size = 6					
Control Area					
Delta River	4	4	8	5	0
Keg Creek	7	6	13	8	1
Hogan Hill	7	2	9	1	?
Ewan Lake	7	4	11	3	1
Sinona Creek	7	4	11	0	0
Subtotal	32	20	52	17	2
Percent pups = 38.5					
Average pack size = 10.4					
Total	43	33	76	20	2
					22
Percent pups = 43.4					
Average pack size = 8.5					

*Includes only mortality prior to Department control.

preliminary results of this study and the more extensive work of Peterson (1977) suggest that frequency of predation during winter is not proportional to pack size but tends to be more nearly constant within the normally observed range of pack sizes.

Rausch (1968) reviewed Unit 13 wolf population estimates made between 1953 and 1967. After five years of predator control by the U.S. Fish and Wildlife Service, 12 wolves were estimated to remain in Unit 13 in 1953. Wolf numbers increased in subsequent years and were estimated at 35 in 1955, 120 in 1958, 100 to 125 in 1961, 140 to 160 in 1962, 400 to 450 in 1965, and 300 in 1967. No population estimates are available for the years 1968 through 1973 although McIlroy (Department files) thought a "peak abundance" was reached in 1970-71, after which numbers were reduced. In March 1974, aerial surveys indicated that a minimum of 207 wolves inhabited GMU 13 (McIlroy, Department files).

Estimates of wolf abundance have been made by several workers in various parts of North America, and these are reviewed in Table 30. The average autumn density of one wolf per 59 mi^2 ($153km^2$) observed during the present study corresponds most closely to levels of abundance reported previously in central Alaska and in northern and western Canada. The Unit 13 density lies roughly in the middle of the range of densities reported in Alaska. Greater densities of wolves have been reported in subunit 20A (Stephenson 1977) and Mt. McKinley Park (Haber 1968), both of which are adjacent to Unit 13, and in Southeastern Alaska. However, current densities over much of Southeast Alaska appear to be lower than the density range of one wolf per 25 to 40 mi^2 (65 to $104km^2$) given in Table 30 due to a significant decline in black-tailed deer *(Odocoileus hemionus sitkensis)* numbers (Merriam, pers. comm.). Wolf abundance over much of northwestern Alaska (Units 23 and 24) is at present roughly comparable to Unit 13. The results of track count surveys conducted in this area during late winter 1977, indicated that densities ranged from one wolf per 45 to 100 mi^2 (117 to $259km^2$) and averaged about one wolf per 60 mi^2 ($155km^2$). Except for limited areas in the northern Brooks Range, wolf abundance over much of Arctic Alaska (GMU 26) currently approximates one wolf per 150 mi^2 ($388km^2$) or less (Stephenson and Shepherd, unpubl. data).

The relative intensity of the harvest of wolves by humans in other Game Management Units can be at last roughly evaluated by expressing the number of wolves killed in terms of wolves per mi^2. A review of these data for Alaska's 26 GMU's for the years 1959 through 1977, shows that reported harvests have ranged from one wolf per 81 mi^2 ($210km^2$) to one wolf per 8,600 mi^2 ($22,274km^2$). In most of Interior and Southcentral Alaska, annual reported harvests range from one wolf per 300 mi^2 ($777km^2$) to one wolf per 1000 mi^2 ($2,590km^2$), with Units 12, 13, 20 and 24 sustaining the most intensive harvests. Since 1964, harvests in these units have ranged from one wolf per 200 to 400 mi^2 (518 to $1,036km^2$). Van Ballenberghe et. al. (1975) calculated a kill rate of one wolf per 47 mi^2 ($121km^2$) for a study area in Minnesota, and stated that this represented a minimum annual mortality of 20 percent. The 1975-76 harvest of 110 wolves in GMU 13 is equal to one wolf per 227 mi^2 ($588km^2$) and appears to represent

Table 30. Reported densities of North American wolf populations.

Location	Area (sq. mi.)	Density of wolves (sq. mi/wolf)	Authority
Isle Royale, Michigan	210	7-10	Mech 1966
			Jordan et al. 1967
		4.6	Peterson 1976
Algonquin Park, Ontario	1,000	10	Pimlott et al. 1969
Ontario	10,000	100-200	Pimlott et al. 1969
Minnesota	2,490	10	Olson 1938
Minnesota	4,100	17	Stenlund 1955
Minnesota	4,203	10.6[1]	Mech 1973
Minnesota	717	9.2	Van Ballenberghe et al. 1975
Northcentral Brooks Range	3,600	65-124	Stephenson 1975
Mt. McKinley Natl. Park, Alaska	2,000	50	Murie 1944
Mt. McKinley Natl. Park, Alaska	1,500	33 (24-42)	Haber 1968
Unit 13, Alaska	20,000	50	Rausch 1967
Tanana Flats, Alaska	7,000	35	Stephenson 1977
Southeast Alaska	7,500	25-40	Atwell et al. 1963
Coronation Island, Alaska	30	3[2]	Merriam 1964
Saskatchewan	--	40-83	Banfield 1951
Northwest Territories	480,000	60-120	Kelsall 1957
Northwest Territories	384	6.9[3]	Kuyt 1972
Manitoba-Saskatchewan	1,274	7.8[3](7.8-13.8)	Parker 1973
Manitoba-Saskatchewan-Northwest Territories	109,000	200[4]	Parker 1973

Table 30. (cont.)

Location	Area (sq. mi.)	Density of wolves (sq. mi/wolf)	Authority
Western Canada	4,200	87-111 (10^5)	Cowan 1947
Western Canada	593	88	Carbyn 1974
Baffin Island	1,800	120	Clark 1971

1. Average for two winters, 1971-72 and 1972-73.
2. Artificial situation; four wolves stocked.
3. Temporary concentration of wolves on winter range of Kaminuriak caribou herd.
4. Total year round range of Kaminuriak caribou herd.
5. Maximum abundance on winter range.

a harvest of about 30 percent of the autumn 1975 population. As noted above, the current population density of wolves in Unit 13 is moderate compared to other areas in Interior and Southcentral Alaska. Because the intensity of harvest is in most cases lower than that currently observed in Unit 13, it is probable that wolf populations of comparable density in other areas are at present harvested at a rate less than that observed in Unit 13. However, unreported harvest and natural mortality would cause these figures to underrepresent the actual mortality to a varying degree depending on the area. This difference would not be large for most areas in recent years. Wolf populations in local areas can, however, be more strongly affected if harvests are concentrated in only a portion of a unit as is often the case. It appears that in general, harvests by man have been at levels roughly equal to or less than the annual reproduction rate of most populations. Although these harvests have various important effects on wolf populations, it is probable that they are causing population declines in only limited areas. However, there is some evidence to suggest that in areas such as GMU 20A where wolf populations are under some nutritional stress, pup production and survival are even lower than in the Nelchina Basin (Stephenson 1977). In these situations, present or even somewhat reduced harvests have the potential to hasten and exaggerate impending wolf population declines.

Territorial Relationships

Studies of wolf populations in North America show that in most areas a wolf pack tends to remain within a home range that remains stable throughout the year (Mech 1970). This mode of life characterizes wolves inhabiting areas offering relatively constant availability of prey such as deer, elk *(Cervus canadensis)*, moose or sheep which undergo seasonal movements over relatively short distances. In areas where caribou are the primary food for wolves, extensive annual caribou movements are sometimes accompanied by similar large scale movements of wolves (Kuyt 1972, Parker 1972).

In the present study, Etkin's (1964) definition of territoriality as "any behavior on the part of an animal which tends to confine...its movements to a particular locality" is used. For the purposes of this report, the actual mechanisms through which territories are established and maintained will not be discussed. Pack territories represented in Fig. 1, in most cases overlapped territories of adjacent packs to some degree when year round movements were used as indicators of territory extent. Although territories would probably appear somewhat larger if the movements of more adult members had been monitored, or if monitoring had been more intensive, we feel that the territories portrayed are adequately representative of the areas used by each pack to allow some normative statements regarding territorial relationships and use during the period of study.

Of the 10 packs for which relatively long-term data were available, 9 were associated with natal dens during 1975, with an average year round territory size of 452 mi^2 (1,171km^2) and a range of 108 to 864 mi^2 (280 to 2,238km^2) (Table 3). One non-denning pack included three male

wolves during much of the period of study. They ranged over an area of at least 1,188 mi^2 (3,077km^2) which included parts of the territories of at least four other packs, one of which was not radio marked. We felt that movement data from four radio-marked packs were adequate to allow the size of summer home ranges to be quantified (Table 3). These ranged from 180 to 378 mi^2 (466 to 979km^2) and averaged 217 mi^2 (562km^2) suggesting that the movements of pack members are less extensive during summer than during winter. This is corroborated by the fact that in most cases the most extensive movements (i.e. those represented by the outermost locations plotted in Fig. 1) were noted in winter after pups began traveling regularly with adult pack members. The considerable overlap of territory boundaries shown in Fig. 1 is somewhat deceptive in that the overlap indicated, resulted from movements observed during a limited portion of the year and, in most cases, a matter of several days. The various amounts of overlap shown, usually resulted from movements undertaken in early winter after pups were large enough to travel regularly with adults, and in some cases, appeared to be undertaken in response to the availability of caribou during this period. During most of the year the packs studied, inhabited territories that were, for the most part, used exclusively by pack members with occasional overlap in movements occurring during winter and to a lesser extent during summer.

Telemetric and other studies of wolves in North America have in recent years provided data reflecting the characteristics of wolf territoriality. Although relatively large territories on the order of 600 mi^2 or greater have been reported for Alaskan wolves in Mt. McKinley National Park (Murie 1944, Haber 1968) and in the Nelchina Basin (Burkholder 1959), studies in Minnesota and Michigan (Stenlund 1955, Mech and Frenzel 1971, VanBallenberghe et al. 1975, Mech 1966, Peterson 1976) and in southern Canada (Cowan 1947, Pimlott et al. 1969) have shown that other packs confine their activities to areas of 100 mi^2 (259km^2) or less. Territories as small as 19 mi^2 (49km^2) have been reported along Lake Superior in northeastern Minnesota. In western Canada, Carbyn (1974) reported that an intensively studied pack ranged over an area of 593 mi^2 (1,536km^2). In these studies, land area is calculated as it is represented on maps (i.e. as if the land in question were flat). The hilly or mountainous nature of much of Unit 13 and other study areas, means that the actual surface area of land within a specified area is to an indeterminant and varying degree greater than reported. The relatively broken nature of much of Alaska's terrain compared to, for instance, much of Minnesota and southern Canada, would mean that wolf density would actually be lower, and territory size, greater than reported here if a strict comparison based on surface area were made.

Pack Cohesiveness, Group Size and Pack Splitting

As discussed above, wolf packs in GMU 13 inhabited territories that were, for the most part, used exclusively by pack members with occasional overlap in movements occurring during winter and to a lesser extent during summer. However, the number and composition of wolf groups were rarely constant over long periods of time and usually varied from one

observation to the next. Packs appeared to be most cohesive during fall and early winter with pack splitting being more common during other periods of the year. Even during summer, however, wolves were observed hunting in groups including as many as seven members with groups of three to six wolves being common. Cases in which significant pack splitting, or what appeared to be extraterritorial movement were observed, are reviewed below. All pertinent events are first described and later discussed.

Ewan Lake Pack - The gray female which was the only radio-marked member of the Ewan pack during most of the study, was often found alone within the pack territory during early summer 1975 but was more often associated with the remainder of the pack in late summer and fall. About 8 October, however, the female began moving north and west, entering the central portion of the Keg Creek territory by 15 October. The wolf traveled in the western end of the Alphabet Hills, an area about 50 miles (80.5km) northwest of the center of the Ewan territory, until 20 October. On one occasion she was found within one mile of the Keg Creek wolves. By 22 October the Ewan wolf had traveled south to the east side of Lake Louise after which she moved east to Crosswind Lake and then northwest again to the Tyone River where she remained for three days before traveling east toward Minnesota Lake and then south to the center of the Ewan Pack territory where she was observed with other pack members on 4 November.

After associating with pack members during November the female remained apart from the pack during December and January, traveling with one other wolf of unknown sex and age. In early February another wolf joined the pair, and this association persisted until at least 25 February after which contact was lost until 30 April when a wider search found the female associated with three other adult wolves in an area 40 miles (64.4km) west of the 1975 Ewan den. We later determined that this pack included at least five adults and that at least two of these were wolves never seen in the Ewan pack. Subsequently referred to as the Mendeltna pack, these wolves raised six pups at a den in the area. It was apparent that the Ewan female and possibly two other Ewan pack members had integrated into another breeding pack during March or April and subsequently remained in that association.

An adult male member of the Ewan pack also displayed erratic movements during early winter 1975. After being radio-collared on 4 November, this wolf, estimated to be eight years old, traveled alone over a large area until 11 December when he was located with other Ewan pack members within the area commonly used by the pack. During this time the male had ranged north to the Minnesota Lake area, south to Nickel Creek on the south side of the Tazlina River and west to Sanona Creek near Lone Butte, 53 miles (85km) from the 1975 Ewan den. On 11, 12 and 18 December the Ewan adult male was found with 5, 6 and 8 other pack members, respectively, within the Ewan territory. On 6 January 1976 the remains of this wolf were found on a lake 26 miles (42km) south of the 1975 Ewan den and 2

miles (3km) north of the den used during 1975 by the St. Anne pack. Tracks indicated that the Ewan male had been killed and completely consumed by several other wolves.

Keg Creek Pack - Although the Keg Creek pack appeared to be a relatively stable social unit compared to the Ewan Lake pack, the behavior of the young adult female radio-marked in April 1975, showed some tendency to travel independently of other pack members during late winter and summer 1976. In the middle of January this wolf was often found alone but stayed for the most part within the territorial boundaries shown in Fig. 1. On 8 March this female was located near the center of the Hogan Hill territory shown in Fig. 1 and was accompanied by the radio-marked Hogan Hill male. 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 (Fig. 1). On this date the Hogan Hill male was accompanied by another wolf, presumably also a Hogan Hill pack member. On the morning of 12 March, the Keg Creek female and Hogan Hill male 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. The Keg Creek female tended to remain some distance from the four remaining pack members during late March and April. However, on 22 April the female was located in the southern portion of the Ewan pack territory, 49 miles (80km) south of the Keg Creek den. This wolf 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 experimental area 24 miles (39km) north of the 1975 den, north of the Maclaren River. Extensive aerial searches during the next two weeks failed to locate the wolf, but on 13 June it had moved west across the Susitna River to the vicinity of Coal Creek. It is probable that during this time, the wolf was in either the Watana or Clearwater Mountains which could not be adequately searched due to inclement weather. On 18 June the wolf was observed pursuing a cow and calf moose four miles (6km) north of her 13 June location. On 22 June the wolf was in the same area but was accompanied by a gray male wolf judged to be a yearling (based on pelage characteristics). On 26 June the pair was observed 8 miles (13km) east of the 13 June location, east of the Susitna River on Clearwater Creek. By 28 June the pair had moved 29 miles (47km) west to the Jay Creek area where they were observed to detect and pursue the radio-marked Tsusena female which in mid-June had also entered the experimental area. The Keg Creek female and her associate pursued the Tsusena female for about four miles in the direction of the Susitna River, but were not able to catch her and eventually ceased pursuit. On 30 June the pair was located in the Watana Creek drainage 8 miles (13km) 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.

The Tsusena female, also a young adult, was first noted in the experimental area on 13 June when she was found alone near a cow and calf moose on Watana Creek east of the Deadman den. On 18 June this wolf was located near Deadman Creek along the eastern border of the experimental area, in the vicinity of a recently-killed bull caribou that was being fed upon by a sow and cub grizzly. On 26 June she was located on the south side of the Susitna River near the mouth of Watana Creek. On 28 June the Tsusena wolf was pursued by the Keg Creek wolf and its associate, as noted above, and on 30 June she was located along Kosina Creek 16 miles (26km) south of the area of the chase. By 2 July she had moved an additional 32 miles (52km) southeast to the headwaters of Sanona Creek, an area about 65 miles (105km) southeast of the Tsusena pack's range.

Hogan Hill Pack - The Hogan Hill female, radio-marked as a yearling in June 1975, also showed some tendency to remain separate from other pack members. During the summer and winter of 1975, the seven adults and two pups in the Hogan Hill pack appeared to be a relatively cohesive social unit. After early February, however, the radio-marked female, now 20 months old, was consistently found apart from the radio-marked male but was accompanied by one and sometimes two associates. These wolves remained largely within the area previously inhabited by the pack except that on 24 February the female and two associates were found to the east near the Richardson highway at a fresh moose kill. On 25 February the trio was found near Round Top Mountain about six miles (10km) northeast of the easternmost pack location recorded previously. The female and her associates subsequently returned to the pack territory but appeared to remain separate from other pack members until at least 20 April when the radio on the female ceased functioning. These observations and those of the radio-marked male described above, suggest that the Hogan Hill pack split, or at least that its members became more loosely associated in early February. The only known mortality in the pack during winter 1975-1976, was a male pup which was snared in late February. The radio-marked male was also snared on the same occasion but was not killed because the radio-collar kept the snare from tightening. This wolf was released and appeared to totally recover.

Sinona Creek Pack - The Sinona Creek female, radio-marked as a young adult in April 1975, was commonly found traveling alone during the summer and fall of 1975, but during early and midwinter was regularly found in association with other pack members. On several occasions in March the female was found alone, however. In April this wolf was again observed traveling with other pack members prior to the malfunction of her radio late in that month. These observations suggested some tendency for the female to remain alone during the breeding season although not to the degree noted for the Ewan Lake, Keg Creek, or Hogan Hill females.

Deep Lake Pack - The radio-marked female in the Deep Lake pack remained separate from the Deep Lake pack members subsequent to being radio-marked in March 1976. This wolf was estimated to be 8 to 10 years old, and was traveling with two and possibly three other wolves when

located in the eastern one-third of the Deep Lake pack territory (Fig. 1) prior to collaring. In subsequent weeks, the female traveled alone in the southern portion of the area shown as the Ewan Lake pack territory (Fig. 1), visiting the dump at Glennallen on two occasions. On 20 June, however, the Deep Lake female was found at the northwest corner of Ewan Lake resting within 30 m of two other gray wolves. One of these wolves was similar in appearance to a member of the Deep Lake pack seen on several previous occasions. This was the only time the female was known to have made contact with other wolves during the three months she was observed. During the remainder of June the female traveled alone in the Glennallen area.

Tyone Male - The Tyone male wolf also traveled alone over a large area. His movements have been described in detail above and will not be reviewed here. As noted, the Tyone wolf traveled alone for nearly five months before entering an association with a denning female with which he may or may not have been associated previously.

Zimen (1976) reviewed the existing knowledge regarding the social organization of wolf packs and characterized seasonal changes in the social and spatial organization of wolf populations in the course of developing a model of pack size regulation. Based on studies of free-ranging and captive wolves, he described a number of phenomena that are pertinent to an evaluation of the movements and behavior described above. Zimen noted that:

1. whether pack members are together or temporarily split up, they form a social unit basically closed to other wolves and well integrated internally;
2. not all wolves live within a pack territory and others may wander over long distances;
3. during winter wolves are more active socially than during summer, and antagonistic behavior is particularly high before and after the breeding season with aggression being relatively low in summer;
4. offensive aggressive behavior of low and moderate intensity occurs predominantly among males as well as between the sexes;
5. aggressive behavior of high intensity occurs mainly among females and rarely between the sexes, and although adult female pack members are usually tolerant of each other, a clash escalates rapidly and often results in the ejection of the lower ranking female from the pack;
6. low ranking adult wolves leave packs more readily than those of high rank and also show a greater willingness to make social contact with strange wolves;
7. a young male is more likely to leave the pack voluntarily than a female;
8. the probability that a wolf will be forced to leave the pack depends upon its age, sex, and rank position as well as on the general frequency, intensity, and direction of aggressive behavior within the pack;
9. the probability of being forced to leave the pack is high for a low ranking adult, especially a female, at the beginning of winter while it is low for high ranking adults, juveniles and pups.

Zimen also conducted food deprivation experiments with captive wolves and noted that up to a point the frequency of aggressive behavior increased with increasing hunger. Increased aggressive behavior toward subdominant adults and evicted wolves was most apparent. Mech (1977) described changes in behavior in a Minnesota wolf pack associated with a decline in prey availability. In this case, the wolves traveled less, slept more, trespassed in other pack territories, and began killing moose in addition to deer.

The packs observed in Unit 13 showed the tendency noted in other studies to split in late winter during the breeding season. The activities of the Ewan, Hogan Hill, Keg Creek, and Sinona females during late winter probably resulted partly from oppression by a dominant, older female. It is known that each of these packs contained at least one other adult female which produced pups in 1975. The tendency of maturing wolves to travel alone for various periods of time is also illustrated by the behavior of each of these young females as well as by the behavior of the Tsusena female which dispersed from her pack territory in June. The extensive wanderings of the Ewan male could have been due in part to advanced age and low social rank and also to nutritional stress within the pack. These circumstances might also explain the solitary wanderings of the Deep Lake female. The entry of the Keg Creek and Tsusena females into the experimental area within five months after removal of most of the resident wolves illustrates the strong tendency shown by wolf populations to repopulate suitable but vacant habitat. In this case, the scarcity of fresh scent marks of other wolves could have encouraged the female to remain in the area as hypothesized by Peters and Mech (1975). The rapid acquisition of a yearling male associate by the Keg Creek female and their aggressive reaction to the Tsusena female illustrate the ease with which young, solitary wolves can enter an association and also suggest a fairly rapid assumption of territorial behavior after the wolves entered an area largely free of other wolves.

The association of members of different packs for even short periods of time has been documented in only a few cases (Mech, pers. comm.), while the acquisition of new associates by young, dispersing wolves appears to be a more regular occurrence. The observations cited above, suggest that members of alien packs may associate under other circumstances as well. The Keg Creek female accompanied the Hogan Hill male for several days during the breeding season although she did not subsequently rear pups and may not have produced any. The Ewan female and possibly two other Ewan pack members successfully integrated with at least two alien adult wolves in a new territory, and this occurred during or shortly after the breeding season. In addition, the Tyone male may have integrated with a parturient female in early summer. Based on the available knowledge of wolf social behavior, the translocation of the Ewan wolves is most notable in that the circumstances in that case normally would minimize the probability of a successful integration of alien pack members.

Wolf Food Habits

The summer food habits of wolves in the Nelchina study area were assessed primarily on the basis of the contents of 1532 scats collected at eight natal dens and five rendezvous sites during summer 1975. Food remains found at dens, and observations of wolves hunting and feeding during summer were used to supplement the data from scats.

Scat analyses are widely used in studies of carnivore food habits, but the degree to which frequencies of identifiable remains represent the actual proportion of prey types consumed is not known. Scott (1941) and Lockie (1959) considered this problem in connection with experiments with red fox *(Vulpes vulpes)* scat analyses and derived correction factors for converting weight of scat contents to actual weight of food eaten. Scott concluded that frequency of occurrence provided the best estimate of the relative importance of prey species and that fecal passages were produced in direct proportion to the quantity of food consumed. Lockie concluded that percentage weight was the most accurate way of interpreting the results of fecal analysis. Scott suggested an additional method of treating data by grouping them so as to minimize the tendency to overemphasize the importance of small prey types and underemphasize the importance of larger prey. Those tendencies are inherent in the method because smaller prey have a comparatively high surface:volume ratio and therefore consist of more hair (the primary item identifiable in scats) compared to larger animals, and because there are usually more species of smaller prey available and more of these can be ingested in a short period of time by a carnivore. Scat content data are presented both in terms of frequency of occurrence and in a grouped form. Using the latter method each group of prey types can score no more than one occurrence in a scat.

Floyd et al. (in press) conducted feeding trials using captive wolves with the goal of establishing criteria for interpreting the relative ratios of animals eaten from wolf scat data. Prey items ranged in size from snowshoe hares to adult white-tailed deer *(Odocoileus virginianus)*. Results of the experiment showed that the weight of small animals consumed is over-represented compared to larger animals in field collectable wolf scats while the number of individuals of small prey consumed is under-represented. A regression equation was derived to estimate the weight of prey eaten per collectable scat for any size prey. The study contrasted the disparity in representation between adult deer and fawns and pointed out that the disparity increased with prey whose sizes differed more than these types. The prey of wolves in the present study ranged in size from microtine rodents to adult moose with a weight difference of more than one thousand fold. Considering only moose, the weight difference between calves and adults is also greater than between fawn and adult deer, tending to create a somewhat greater potential for error if an assessment of the importance of prey species in summer is based solely on frequency of occurrence.

Table 31 summarizes data reflecting the frequency of occurrence of various prey types in scats. To allow for a more correct interpretation of the summer food habits data obtained in the present study, the method derived by Floyd et al. (in press) was applied to the cumulative frequency of occurrence data given in Table 31 (Table 32). According to these workers, the linear equation, $y = 0.38 + 0.02x$, describes the relationship between weight of a prey type and the weight of prey represented by each collectable wolf scat (y is the kilograms of prey per collectable scat, and x, the weight of a given prey type). The average weight for moose calves given in Table 32 is based on weights of moose calves raised in captivity (unpubl. data, Department files) and represents only the period from 1 June to 12 July, which corresponds roughly with the period of use for natal dens during the study.

The data derived in Table 32 indicate that the 1975 collection of 1532 scats containing mammalian remains, represented 3347 kgs of prey consumed. Of this total, moose comprised 2832.2 kgs or 84.6 percent. Calves accounted for only 21.1 percent of the weight of moose eaten and 17.9 percent of the total weight of prey consumed despite the fact that they were the most frequently occurring remains in scats. In terms of number of individuals taken, however, moose calves exceeded adults by a ratio of about 3.6:1. This figure is especially liable to error because calf moose weights change rapidly during summer with weight increase being roughly 40 percent during the first 9 days of life and persisting at rates of about 15 percent per week through July (unpubl. data, Department files). Thus, the ratio of calf moose weight to that of adults would change rapidly as would the "y" value for calves. For this reason the data derived in Table 32 should be viewed as only a general indication of the proportions of weight and numbers of moose consumed.

Table 33 presents treated scat analysis data for each den and rendezvous site for which scat collections were sufficiently large for meaningful analysis (excludes Maclaren and Deadman rendezvous sites). Only the major food items are treated. These data suggest that adult moose were the most important source of food at all dens, accounting for the largest volume of food consumed, but that calf moose were more important than adults in all but one case (Ewan rendezvous) in terms of numbers of individuals taken. However, the tendency wolves have for visiting old kills, and the persistent nature of the identifiable remains of adult moose, could result in an exaggeration of the actual number of adult moose taken during summer. Beaver and/or snowshoe hares appear to have been important sources of food at several dens including the Ewan, Sinona, Keg Creek, Delta, St. Anne, and Second Hill Lake dens and the Ewan and Delta rendezvous sites. In total, these two species of small mammals exceeded calf moose in terms of weight eaten at the Ewan den and rendezvous, the Delta den and rendezvous, and at the St. Anne den. As noted earlier, the Delta and Ewan packs appeared to be in relatively poor nutritional condition during summer and early fall, and inhabited areas known to have low densities of ungulate prey. The relatively greater reliance on small mammals reflected in the scat data may

Table 31. Incidence of food remains in 403 adult wolf scats and 1129 pup wolf scats collected between July and October 1975 at wolf dens and rendezvous sites used during the summer of 1975 in Game Management Unit 13, southcentral Alaska.

Food item	Items in adult scats n = 403 No.	%	Items in pup scats n = 1129 No.	%	Total items n = 1532 No.	%
Adult moose	92	22.8	169	15.0	261	17.0
Calf moose	132	32.8	472	41.8	604	39.4
Caribou	22	5.4	58	5.1	80	5.2
Dall sheep	2	0.5	6	0.5	8	0.5
Beaver	50	12.4	187	16.5	237	15.5
Snowshoe hare	158	39.2	281	24.9	439	28.7
Ground squirrel	8	2.0	16	1.4	24	1.6
Red squirrel	2	0.5	0	0.0	2	0.1
Muskrat	5	1.2	6	0.5	11	0.7
Microtines	8	2.0	32	2.8	40	2.6
Lynx	0	0.0	6	0.0	6	0.4
Wolf	0	0.0	5	0.0	5	0.3
Fish	3	0.7	2	0.2	5	0.3
Bird	11	2.7	7	0.6	18	1.0
Eggshells	6	1.5	6	0.5	12	0.8
Invertebrates	0	0.0	3	0.3	3	0.2
Vegetation	3	0.7	28	2.5	31	2.0
Unidentifiable	0	0.0	8	0.7	8	0.5
Total	502		1282		1784	

Total Grouped Data: n = 1532 scats

Food Item	Number	Percent
Ungulate	953	62.2
Small mammal	735	48.0
Other	90	5.9
Total occurrences	1778	

Table 32. Results of Unit 13 wolf scat analysis treated with conversion factors derived by Floyd, et al. (in press). Only mammalian prey types are included.

Prey item	Weight of prey indiv. or x (kgs)	Kgs per scat (y)[1]	# of scats	Kgs eaten[2]	Ratios of weight eaten[3]	# of indiv. eaten[4]	Ratios of # of indiv.
Adult Moose	(409)	8.56	261	2234.2	1.0	5.5	1.0
Calf Moose	(30.4)[5]	.99	604	598	.268	19.7	3.58
Caribou	(68.2)	1.7	80	136	.061	2.0	.36
Dall Sheep	(54.5)	1.47	8	11.8	.0053	0.2	.04
Beaver	(13.6)	.65	237	154.1	0.07	11.3	0.18
Snowshoe Hare	(1.6)	.41	439	180	.081	112.5	20.45
Ground Squirrel	(.8)	.40	24	9.6	.0043	12.0	2.18
Red Squirrel	(.5)	.39	2	.78	.00035	1.6	0.29
Muskrat	(1.8)	.42	11	4.6	.0021	2.6	0.47
Microtines	(.1)	.38	40	15.2	.0068	152	27.63
Lynx	(9.1)	.56	6	3.4	.0015	0.4	0.07
Wolf	(38.6)	1.15	5	5.75	.0026	0.2	0.04
Totals			1707	3347			

[1] Calculated from the linear equation y = 0.38 + 0.02 (x).
[2] Derived from the number of scats in sample times the number of kilograms per scat.
[3] Relative ratios with adult moose as the primary unit.
[4] Derived from the number of kilograms eaten divided by average weight of prey item.
[5] An average weight for moose calves for the period 1 June - 12 July based on weights of calves raised in captivity.

Table 33. Amount of major prey types represented by scats collected at dens and rendezvous sites, Nelchina Basin, 1975.

Den or rendezvous site		Ewan Den		Ewan Rendezvous		Sinona Den		Hogan Hill Den		Keg Creek Den		Keg Creek Rendezvous	
	Kgs. per scat	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten
Adult Moose	8.56	13	112.3	57	487.9	39	333.8	20	171.2	8	68.4	24	205.4
Calf Moose	.99	37	36.6	15	14.9	77	76.2	46	45.5	51	50.5	100	99
Caribou	1.7	8	13.6	0	0	1	1.7	22	37.4	0	0	1	1.7
Dall Sheep	1.47	0	0	0	0	0	0	0	0	0	0	0	0
Beaver	.65	58	37.7	46	29.9	13	8.45	0	0	8	5.2	0	0
Snowshoe Hare	.41	54	22.1	5	2.1	2	0.8	64	26.2	17	7.0	10	4.1
Ground Squirrel	.4	0	0	0	0	0	0	0	0	0	0	0	0

Table 33. (Continued).

Den or rendezvous site	Delta Den		Delta Rendezvous		Brushkana Den		St. Anne Lake Den		Second Hill Lake Den		Total Kgs. eaten
	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	No. scats	Kgs. eaten	
Adult Moose	20	171.2	4	34.2	14	119.8	24	205.4	19	162.6	2072.3
Calf Moose	39	38.6	9	8.9	94	93.1	61	60.4	46	45.5	569.2
Caribou	0	0	0	0	45	76.5	0	0	3	5.1	136.3
Dall Sheep	0	0	0	0	8	11.8	0	0	0	0	11.8
Beaver	24	15.6	45	29.3	12	7.8	9	5.9	19	12.4	152.3
Snowshoe Hare	67	27.5	5	2.1	0	0	195	80.0	16	6.6	178.5
Ground Squirrel	3	1.2	21	8.4	0	0	0	0	0	0	9.6

Table 33b. Number of individuals of each prey type represented in each of the collections designated in Table 33.

Prey Species	Assumed weight (kgs.)	Ewan Den	Ewan Rendezvous	Sinona Den	Hogan Hill Den	Keg Creek Den	Keg Creek Rendezvous
Adult Moose	409	0.3	1.2	0.8	0.4	0.2	0.5
Calf Moose	30.4	1.2	0.5	2.5	1.5	1.7	3.3
Caribou	68.2	0.2	0.0	.03	0.5	0.0	.03
Dall Sheep	54.5	0.0	0.0	0.0	0.0	0.0	0.0
Beaver	13.6	2.8	2.2	0.6	0.0	0.4	0.0
Snowshoe Hare	1.6	13.8	1.3	0.5	16.4	4.4	2.6
Ground Squirrel	.8	0.0	0.0	0.0	0.0	0.0	0.0

Table 33b. (Continued).

Prey Species	Delta Den	Delta Rendezvous	Brushkana Den	St. Anne Lake Den	Second Hill Lake Den	Total individuals represented
Adult Moose	0.4	0.1	0.3	0.5	0.4	5.1
Calf Moose	1.3	0.3	3.1	2.0	1.5	18.9
Caribou	0.0	0.0	1.1	0.0	0.1	2.0
Dall Sheep	0.0	0.0	0.2	0.0	0.0	.2
Beaver	1.2	2.2	0.6	0.4	0.9	11.3
Snowshoe Hare	17.2	1.3	0.0	50.0	4.1	111.6
Ground Squirrel	1.5	10.5	0.0	0.0	0.0	12

reflect a necessity for this reliance rather than a greater availability of small mammals in the immediate vicinity of certain den sites.

Although various sources of error remain in applying this method, the results are more nearly representative of wolf summer food habits under present ecological conditions in the study area than those based on an interpretation of frequency of occurrence. The results suggest that even "grouping" scat data (Table 31) considerably underemphasizes the importance of large mammals since this prey type (ungulates) occurred at a frequency of 62.2 percent in grouped data while constituting 89 percent of the total weight of prey consumed as derived using the method of Floyd et al. (in press).

Characteristics of Predation on Ungulates

Between 20 April 1975 and 30 June 1976 the carcasses of 120 ungulates were found in connection with telemetry studies of wolves. Conditions rarely allowed us to land and inspect carcasses on the ground, and on only 10 occasions were the characteristics and condition of prey evaluated in this manner. In other cases, aerial observations, usually with the aid of binoculars, provided the bulk of the information regarding the characteristics of ungulate carcasses. Basic information reflecting the sex and age composition of carcasses noted, and the probable cause of death is given in Table 34. In 12 instances, all available evidence suggested that grizzly bears had killed the ungulate in question, and in another case, a black bear *(Ursus americanus)* was observed feeding on a moose calf. In addition, grizzly bears had visited nine other carcasses listed in the record of kills for each pack, and these are classed as possible bear kills. The criteria for establishing whether wolves or bears killed a moose were somewhat subjective. Bears characteristically cover the remains of large prey with large amounts of soil and debris. When this was noted, or a bear was seen at a carcass, the possibility that a bear killed the animal had to be considered whether or not wolves were present in the area. In 10 cases, kills attributed to bears were located when radio-marked wolves were located. In those cases where most of the carcass was consumed and the remainder covered and located in an area that radio-marked wolves and their associates had not frequented during the preceding several days, we considered it likely that a bear had made the kill.

In some cases, only one wolf was observed near a bear on the carcass of an adult moose. Here also the probability that the bear killed the animal was great since single wolves are rarely successful in killing adult moose. On one occasion, a large male grizzly was found feeding on the carcass of a large bull moose and three members of the Hogan Hill pack were located nearby. In this case the moose was resting on its sternum with its hindlegs twisted upward as if its spine were broken, suggesting that it had died abruptly with the bear being the probable cause of death. We feel that the criteria used to differentiate wolf and bear kills allowed us to accurately distinguish the two types of predation in most cases despite the element of subjectivity involved.

Table 34. Classification of kills observed in conjunction with telemetry studies of wolves, 20 April 1975 through 20 July 1976, GMU 13 Alaska.

Species	Adult Male	Adult Female	Adult Unknown Sex	Sex and Age Calf	Unknown	Total
Known and probable wolf kills:						
Moose	3	11	25	13	23	75
Total known adults(%)	39(75%)					
Total known calves(%)	13(25%)					
Total known age kills	52					
Caribou	2	5	4	2	12	25
Total known adults(%)	11(84.6%)					
Total known calves(%)	2(15.4%)					
Total known age kills	13					
Species unidentifiable						4
Known and probable bear kills (includes one calf moose killed by a black bear, all other kills made by grizzly bears):						
Moose	1	2	6	2	2	13
Total known adults(%)	9(81.8%)					
Total known calves(%)	2(18.2%)					
Total known age kills	11					
Probable winter kills			3			3
					Total	120

Table 35. Sex and age composition of wolf-killed moose during early summer, late summer, and winter, GMU 13, 1975-76.

Period	Adult No. (%)	Calves No. (%)	Unknown No. (%)	Total
5/15 - 6/30	2 (20)	4 (40)	4 (40)	10
7/1 - 9/15	4 (80)	1 (1)	0	5
9/15-5/15	33 (55)	8 (13.3)	19 (31.7)	60
	39 (52)	13 (17.3)	23	75

Both bears and wolves have a high level of olfactory acuity and are capable of locating carcasses over long distances. It is probable that bear and wolf densities in GMU 13 are comparable although bears may be somewhat more abundant than wolves. The daily travel rate of wolves is probably several times that of bears, however, and we conjecture that wolves would have an opportunity to detect and scavenge carcasses that is equal to and possibly greater than that of bears.

In addition to the ungulate kills listed, one red fox was killed by the Ewan Lake wolves in late September 1975 and the Deep Lake wolves were observed with a freshly killed otter *(Lutra canadensis)* in spring 1976.

Table 35 gives the characteristics of moose taken by wolves in early summer, late summer and winter. The data suggest that calves were the predominant age class taken during summer but that during winter, they were taken in smaller numbers than adults. The kills of unknown age could alter these ratios somewhat although, in the case of summer kills, the probability of calf remains persisting long enough to be detected but not identified as such is small. Thus it is probable that the four summer moose kills of unknown sex and age were actually adults. The winter kills of unknown sex and age could conceivably alter the adult-calf ratio considerably but it is unlikely that this is the case.

Of possible significance is the fact that three yearling moose were known to have been killed by wolves during the 1975-76 study. Two of these kills occurred during summer and one during early winter. Because the remains of yearlings are usually difficult to distinguish from those of adults when observed from the air and during winter remains of yearlings and calves may be confused, it is likely that some additonal kills included in these categories were actually yearlings. It appears that, followng abandonment by the cow, yearling moose remain relatively vulnerable to wolf predation probably due to their small size and lack of aggressiveness compared to older animals.

Autumn 1976 moose composition counts conducted in GMU 13 provide data on the composition of the moose population which can be compared the composition of wolf-killed moose. In November 1976, calves comprised 15.0 percent of 4424 moose that were classified. The bull:cow ratio among adults was 16:100 (Department files). In the sample of wolf kills, calves comprised 25 percent of the total of 52 known-age moose, with 45.5 percent of 11 known-age summer wolf-kills, and 19.5 percent of 41 known-age winter wolf kills being calves. This suggests that wolves show a predilection for calves during summer but that during winter, calves are taken more nearly in proportion to their occurrence in the population. The ratio of adult males to adult females among 14 adult moose killed by wolves was 27:100, slightly higher than the ratio observed in the moose population.

McIlroy (1976) reported on the composition of 119 ungulate carcasses found during the winter of 1974-75 in the same area studied during the present work in GMU 13. These included 35 adult moose, 28 calf moose,

30 moose of unknown age, 11 caribou, 9 ungulates of unknown species, and 6 moose that died of starvation. All animals not dying of starvation were judged to be wolf kills with the exception of one moose calf which had been killed by a bear. In this sample, 44 percent of the known-age moose were calves while in autumn composition counts, calves comprised only 20 percent of the moose population. This indicates some selection for calves during winter by wolves.

Johnson (Stephenson and Johnson 1973) reported data from the remains of 57 moose killed by wolves in the Nelchina area during the unusually severe winter of 1971-72. In this case, calves comprised 56.1 percent of the wolf-killed moose and only 15.8 percent of the autumn 1971 moose population, suggesting a high vulnerability of calves to wolf predation during a winter of deep snow.

A number of studies of wolf ecology have shown that wolves select calves and fawns of various ungulate species during summer (Thompson 1952, Pimlott et al. 1969, Mech 1966, Shelton 1966, Frenzel 1974, VanBallenberghe et al. 1975), while under normal winter conditions they are taken more nearly in proportion to their relative abundance. The wolf scat analyses and winter wolf kill data obtained in the present study show that this pattern also characterizes wolf predation in the Nelchina Basin. The winter of 1975-76 was relatively mild in terms of the duration and extent of snow cover (Soil Conservation Service Report, May 1, 1976), and apparently did not cause moose calves to be more vulnerable to wolf predation. As noted, however, the carcasses of three moose that may have died from causes other than predation were found. This was indicated by the fact that although the carcasses were visited by wolves, these moose died while resting on their sternum (Stephenson and Johnson 1973). However, both carcasses were observed in December which is unusually early for winter-kill to occur, except in the most severe winters, making their classification as winter kills questionable.

In most respects, observations of wolf predation during winter in GMU 13 parallel those of Mech (1966), Peterson and Allen (1974) and Peterson (Annual Reports 1975, 1976, 1977) on Isle Royale, although Mech concluded that there was some selection for calves in three winters of normal severity for which he obtained data.

Occurrence of Caribou in the Winter Diet of Wolves

The availability of caribou to radioed packs varied from season to season and area to area. The Nelchina caribou herd, numbering approximately 12,000, was present in the study area primarily during winter although during summer, small groups were found in the western portion of the experimental area, and to a lesser extent in the remainder of the area inhabited by radioed packs. The primary calving area on Kosina Creek lies 20 to 50 miles (32 to 80.5km) south and west of the nearest radio-marked wolf pack territories. The eastward fall migration resulted in considerable numbers of caribou being available to wolves in the western portion of the Lake Louise flats and along the West Fork of the Gulkana

River, and by early November 1975, caribou were distributed over most of the Lake Louise flats as far east as the vicinity of the Richardson Highway and north into the Alphabet Hills. Observations of kills made by radio-marked packs, suggest that the occurrence of caribou in the winter diet of wolf packs coincided closely with their presence in pack territories. All of the caribou kills were observed during the winter months with the earliest being found on 19 October and the latest on 6 May. The data also suggest that all but one pack continued to take moose when caribou were available. Only in the case of the Ewan pack did there appear to be a drastic shift in hunting efforts to caribou manifested in part by an apparent northward extension of movement to the West Fork area where the initial easterly movement of caribou was most extensive. Ten caribou were known to have been taken by this pack during winter 1975-76. This exceeds the number taken by any other pack. The home range of the Ewan pack appeared to support very low numbers of moose relative to most other pack territories, probably accounting for extensive reliance by this pack on caribou once they were available.

As indicated in Table 34, the carcasses of 25 wolf-killed caribou were found, constituting 25 percent of 100 wolf-killed ungulates observed. Eighty-five percent of 13 known-age kills were adults and 15 percent calves. In sex and age composition counts conducted during March 1975 and March 1976 (Department files), calves comprised 21 percent of the herd. The small sample of wolf-killed caribou available shows a slightly lower occurrence of caribou calves than does the population, giving no indication of the selection for calves during winter documented in other studies (Miller 1975, Parker 1972).

Condition of Ungulate Prey

Table 36 presents data from four moose and five caribou kills which were examined on the ground. In some cases, as indicated, long bones were used (femurs when possible) and/or teeth were unavailable. Franzmann and Arneson (1976) studied the fat content of 181 moose dead from accidents, malnutrition, and wolf predation on the Kenai Peninsula. They found that marrow fat values from accidental and wolf-killed moose were significantly higher than from winter-killed moose, with 8 wolf-killed calves and 11 adults averaging 22.1 percent and 69.9 percent fat, respectively. They also concluded that femur marrow fat values below 10 percent may reliably identify moose that are winter-killed. Johnson (Stephenson and Johnson 1973) reported that marrow samples from 8 adult moose killed by wolves in GMU 13 during the winter of 1971-72, averaged 75.8 percent fat while marrow from 14 moose calves killed by wolves averaged 21.8 percent fat. Stephenson (1975) reported that marrow samples from 17 adult and 1 calf moose killed by wolves in GMU 20A during the winters of 1973-74 and 1974-75, averaged 71.4 percent. One adult and one yearling moose (Table 2) killed by wolves during 1975-76 in GMU 13, show comparable fat values while one, a four-year-old adult female, shows a lower but not critically low fat level.

Table 36. Sex, age and nutritional condition information from moose and caribou taken by wolves, GMU 13, Alaska 1975-76.

Species	Date of kill or collection	Radioed pack involved	Sex	Age	Percent marrow fat	Degree of utilization	Location and Remarks
moose	6/6/75	Hogan Hill	F	11	56	95%	SW of Hogan Hill
moose	11/24/75	Sinona Creek	na	calf	na	95%	2 mi SW Sinona Lodge
moose	5/5/75	Deep Lake	F	4	26	95%	2 mi S Lake Louise
moose	6/21/76	Sinona Creek	M	1	60	70%	Spring Cr - Gakona R
caribou	11/12/75	None	M	old ad	8	80%	Tyone Cr - Lone Butte
caribou	12/5/75	Keg Creek	na	ad	na	100%	Hdwtrs Keg Creek
caribou	4/21/76	Keg Creek	F	ad	8	90%	West Fork Gakona R
caribou	5/3/76	Mendeltna	F	ad	60	20%	Grayling Lake, pregnant

Table 37. Predation rates calculated for five radio-marked wolf packs, GMU-13, 1975-76.

Pack	No. radio locations	Total no. kills observed	Pack size (including pups)	Avg. no. days between kills	
				Method 1	Method 2
Ewan Lake	151	17[2]	10	9.8	9.4
Hogan Hill	155	12[2]	9	10.4	12.8
Keg Creek	365	11[3]	13	17.7	33.3
Sinona Creek	168	18[4]	11	8.6	9.3
Maclaren	51	12	6	6.2	4.3
Total	890	70	avg. 9.8	avg. 10.5	avg. 13.8

[1] Includes two kills found after the Ewan female had joined the Mendeltna pack.
[2] Excludes two moose judged to be winter kills and six judged to have been killed by bears.
[3] Excludes five moose judged to have been killed by bears.
[4] Excludes four moose judged to have been killed by bears.

Two of the four adult caribou from which marrow samples were obtained show very low (8%) marrow levels with the remaining two showing moderately high levels of marrow fat. This suggests that poor nutritional condition could have rendered these animals more vulnerable to predation. Davis (1977) reported the sex and age composition and nutritional condition of 26 wolf-killed caribou examined in northwestern Alaska during March and April 1977. Four (15%) were calves which corresponded closely to the occurrence of calves in the population. The nutritional condition of caribou taken by wolves varied, and a correlation with snow depth was evident. In areas where snow depth was 45 to 90 cm deep, wolves appeared to take animals of any sex and age, and these were in good nutritional condition with marrow fat averaging 64.6 percent. In the Selawik Flats area, where snow depths ranged from 0-25 cm, five of six wolf-killed caribou were in poor condition with femur marrow values averaging 18.3 percent.

Rate of Predation by Wolves

During the first year of GMU 13 wolf radio-tracking studies, efforts were directed toward providing basic information on the movements, productivity, and food habits of all radio-marked packs. As a result, time did not allow the intensive contact with packs necessary to provide complete records of kills made over periods of weeks or months as has been done in some other studies (Mech 1966, Kolenosky 1972, Burkholder 1959, Peterson 1976). The data collected do, however, provide some indication of the rate at which wolves took prey on a year round, and to a lesser extent, on a summer-winter basis.

The data presented in Table 37 are based on observations of wolves at kills and include only data from five packs with which we had most frequent and regular contact. The rate of predation was assessed in two ways. In Method 1, periods during which contact was regular and relatively frequent, were selected and an average period between kills calculated. Method 2 involved calculating the number of kills per year by expressing the number of kills found as a percent of the number of times each pack was located, and projecting this to a one year period. Both moose and caribou (calves and adults) were included in the diet of each pack with the exception of the Sinona Creek pack which was observed to prey only on moose.

For various reasons, the kill rates indicated should be regarded as minimum rates except in the case of the Maclaren pack for which we feel that chance resulted in our locating a relatively high proportion of kills. The fact that a maximum of three members were radio-marked in each study pack and that packs commonly split up into subunits of various sizes which often included no radio-marked individuals, tended to lessen our chances for locating kills, as did the relatively extensive nature of our contact with radio-marked packs. A further indication of the conservative nature of these figures lies in the fact that in several instances packs were located at fresh kills made as little as three days

apart. For instance, between 16 October and 9 November 1975, the Maclaren pack was known to have killed five moose, although the pack was comprised of only two adults and four pups.

Mech (1966) found that a pack of 15 wolves on Isle Royale killed an average of 1 moose every 3 days during late winter, and in subsequent studies Peterson (1976) found that 3 packs averaging 12 members also killed an average of 1 moose per 3 days with the largest pack (17 wolves) killing 1 moose per 2.6 days during late winter. Kolenosky (1972) found that a pack of 8 wolves in Ontario killed one deer every 2.2 days during a 63-day period in an area having a high density of wintering deer. Burkholder (1959) found that during a 45-day observation period, a pack of 10 wolves inhabiting part of the present GMU 13 study area, killed a caribou or moose every 1.2 days during late winter.

Each of these studies indicated a predation rate higher than that derived in the present study. This is probably due at least in part to the intensive techniques characterizing these studies, but may also reflect a somewhat lower rate of kill among the GMU 13 wolves which, under present ecological conditions, inhabit an area with prey densities much lower than in any of the above-mentioned studies. As noted earlier, the frequency of predation during winter is not proportional to pack size but tends to be more nearly constant within the normally observed range of pack sizes (Peterson 1977).

There remain some questions as to possible seasonal variation in rate of kill due to seasonal changes in pack behavior. The predation rates derived in this and other studies cited are based primarily on observations made during middle and late winter when snow conditions are favorable for gathering this kind of data. Based on intensive studies of a pack of wolves in Minnesota, Mech (1977) noted that the number of deer killed peaked from mid-February through mid-March suggesting that predation rates observed in late winter may not accurately represent predation during other seasons. A subjective evaluation of the GMU 13 data reveals no drastic variation from early to late winter. The characteristics of summer predation are more difficult to compare due to less favorable viewing conditions. We can surmise, however, that the rate of predation during summer would tend to be relatively high due to the smaller size of most prey individuals.

Observations on Predation by Grizzly Bears

As shown in Table 34, 12 cases in which grizzly bears killed moose were noted during telemetry studies of wolves and associated field activities. One instance in which a black bear killed a moose calf was also noted. In nine other cases, the possibility that bears had made kills was suggested, although these kills could have been made by wolves and then appropriated by bears. In addition, a sow and yearling grizzly were observed feeding on a recently-killed adult bull caribou with a solitary radioed wolf located within a few hundred yards. In this case, there was no clear indication as to which predator killed the animal.

Indications of bear predation on ungulates were observed as early as 7 May and as late as 16 October, and the phenomenon was noted in all parts of the study area.

Although grizzly bears have not often been considered to be a significant cause of mortality to big game animals in Alaska, evidence from this and other studies suggests that predation on moose by grizzly bears is a common occurrence. This phenomenon has been witnessed and reported in nearly all parts of Alaska by various observers and has been noted in the course of various ecological studies by the Department of Fish and Game and other resource agencies. Glenn (1971) noted that brown bears on the Alaska Peninsula took advantage of lowland moose and caribou calving areas in spring 1970, and appeared to be quite successful in catching calves and finding dead or dying animals. He observed a four-minute chase in which a sow grizzly successfully captured a moose calf. Crook (1971) watched a grizzly kill a yearling moose in the northern Brooks Range and noted that grizzlies apparently concentrated near the calving grounds of the Western Arctic caribou herd. More recent studies on this calving ground indicate that grizzlies are sometimes successful in killing calf caribou, and they have also been observed feeding on the carcasses of adults (J. Davis, H. Reynolds, pers. comm.). Didrickson et al. (1977) noted evidence of brown bear predation on moose in the lower Susitna River valley and Copper River Delta areas, and in the latter area the phenomenon was thought to be common in late spring with both newborn calves and adults being taken. McIlroy (1976) stated that grizzly bears were frequently seen on moose carcasses in GMU 13 but did not elaborate. In Mt. McKinley National Park at least a few cases of grizzly bear predation on moose calves are reported each summer (Buskirk, pers. comm.).

Chatelain (1950) discussed black and brown bear food habits on the Kenai Peninsula based on analyses of 290 bear scats and on numerous reports of predation on moose, primarily calves, by both species. He found that although remains of adult moose occurred rarely in scats, remains of calves were common during June, July and early August. Chatelain reached no conclusions regarding the importance of bear predation on moose, stating only that it occurred, and that while both species of bears seemed capable of killing calves, only brown bears possessed the ability to kill adult moose. LeResche (1966) reported two instances of successful predation on moose by brown bears involving a cow and twin calves and a calf, respectively, and in addition, referred to a number of unsuccessful attempts. Based on his studies in the Matanuska Valley, he concluded that brown bear predation is a factor in early mortality of calves but that moose more than about three weeks of age are capable of escaping bears in most situations. A number of studies in other parts of Alaska (cf: Linderman 1974, Crook 1971) have noted the importance of carrion, usually that provided by wolf-killed moose and caribou, in the diet of brown bears immediately after emerging from hibernation. Ungulate remains identified in bear scats originating from later in the season have also been assumed to result from carrion feeding.

Schlegel (1977) reported the results of a study in Idaho in which 35 of 67 radio-collared elk calves were killed by predators. Twenty-five of the calves lost to predation were taken by black bears, suggesting that black bears can, under certain circumstances, constitute a significant source of mortality to ungulates.

The data from moose killed by bears in the study area (Table 34) show no obvious preponderance of either adults or calves, but the number of kills is too small to allow any conclusions regarding selectivity by bears for certain age classes of moose. It is apparent that both adult and calf moose are taken, however. We can surmise that cow moose would have difficulty defending young calves against large bears since they would likely be killed themselves, although one instance in which a cow moose was successful in driving a brown bear away from her twin calves was reported by a hiker in Katmai National Monument.

In the course of 1975-76 telemetry studies in GMU 13, 65 grizzly bears were observed and numerous other sightings were reported by residents of the area. Of 62 bears seen by Department biologists, 12 were judged to be large males, 13 were solitary bears of unknown sex, 4 were sows without cubs (two of these were observed with boars during the mating season in June), and 11 were sows accompanied by a total of 25 cubs of various ages. Two, four and five sows accompanied by one, two and three cubs, respectively, were observed.

Although the status of the GMU 13 grizzly bear population has not been systematically monitored, a general picture of grizzly abundance can be assembled from the memory of area residents. The comments of many residents were solicited during field activities, and all were emphatic in stating that the abundance of grizzly bears is currently greater than at any time in their memory. Cleo McMahon, a resident pilot and guide in the area since 1941, stated that grizzlies were common in the area prior to the early 1950's when poisoning intended by the U. S. Fish and Wildlife Service to reduce wolf numbers inadvertently resulted in a drastic reduction in bear numbers as well. He referred to grizzlies as being virtually absent until the 1960's after which a population increase took place resulting in the present high, and possibly still increasing population. Mr. McMahon stated that prior to recent years, most bears seen were either sows with cubs or small solitary bears, whereas at present, large adult males are commonly seen.

The data collected during the present study suggest that at their current population level in GMU 13, grizzly bears constitute a significant source of mortality to the moose population in that they are killing moose in more than an incidental fashion. The carcasses of wolf-killed ungulates are sometimes also appropriated, thus increasing to some extent the frequency with which wolves take prey during the spring, summer and fall months. The importance of grizzly bear predation has probably been underestimated largely because it occurs primarily during the snowfree period of the year and is much more difficult to detect and measure than, for instance, wolf predation during winter.

Status of Predator-Prey Relationships

The history of the moose population in the Nelchina Basin has been discussed by Bishop and Rausch (1974) and VanBallenberghe (1977). In the early 1950's, moose numbers were thought to be increasing; calf survival to six months appeared excellent, and bull:cow ratios were not significantly affected by hunting (Bishop and Rausch 1974). Moose numbers peaked about 1960, and despite severe winters in 1961-62 and 1965-66 during which extensive mortality occurred, moose densities exceeding one per square mile were thought to persist over the Basin as a whole through the late 1960's (Rausch 1969). Calf:cow ratios obtained during November surveys declined from a mean of 42.6:100 during the period 1960-1963 to a mean of 28.5 during 1965-1971 (VanBallenberghe 1977). This area had a record snowfall in 1971-72, and extensive mortality occurred among all age classes (Stephenson and Johnson 1973). The lowest calf:cow ratio (17.7:100) recorded during the period 1952-1971 was observed the following November (Bishop and Rausch 1974). Calf:cow ratios have remained low through 1976, and it appears that moose numbers have declined by perhaps 50 percent. Moose harvests averaged 1517 animals, primarily bulls, from 1963 to 1971 but since then have declined to about 700 bulls annually.

Since the 1950's, caribou numbers have also fluctuated, increasing to an estimated 71,000 in 1962 and then declining to an estimated 8,100 in 1972 with the current population numbering about 12,000 animals. Excessive harvests, a decline in productivity, emigration, and wolf predation are thought to be major causes of the present low numbers (Bos 1975).

There are a number of factors, acting in combination, that probably account for the relatively low numbers of moose and the low recruitment currently observed in the Nelchina Basin. The severe winters of 1961-62, 1965-66, and 1971-72 had dramatic effects on moose abundance, and it appears that following the record winter of 1971-72 and possibly earlier, total annual mortality has been sufficient to severely limit the ability of the moose population to increase in numbers at even a slow rate. Although wolf numbers have apparently remained at a moderate level throughout this period, the effect of wolf predation has probably become increasingly important as moose numbers declined. During the same period, the number of grizzly bears has increased, and bears now constitute an important additional burden on the moose population. Although curtailed in recent years by more restrictive seasons, moose harvests by man have been an additional cause of declining moose numbers but have been of less importance than predation by bears and wolves. The most drastic changes in moose numbers have apparently been caused by severe winters which have greatly altered predator-prey ratios during periods of only a few months. In addition, the significant decline in caribou numbers during this period has resulted in a lessening in their availability to wolves, thus causing wolves to rely to a somewhat greater extent on the more widely distributed moose population.

Experimental Removal of Wolves

During January and March 1976, 29 wolves were removed from the experimental area by shooting by Department personnel. These included all known members of the Maclaren, Butte Lake, Brushkana, and Deadman packs and most members of one and possibly two other packs in the southern portion of the area in the vicinity of Jay Creek and the Oshetna River. In addition, two wolves were known to have been taken in October 1975 by residents of the area. Pertinent data are given in Table 38. Following the removal of wolves and prior to the loss of snow cover in late April, much of the experimental area was surveyed to detect the occurrence of wolves remaining in or entering the area. Observations suggested that two or three wolves remained in the vicinity of Coal Creek but that the majority of the area was free of wolves prior to the onset of moose calving in late May. During June, however, a small amount of ingress was detected during routine monitoring of radio-marked wolves adjacent to the study area. As noted previously, three radio-marked wolves entered the area during late May and June, and two of these acquired associates in the area. Some additional ingress probably occurred during summer, but it is unlikely that any large packs established themselves in the area during the first several months following initial removal efforts.

A number of studies (Balser et al. 1968, Chesness et al. 1968, Beasom 1974, Bergerud 1971) have employed the technique of removing predators to determine the impact of predation on the productivity of various prey animals. Beasom measured predation by coyotes *(Canis latrans)* and bobcats *(Lynx rufus)* on white-tailed deer in south Texas using an experimental and a control area each about 8.4 mi^2 (22km^2) in size. In the present study, the experimental area boundaries encompass 3,200 mi^2 (8,288km^2). Wolves were known to inhabit approximately 2,700 mi^2 (6,993km^2) of the area, and although moose can be found in most parts of the experimental area, the bulk of the population is found in lowland areas which comprise only about half of the total area. As discussed earlier, analysis of scats and the remains of wolf-killed ungulates observed in the experimental area, indicated that moose were the most important constituent of the diet of wolves in the experimental area with caribou being an important supplement.

As indicated in Table 28, wolf numbers in the experimental area were estimated at 19 and 36 in May and October 1975, respectively. Assuming that there were 19 yearling or adult wolves in the area during the summer of 1975, a comparison of November 1975 calf survival figures with similar figures from 1976 should theoretically measure the impact that approximately 19 wolves had on calf survival during the six-month period prior to the time when composition counts are accomplished in November. It is probable, however, that an additional small number of wolves used parts of the area. Critical to the evaluation of the experiment is a knowledge of the seasonal movements of moose relative to the boundaries of the experimental area. Telemetry studies of moose designed to illuminate

Table 38. Pertinent data from wolves removed from the experimental area, GMU 13, between 1 January 1976 and 30 June 1976.

Acc.No.	Pack Association or Location	Sex	Age	Color	Date Taken	General Nutritional Condition	Stomach Contents	Comments
61324	Lone male 10 miles SE Lone Butte, poss. Oshetna	M	A	Gray	3-20-76	Fair	moose	
61323	Oshetna, between Clarence Lake and Goose Creek	F	A	Gray	3-20-76	Poor	moose	Radio-collared female wolf
61322	Killed about 4 miles west of 61323, prob. Oshetna	F	A	Gray	3-19-76	Fair	moose	with 61321 and 61319
61321	Killed about 4 miles west of 61323, prob. Oshetna	M	A	Gray	3-19-76	Fair	moose	
61319	Killed about 4 miles west of 61323, prob. Oshetna	M	A	Gray	3-19-76	Fair	moose	
61320	West end of Alphabet Hills, pack association unknown	M	A	Gray	3-19-76	Fair	moose	
61305	Butte Creek, pack of 3 M	M	A	Black	1-17-76	Fair	moose	Radio-collared male
61311	Butte Creek, pack of 3 M	M	A	Black	1-17-76	Good	caribou	
--	Butte Creek, pack of 3 M	M	A	Gray	1-17-76	N/A		Carcass lost in field
61300	Deadman pack, Watana Creek	M	P	Black	1-17-76	Fair	moose	
61301	Deadman pack, Watana Creek	M	P	Black	1-17-76	Fair	empty	
61316	Deadman pack, Watana Creek	F	P	Gray	1-17-76	Good	empty	
61317	Deadman pack, Watana Creek	M	A	Gray	3-19-76	Good	caribou	
61318	Deadman pack, Watana Creek	F	A	Gray-Black	3-19-76	Good	carbou	Radio-collared female
61302	Maclaren pack	M	P	Gray	1-17-76	Good	moose	
61303	Maclaren pack	M	P	Gray	1-17-76	Good	moose	
--			P	Gray	1-17-76			Carcass lost in field
--		M	A	Gray	1-17-76			Carcass burned in helicopter fire
--		F	A	Gray	1-17-76			Carcass burned in helicopter fire, radio-collared female

Table 38. (Continued).

Acc.No.	Pack Association or Location	Sex	Age	Color	Date Taken	General Nutritional Condition	Stomach Contents	Comments
61304	Killed on Butte Creek, poss. Brushkana pack	M	A	Black	1-17-76	Good	empty	
61307	Brushkana pack	F	A	Black	1-17-76	Good	moose	
61314	Brushkana pack	F	A	Black	1-17-76	Good	empty	Radio-collared female
61312	Brushkana pack	F	yrlg	Black	1-17-76	Good	caribou	
61306	Bruskkana pack	F	P	Black	1-17-76	Good	moose	
61308	Brushkana pack	F	P	Black	1-17-76	Good	moose	
61310	Brushkana pack	F	P	Black	1-17-76	Good	empty	
61315	Brushkana pack	F	P	Black	1-17-76	Good	caribou	
61309	Brushkana pack	M	P	Black	1-17-76	Good	moose	
61313	Brushkana pack	M	P	Black	1-17-76	Fair	caribou	
--	Brushkana pack	M	A	Black	10-24-75	--		Shot by J. Grimes
--	Unknown, Valdez Creek	M			10-75			Shot by miner at Valdez Creek

this aspect of moose ecology in the area were initiated in late 1976, and results will be reported in a subsequent progress report as will the response in moose calf survival rates during the first year.

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LITERATURE CITED

Atwell, G., P. Garceau and R. A. Rausch. 1963. Wolf investigations. Alaska Fed. Aid Wildl. Rest. Proj. W6R3, Work Plan K. Juneau. 28pp.

Balser, D. S., H. H. Dill and H. K. Nelson. 1968. Effect of predator reduction on waterfowl nesting success. J. Wildl. Manage. 32(4): 669682.

Banfield, A. W. R. 1951. Populations and movements of the Saskatchewan timber wolf *Canis lupus Knighlii* in Prince Albert National Park, Saskatchewan, 1947 to 1951. Wildl. Manage. Bull. Ser. 1, No. 4. 24pp.

Beasom, S. L. 1974. Relationships between predator removal and whitetailed deer net productivity. J. Wildl. Manage. 38(4):854859.

Bergerud, A. T. 1971. The population dynamics of Newfoundland caribou. Wildl. Monogr. 25. 55pp.

Bishop, R. H. and R. A. Rausch. 1974. Moose population fluctuations in Alaska, 19501972. Naturalist Can. 101:559593.

Bos, G. N. 1975. A partial analysis of the current population status of the Nelchina caribou herd. Pages 170180 In J. Luick et al. eds. Proc. First Int. Reindeer and Caribou Symp. Biol. Pap. Univ. of Alaska. Spec. Rep. No. 1.

Burkholder, B.L. 1959. Movements and behavior of a wolf pack in Alaska. J. Wildl. Manage. 23:1-11.

Carbyn, L. N. 1974. Wolf predation and behavioural interactions with elk and other ungulates in an area of high prey diversity. Can. Wildl. Serv. Rept. (unpubl.), Edmonton. 233pp.

Chatelain, E. F. 1950. Bear-moose relationships on the Kenai Peninsula. Proc. 15th N. Am. Wildl. Conf. pp.224-234.

Chesness, R. A., M. M. Nelson and W. H. Longley. 1968. The effect of predator removal on pheasant reproductive success. J. Wildl. Manage. 32(4):683-697.

Clark, K. R. F. 1971. Food habits and behaviour of the tundra wolf on central Baffin Island. Univ. Toronto. Ph.D. Thesis. 223pp.

Cowan, I. McT. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res. 25D(5):139-174.

Crook, J. L. 1971. Determination of abundance and distribution of brown bear *(Ursus arctos)* north of the Brooks Range, Alaska. M.S. Thesis. Univ. Alaska, Fairbanks. 78pp.

Davis, J. 1977. Determination of calf mortality chronology and identification of calf mortality factors in the Western Arctic caribou herd. NPR-A Quart. Res. Rept. 12pp. (Unpubl.)

Didrickson, J. C., D. Cornelius and J. Reynolds. 1977. Southcentral moose population studies. Alaska Fed. Aid Wildl. Rest. Rept. Proj. W-17-6,7 and 8. Juneau.

Etkin, W. 1964. Cooperation and competition in social behavior. Pages 1-34 In W. Etkin, ed. Social behavior and organization among vertebrates. Univ. Chicago Press, Chicago, Illinois.

Floyd, T. J., L. D. Mech and P. A. Jordan. In Press. Relating wolf scat content to prey consumed.

Franzmann, A. W. and P. D. Arneson. 1976. Marrow fat in Alaskan moose femurs in relation to mortality factors. J. Wildl. Manage. 40(2): 336-339.

Frenzel, L. P. 1974. Occurrence of moose in food of wolves as revealed by scat analyses: a review of North American studies. Naturalist Can. 101:468-479.

Glenn, L. P. 1971. Report on 1970 brown bear studies. Alaska Fed. Aid Wildl. Rest. Prog. Rept. Proj. W-17-3. Juneau. 67pp.

Haber, G. C. 1968. The social structure and behavior of an Alaskan wolf population. Unpubl. M.S. Thesis, Northern Michigan Univ. 198pp. 51 illus.

Harper, J. 1970. Wolf management in Alaska. Pages 24-27 In S. E. Jorgenson, C. E. Faulkner and L. D. Mech, eds. Proceedings of a symposium on wolf management in selected areas of North America. U. S. Dept. Interior, Twin Cities, Minnesota.

Jordan, P. A., P. C. Shelton, and D. L. Allen. 1967. Numbers, turnover and social structure of the Isle Royale wolf population. Am. Zool. 7:233-252.

Kelsall, J. P. 1957. Continued barren-ground caribou studies. Can. Wildl. Serv., Wildl. Manage. Bull. Ser. 1, No. 12. 148pp.

Kolenosky, G. B. 1972. Wolf predation on wintering deer in eastcentral Ontario. J. Wildl. Manage. 36(2):357-369.

Kuyt, E. 1972. Food habits of wolves on barren-ground caribou range. Can. Wildl. Serv. Rept. Ser. No. 21. 36pp.

LeResche, R. E. 1966. Behavior and calf survival in Alaskan moose. M.S. Thesis. Univ. Alaska, Fairbanks. 82pp.

Linderman, S. 1974. Ground tracking of arctic grizzly bears. Alaska Fed. Aid Wildl. Rest. Final Rept. Proj. W-17-6. Juneau. 17pp.

Lockie, J. D. 1959. The estimation of the food of foxes. J. Wildl. Manage. 23(2):224-227.

McIlroy, C. 1976. Survey-Inventory Progress Report, Moose, 1974, GMU 13. Ann. Rept. S&I Activities. Part II.

Mech, L. D. 1966. The wolves of Isle Royale. U.S. Natl. Park. Serv. Fauna Ser. 7. 210pp.

_____. 1970. The wolf: the ecology and behavior of an endangered species. The Nat. Hist. Press. 384pp.

_____. 1973. Wolf numbers in the Superior National Forest of Minnesota. N. Cent. For. Exp. Stn., St. Paul, Minnesota. 10pp.

_____. 1977. Population trend and winter deer consumption in a Minnesota wolf pack. Pages 55-83 In R. L. Phillips and C. Jonkel, eds. Proc. 1975 Predator Symposium. Montana Forest and Conservation Experiment Station, Univ. Montana, Missoula.

_____ and L. D. Frenzel, Jr., eds. 1971. Ecological studies of the timber wolf in northeastern Minnesota. N. Cent. For. Exp. Sta., St. Paul, Minnesota. 62pp.

Merriam, H. R. 1964. The wolves of Coronation Island. Proc. Alaska Sci. Conf. 15:27-32.

Miller, D.R. 1975. Observations of wolf predation on barren ground caribou in winter. pp. 209-220 In Luick et al. (Eds.) Proc. 1st. Int. Reindeer and Caribou Symp. Fairbanks. 551 pp.

Murie, A. 1944. The wolves of Mount McKinley. U.S. Natl. Park Serv., Fauna Ser. 5. 238pp.

Nielson, C.A. 1977. Wolf necropsy report: preliminary pathological observations. Alaska Fed. Aid Wildl. Rest. Special Rept., Projects W-17-8 and W-17-9. 129 pp.

Olson, S. F. 1938. A study in predatory relationship with particular reference to the wolf. Sci. Month. 66:323-336.

Parker, G. R. 1972. Biology of the Kaminuriak population of barren-ground caribou. Part 1. Can. Wildl. Serv. Rept. Ser. 20, Ottawa. 95pp.

_____. 1973. Distribution and densities of wolves within barren-ground caribou range in northern mainland Canada. J. Mammal. 54(2):341-348.

Peters, R.P. and L.D. Mech. 1975. Scent-marking in wolves. Amer. Sci. 63(6): 628-627.

Peterson, R. O. 1976. The role of wolf predation in a moose population decline. First Conference on Scientific Research in the National Parks. New Orleans, Louisiana. (Unpubl.)

_____. 1977. Ecological studies of wolves on Isle Royale. Annual Report 1976-77. 12pp.

_____ and D. L. Allen. 1974. Snow conditions as a parameter in moose-wolf relationships. Le Nat. Can. 101:481-492.

Pimlott, D. H., J. A. Shannon and G. B. Kolenosky. 1969. The ecology of the timber wolf in Algonquin Provincial Park. Ontario Dept. Lands and For. Res. Rept. (Wildl.) No. 87. 99pp.

Rausch, R. A. 1967. Some aspects of the population ecology of wolves, Alaska. Am. Zool. 7:253-265.

_____. 1968. Wolf studies. Alaska Fed. Aid Wildl. Rest. Rept. Proj. W-15-R-2 and 3. Juneau. 51pp.

_____. 1971. Predator control and bounties in Alaska. Pages 173-182 In S. A. Cain, chairman. Report to the Council on Environmental Quality and Department of Interior by the Advisory Committee on Predator Control. Inst. Environ. Quality, Univ. Michigan, Ann Arbor.

_____ and R. A. Hinman. 1977. Wolf management in Alaska - an exercise in futility? Pages 147-156 In R. L. Phillips and C. Jonkel, eds. Proc. 1975 Predator Symposium. Montana Forest and Conservation Experiment Station.

_____ and R. L. Winters. 1964. Wolf studies. Alaska Fed. Aid. Wildl. Res. Rept. Proj. W-6-R-4. Juneau.

Schlegel, M. 1977. Mortality factors of calf elk in North Central Idaho. Abs. paper presented 28th Conf. NW Section Wildl. Soc., Kalispell, Montana.

Scott, T. G. 1941. Methods and computation in fecal analysis with reference to the red fox. Iowa State College. J. Sci. 15(3):279-285.

Shelton, P. C. 1966. Ecological studies of beavers, wolves and moose in Isle Royale National Park, Michigan. Ph.D. Thesis. Purdue University, Lafayette, Indiana. 308pp.

Stenlund, M. H. 1955. A field study of the timber wolf *(Canis lupus)* on the Superior National Forest, Minnesota. Minn. Dept. Conserv. Tech. Bull. 4. 55pp.

Stephenson, R. O. 1975. Wolf report. Alaska Fed. Aid Wildl. Rest. Final Rept., Proj. W-17-3 through W-17-7. Juneau. 18pp.

_____. 1977. Characteristics of exploited wolf populations. Alaska Fed. Aid in Wildl. Rest. Final Rept., Proj. W-17-3 through W-17-8. 17pp.

_____ and L. Johnson. 1972. Wolf Report. Alaska Fed. Aid Wildl. Rest. Rept. Proj. W-17-3. Juneau. 51pp.

_____ and _____. 1973. Wolf report. Alaska Fed. Aid Wildl. Rest. Proj. W-17-4. Juneau. 52pp.

_____ and J. Sexton. 1974. Wolf report. Alaska Fed. Aid Wildl. Rest. Prog. Rept. Proj. W-17-5. Juneau. 28pp.

Thompson, D. Q. 1952. Travel, range, and food habits of timber wolves in Wisconsin. J. Mammal. 33(4):429-442.

VanBallenberghe. V. 1977. Final report on the effects of the Trans-Alaska pipeline on moose movements. Spec. Rept. #12. Joint State/Federal Fish and Wildl. Advis. Team.

_____ A. W. Erickson and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildl. Monogr. 43. 43pp.

Zimen, E. 1976. On the regulation of pack size in wolves. Z. Tierpsychol. 40:300-341.

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