(16)

SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

Volume V WOLF

Warren B. Ballard
Craig L. Gardner
John H. Westlund
James R. Dau

ALASKA DEPARTMENT OF FISH AND GAME
Submitted to the Alaska Power Authority
March 1982

SUSITNA HYDROELECTRIC PROJECT

FINAL PHASE I REPORT

BIG GAME STUDIES

VOLUME V WOLF

Warren B. Ballard,
Craig L. Gardner,
John H. Westlund
and
James R. Dau

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

PREFACE

In early 1980, the Alaska Department of Fish and Game contracted with the Alaska Power Authority to collect information useful in assessing the impacts of the proposed Susitna Hydroelectric Project on moose, caribou, wolf, wolverine, black bear, brown bear and Dall sheep. This information, along with information on furbearers, small mammals, birds, and plant ecology collected by the University of Alaska, is to be used by Terrestrial Environmental Specialists, Inc. of Phoenix, New York, in preparation of exhibits for the Alaska Power Authority's application for a Federal Energy Regulatory Commission license to construct the project.

The studies were broken into phases which conformed to the anticipated licensing schedule. Phase I studies, January 1, 1980 to June 30, 1982, were intended to provide information needed to support a FERC license application. If the decision is made to submit the application, studies will continue into Phase II to provide additional information during the anticipated 2 to 3 year period between application and final FERC approval of the license.

Wildlife studies did not fit well into this schedule. Data collection could not start until early spring 1980, and had to be terminated during fall 1981 to allow for analysis and report writing. (Data continued to be collected during winter 1981-82, but could not be included in the Phase I report.) The design of the hydroelectric project had not been determined. Little data was available on wildlife use of the immediate project area, although some species had been intensively studied nearby. Consequently, it was necessary to start with fairly general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. This was the thrust of the Phase I Big Game Studies. During Phase II, we expect to narrow the focus of our studies to evaluate specific impact mechanisms, quantify impacts and evaluate mitigation measures.

Therefore, the Final Phase I Report is not intended as a complete assessment of the impacts of the Susitna Hydroelectric Project on big game.

The reports are organized into the following eight volumes:

Volume I.	Big Game Summary Report
Volume II.	Moose - Downstream
Volume III.	Moose - Upstream
Volume IV.	Caribou
Volume V.	Wolf
Volume VI.	Black Bear and Brown Bear
Volume VII.	Wolverine
Volume VIII.	Dall Sheep

SUMMARY

In 1980 and 1981, wolf packs which potentially could be impacted by the proposed Susitna Hydroelectric Project were studies. Thirty-six wolves from six separate packs were radio-collared and relocated a total of 1,175 times from fixed-wing aircraft. Several packs occupying areas in or adjacent to the impoundments were not studied because poor snow conditions precluded their capture.

From radio-relocations, ground observations, and previous studies we were able to describe the histories of individual wolves and their associated packs. Interactions between pack members and between separate packs were observed throughout the study.

Wolves in the Watana pack were most frequently observed in shrub (50%) habitats with ecotones being of particular importance. No slope or aspect selection was observed. Approximately 1/3 of all radio-locations of the Watana pack were located in areas to be inundated by the proposed impoundment.

Of 83 wolf kills observed for six packs, 57% were moose, 33% were caribou and the remainder were small mammals. Fifty-one percent of the moose killed and 7% of the caribou killed by wolves were calves. Food habits and predation rates data suggested that wolves were annually preying upon from 11-13% of the moose population and from 2-10% of the Nelchina caribou herd. These data suggested that the percentage of caribou in wolves' diet may be a function of their availability. As caribou become more abundant, they make up a greater proportion of the wolves' diet.

The minimum estimated wolf population in the study area ranged from a fall high of 80 to a spring low of 40. These wolves were divided into 13 packs. Pack territory sizes ranged from 346-981 mi^2 and averaged 545 mi^2. An estimated 6-7 packs will be directly affected by the proposed impoundment and an additional

14-16 packs could be indirectly affected due to changes in either moose or caribou movements and numbers.

Wolf harvests in GMU 13 from 1971-1981 ranged from a high of 128 in 1977-78 to a low of 45 in 1980-81. The low harvest in 1980-81 was attributed to poor weather and relatively low wolf densities. Shooting was the most common harvest method throughout the period.

Twenty-three wolf den and rendezvous sites were examined. Most dens were located on slightly elevated, well-drained sites with a south or east exposure usually near the center of the territory. Average distance between contiguous natal dens was 28 miles. Although the number of actual and potential den sites which would be inundated by the impoundment was not determined it was suggested that loss of the sites would be of minor significance.

Intensive ground observations of active wolf den sites in May and June of 1980 and 1981 allowed us to detail summer activity patterns and food habits. These observations revealed that wolves were present at den sites throughout the day. Helicopters flying near dens always annoyed wolves; however, they became more tolerable over time. Judging from observed behavior patterns and a review of the literature, it was recommended that all human ground activities be restricted from a 1.5 mile radius of active dens. This is particularly important in spring to avoid den site abandonment. If human activity must occur near dens, these activities should be limited to early morning and late evening hours.

The most important potential impact of the Susitna Hydroelectric Project on wolves would occur indirectly due to reductions in prey density, particularly moose. Disruption of movements or reductions in numbers of migratory moose and caribou may reduce wolf densities long distances from the impoundments. Temporary increases in wolf density may occur in the project area due to

their displacement and the displacement of moose and caribou from impoundment areas. Direct inundation of wolf habitat in the long term may long lower wolf densities. Additional wolf mortality will probably occur due to increased hunting and trapping activities resulting from publicity concerning the area's wildlife and as access becomes developed.

We propose a continuation of all Phase I studies into Phase II to increase our data base, particularly on packs which occupy impoundment areas which have not been studied and to gather information on winter predation rates. Phase II studies should also include a comprehensive investigation of the relationships of all large predators to their ungulate prey. Of particular importance are the effects of wolves and bears on moose and caribou calf mortality. Finally, we suggest that wolf studies be extended to downstream areas.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF TABLES

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

LIST OF FIGURES

LIST OF FIGURES (cont'd)

INTRODUCTION

Development of hydroelectric power facilities along the Susitna River is expected to have detrimental affects on a number of wildlife species occupying habitats in and adjacent to proposed reservoirs (Taylor and Ballard 1979). Of particular importance are the potential effects these developments could have on both moose (*Alces alces*) and caribou (*Rangifer tarandus*) populations. Equally important are the effects of these impacts on predators and scavenging species which depend on ungulates for food. Three large predator species besides man occur in the Susitna Basin. They include gray wolves (*Canis lupus*), brown bear (*Ursus arctos*) and black bear (*Ursus americanus*). This report concerns studies conducted to date for determining the potential impacts of Susitna hydroelectric development on wolves.

Wolves in Game Management Unit (GMU) 13, commonly referred to as the Nelchina Basin, have been the focus of interest and study for over 30 years (Ballard 1981). History of GMU 13 wolves from 1957 through 1968 was summarized by Rausch (1969). From 1948 to 1953 poisoning and aerial shooting by the Federal Government reduced populations of predators to low levels. By 1953 only 12 wolves were estimated to remain in the basin. This small population quickly expanded and by 1965 was thought to have peaked at 400-450 (Rausch 1969). Although no systematic studies were conducted from 1969 through 1974, McIlroy (1976) suggested that a second population peak occurred in 1970.

During the period of wolf population growth, moose populations in GMU 13 declined suggesting a cause-effect relationship. Subsequently in 1975 a series of predator-prey relationships studies involving wolves were initiated. Results of these studies were provided by Stephenson (1978), Ballard and Spraker (1979), Ballard and Taylor (1980), Ballard et al. (1980) and Ballard et al (1981a and b). Portions of the aforementioned studies involved experimentally manipulating wolf densities in part of the area which could be impacted by Susitna hydroelectric development

(Ballard et al. 1980). Wolf control activities were conducted from 1976 through July 1978. By 1980 wolf densities in the reduction area had returned to pre-control levels (Ballard 1980) and thus studies to determine the potential impact of hydroelectric development on wolves would not be influenced by the earlier wolf control activities. Description of the proposed Devil Canyon and Watana Dam projects have been briefly described elsewhere (Taylor and Ballard 1979).

Objectives of Susitna hydroelectric wolf studies during Phase I were as follows:

(1) To identify wolf packs occupying areas that will be impacted by the Susitna Hydroelectric Project.

(2) To delineate the territories of each pack and identify den sites, rendezvous sites and major feeding areas.

(3) To determine the numbers of wolves and rates of turnover for each pack.

(4) To determine the food habits for each pack.

Data collected from earlier and ongoing GMU 13 wolf studies were, in some cases, combined with those collected during this study in an effort to provide a better understanding of wolf ecology in the Susitna Basin.

METHODOLOGY

Wolves were captured for radio telemetry studies with a Cap-Chur gun and dart (Palmer Chemical Co.) fired from a Jet Ranger 206B helicopter using methods similar to those described by Baer et al. (1978).

Wolves were immobilized with either 2 to 2.5 mg of etorphine (M-99, D-M Pharmaceuticals, Inc., Rockville, MD) or a combination of 1cc phencyclidine hydrochloride (100 mg/cc, sernylan, Parke-Davis Co.) and 1cc of promazine hydrochloride (100 mg/cc, Sparine, Wyeth Laboratories). After being processed and radio-collared, each wolf which had been immobilized with etorphine was given an equivalent cc dosage (2 mg/ml) of the antagonist diprenorphine (M 50-50, D-M Pharmaceuticals, Inc., Rockville, MD) which was injected into the radial vein. No antagonist is available for sernylan. A paper comparing M-99 with sernylan for immobilizing wolves was prepared and accepted by the Journal of Wildlife diseases (Appendix A).

Captured wolves were equipped with an adjustable radio collar made of fiberglass and urethane manufactured by Telonics (Mesa, AZ). Blood samples were taken from each wolf using methods similar to those described for calf and adult moose (Ballard et al. 1979). Blood samples were shipped frozen to Pathologist Central Laboratory in Seattle, Washington for SMAC analysis and protein electrophoresis. When practical, the following body measurements were recorded: Weight, total length, hearth girth, chest height, neck circumference, shoulder height, tail length, and length of canines.

Radio-collared wolves were tracked and, when possible, visually observed from fixed-wing aircraft using the methods described by Mech (1974). Radio signals were received with a programmable scanning receiver (Telonics). Monitoring intensity was variable but an attempt was made to locate each pack once or twice/week. Approximate ages of captured wolves were determined on the basis

of tooth eruption and wear. Estimates of the ages of wild wolves were based upon their relative size and by criteria described by Jordan et al. (cited by Mech 1970). In some cases, age and sex structures of certain packs were not ascertained until the animals had been killed by hunters and trappers. Hunters and trappers were encouraged to provide the Department with wolf carcasses taken in Unit 13 by offering $10.00 per carcass. Ages of harvested wolves were determined by both tooth eruption and wear, and by examining epiphyseal cartilage of the longbone according to methods described by Rausch (1967).

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

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

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

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

During January through April 1980 an attempt was made to locate and examine all kills made by selected radio-collared wolf packs during a 2-3 month period. An attempt was made to radio-locate these packs every other day and to backtrack them to their previous location by following tracks.

In early May 1980 two members of the Susitna wolf pack and in 1981 seven members of the Watana wolf pack were equipped with activity transmitters (Telonics) in an effort to determine the daily activity patterns of a denning wolf pack. Each activity transmitter was equipped with a tip switch which altered the pulse rate of the transmitter which was dependent on the position of the animal's head. When the animal's head was down, the pulse of the radio decreased and conversely when the animal was standing, the pulse rate increased. A semi-permanent monopole antennae was erected ¼ mile away from the pack's den site. Both amplitude and period of each radio transmitter was monitored during the denning season with a portable digital data processor (Telonics TDP-1) which was connected to a portable programmable scanning receiver and a rustrak recorder (Gulton Inc., Manchester, N.H.). All three instruments were powered by a 12volt battery, all of which were housed in a large plastic container for weather protection. While activity patterns were monitored electronically, the Susitna den area was observed from a blind for a 31 day period in 1980. The Watana den was observed for a 47-day period. During ground observations the presence or ab-

sence of radio-collared animals was determined by manually scanning the den site area with a hand-held antenna (Ballard et al. 1977). Both ground and aerial observations were used to verify activity data which were plotted on the rustrak recorder.

The recorder continuously plotted radio signal information on a paper spool at the rate of 8 inches/hour. A separate bench mark transmitter was used as a control to calibrate the receiver so that a continuous comparison could be made between the known location and activity of the bench mark transmitter to data collected from the wolf transmitters.

Descriptions of the proposed Devil Canyon and Watana Dam projects have been described elsewhere (Taylor and Ballard 1979) Because moose are the principal wolf prey, the boundaries of the wolf study area were the same as those described for upstream moose studies except that some packs were studied outside the boundary area because of wolf dispersal from the primary study area. Boundaries of the primary study area were as follows:

The Denali Highway on the north to its confluence with the Maclaren River on the east, the Maclaren River to its confluence with the first unnamed creek in R4E, T13N (Gulkana Quad) upstream to Monsoon Lake, then a straight line to Tyone Village continuing up Lake Louise to the Lake Louise Road to its intersection with the Glenn Highway, on the south the Glenn Highway to the Little Nelchina, then upstream to the peak of the Talkeetna Mountains, on the west the upper elevations of the Talkeetna Mountains to the confluence of the upper north and south forks of the Talkeetna River, then northwest to the mouth of Portage Creek, then upstream of Portage Creek to its headwaters to the headwaters of Brushkana Creek to its confluence with the Denali Highway (Fig. 1).

Vegetation, topography and general climate of the area has been described by Skoog (1968), Bishop and Rausch (1974), and Ballard (1981) and thus no further descriptions are needed until vegetation studies under Subtask 7.12 are completed.

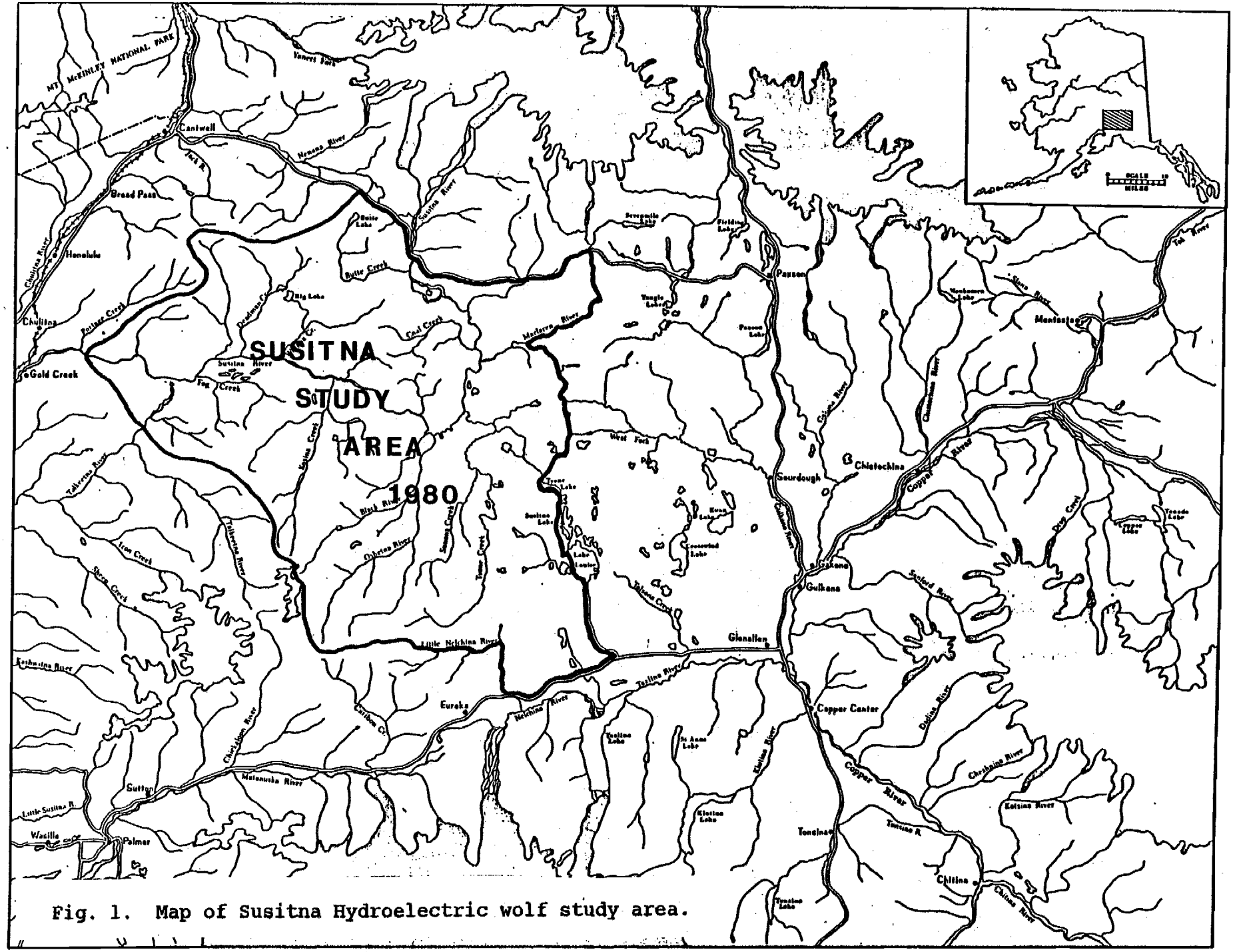


Fig. 1. Map of Susitna Hydroelectric wolf study area.

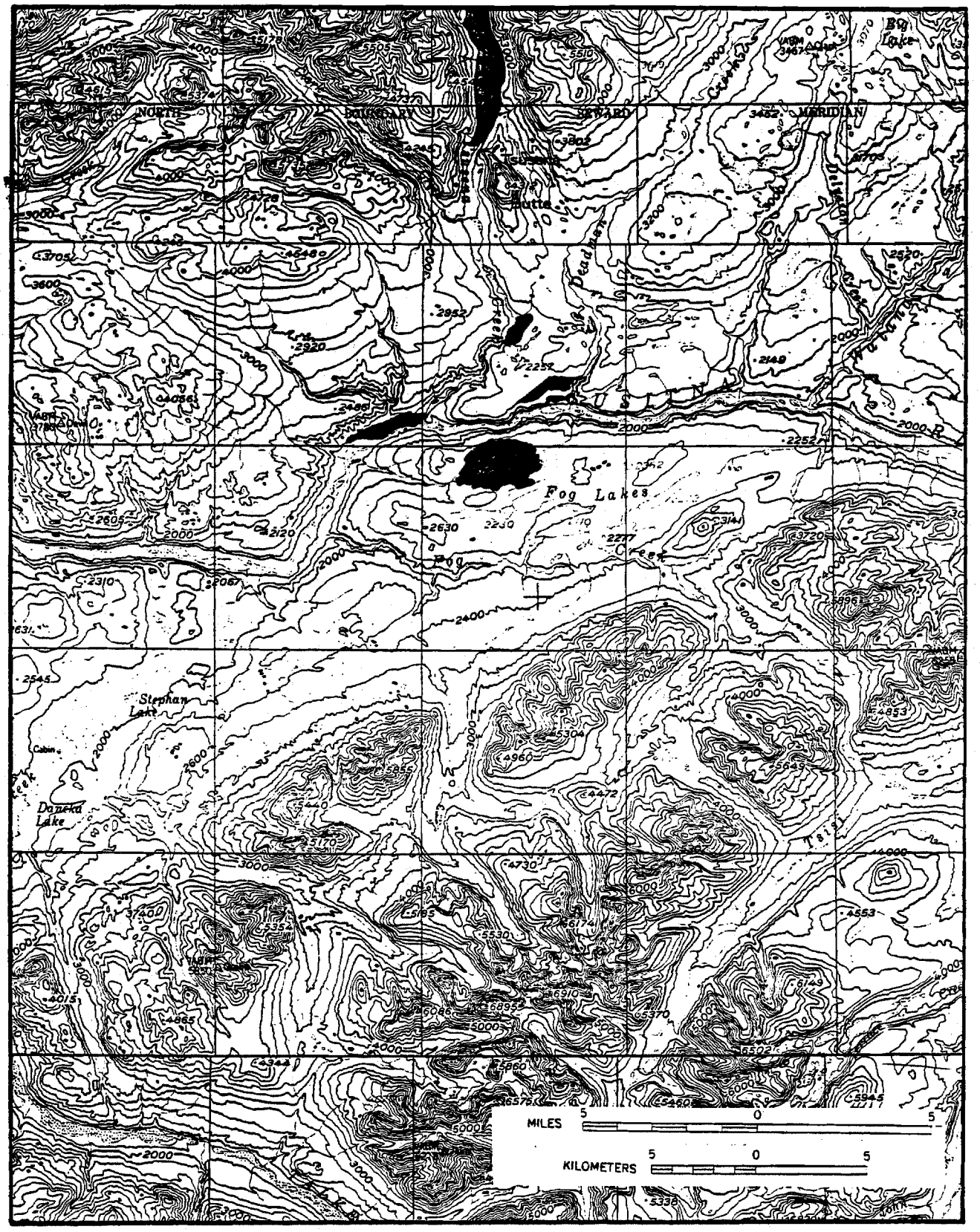
For purposes of this analysis we assumed the proposed project would consist of a 2-dam system; a dam on the Susitna River between Deadman and Tsusena Creek; and a dam on the Susitna River at Devil's Canyon. The upper Watana impoundment would inundate an area up to 2,200 foot elevation, while the Devil's Canyon impoundment would inundate an area up to the 1,450 feet elevation. Characteristics and timing of drawdown and fill were not available for this report.

At the time this report was written the plan of construction was poorly understood. Final decisions on locations of access routes, barrow pits, construction camps, etc., had not been made. Therefore, impacts of a range of alternatives were considered.

Location of proposed borrow areas was provided by Acres American, Inc., in October 1981 (Figure 2), however, details concerning access, volume of gravel to be extracted, method of extraction, etc., were not provided. Proposed alternative access routes are depicted in Figure 3. Apparently any of the routes could be used for either a road or in some cases a railroad bed.

Preliminary plans call for 5,000 construction workers at height of construction, requiring at least two or more camps. Operation of the project will include an unknown number of buildings and permanent housing for approximately 120 permanent personnel.

Figure 2. Location of proposed gravel borrow areas to be used for construction of the Susitna Hydroelectric Project.



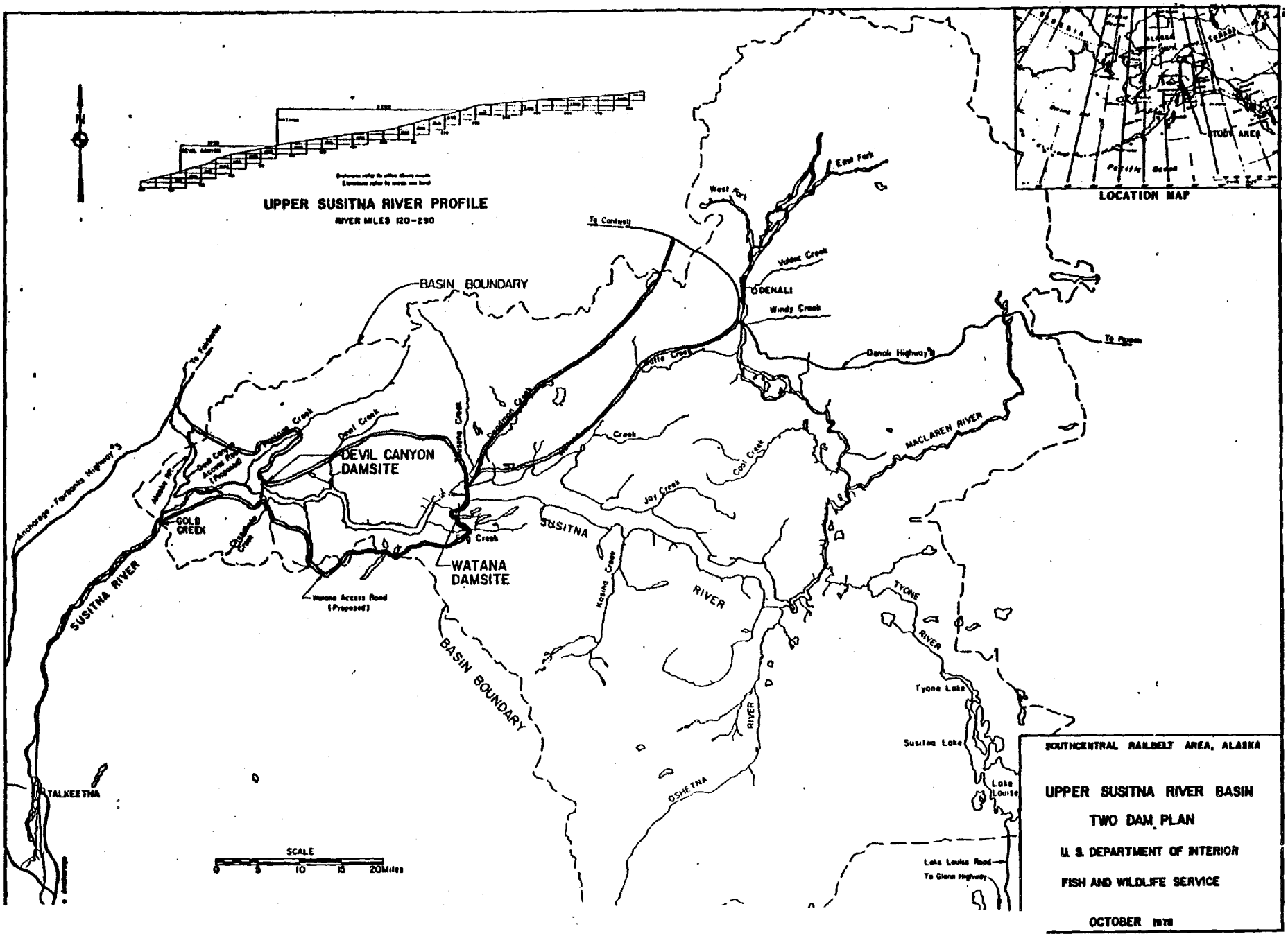


Figure 3. Location of proposed access routes to the Watana and Devil Canyon hydroelectric facilities.

RESULTS AND DISCUSSION

From 20 February 1980 through May 1981, 36 gray wolves from six individual packs were captured and radio-collared for this study. Seven wolves were recaptured on one or more occasions for recollaring. Twenty-one (57%) of the captured wolves were males (6 pups and 15 adults) and 15 (43%) were females (7 pups and 8 adults (Table 1). Six of the 23, were recaptured from earlier studies. Induction and recovery times of wolves immobilized with M-99 are compared to those of wolves immobilized with Sernylan in Appendix A.

Morphometric measurements and blood analysis of captured wolves are in the process of being entered in to a computer and therefore, except for weights, packed cell volume, and percent hemoglobin, will not be presented at this time. Data from this and earlier wolf studies (Appendix B) will be combined and analyzed jointly to describe morphometric growth and development in this wolf population.

One thousand one hundred and seventy-five individual radio locations were obtained for the 36 radio-collared wolves from January 1980 through October 1981 (Table 2), yielding an average of approximately 33 locations per animal. A total of 2,255 wolf sightings were made while locating the radio-collared packs which represented 437 pack days (pack day is defined as any day on which one or more members of a pack was located one or more times).

Radio contact with at least four and perhaps as many as six wolf packs occupying habitats along the Susitna River near the proposed impoundments was not established during this study. Lack of adequate snow cover and clear sunny weather seriously hampered capture efforts between spring 1980 and fall 1981. With the exception of the Watana wolf pack, radio contact with the packs studied was possible only because a few members of each pack had functioning radio collars from earlier studies facilitating location of the packs for additional collaring.

Table 1. Summary of statistics associated with wolf radio-collaring activities for Susitna Hydroelectric studies in GMU 13 of southcentral Alaska during 1980 and 1981.

Orig. Pack Affiliation	Accession Number	Date Captured	Est. Age	Color	Sex	Weight (lbs)	Drug Dosage (mg)	Location of Injection	Induction Time (min)	Antagonist Dosage (cc)	Reverse Time (min)	Packed Cell volume	% Hb
Fish Lake	122326	04/14/81	Adult	Gray	F	92	M-99 2.5	Top back	5.0	2.5	2.0	49.3	16.7
	122327	04/14/81	Pup	Gray	M	94	M-99 2.5	Rump	8.0	2.5	10.0	54.3	18.8
	122329	04/17/81	Pup	Gry/Blk	F	57	M-99 2.5	?	5.0	2.5	2.0	-	-
Susitna	122229*	04/16/80	Yrl.	Gray	M	105	M-99 2.5	Left rump	5.5	2.5	1.7	57	20+
	122295*	03/20/80	4 yr.	Gray	F	-	Sernylan: 1:1 Sparine	?	-	N/A	N/A		
		04/15/80				100est	M-99 2.0	Left leg	7.0	2.0	1.0	49.5	17.9
	122296*	02/20/80	6-7 yr.	White	M	110est	Sernylan: 1:1 Sparine	?	-	N/A	N/A		
	122302	02/20/80	Pup	Gray	F	-	Sernylan: 1:1 Sparine	-	-	N/A	N/A		
		10/16/80	Yrl.			75	M-99 2.0	Tail	5.0	2.5	1.5	63	20+
	122303	02/20/80	Yrl.	Gray	M	80	Sernylan: 2.0 Sparine	Left rump	-	N/A	N/A		
	122305	04/13/80	3 yr.	Gray	M	100	M-99: 2.0-.25 Rompun	?	8.0	3.0	1.0	55	20+
		10/16/80				106	M-99 2.5	Right rump	5.5	2.5	2.0	68	20+
	122306	04/13/80	Pup	Gray	M	85est	M-99: 2.0:4 Rompun	?	8.0	3.0	1.0	53	18.9
	122330	4/17/80	Yrl	Gray	M	97	M-99 2.5 On ground 1.0	Back	8.0	2.5	2.0	-	-
	122331	4/17/80	Yrl	Gray	M	105	M-99 2.5	Rump	3.0	2.5	2.0	-	-
Susitna-Sinona	122312	10/14/80	Pup	Gray	M	46	M-99 2.5	Top back	5.0	2.5	.8		
	122313	10/14/80	2-3yr	Gray	M	106	M-99 2.25	Left leg	-	2.5	1.0	63	20
Tolsona	122220*	07/06/80	2.5yr	Black	F	68	M-99 2.25 2nd dart 1.5	Front leg ?	20.0 3.0	2.5	1.0		
	122315	10/16/80	3-4yr	Black	F	78	M-99 2.5 2nd dart 2.5	Top back ?	5.0	5.0	5.3	68	20+
	122316	10/16/80	Yrl	Gray	M	82	M-99 2.5	?	6.0	2.5	1.5	62	20+
	122210*	04/14/81	Adult	Gray	M	97	M-99 2.5	Leg	11.0	2.5	12.0	57.9	19.2
	122328	04/14/81	1-2yr	Gray	F	70	M-99 2.5	Back	7.0	2.5	6.0	58.9	19.3

Table 1. (cont'd)

Orig. Pack Affiliation	Accession Number	Date Captured	Est. Age	Color	Sex	Weight (lbs)	Drug Dosage (mg)	Location of Injection	Induction Time (min)	Antagonist Dosage (cc)	Reverse Time (min)	Packed Cell volume	% Hb
Tyone	122215*	02/20/80	3-4yr	Gray	M	111	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A		
	122216*	02/20/80	3-4yr	Gray	F	95	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A	51	20
	122298	02/20/80	Pup	Gray	F	84	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A	44	20
		10/16/80	1.5yr			82	M-99 2.5	?	12.0	2.5	.8	56	19.5
							2.5	?	12.0				
	122299	02/20/80	Pup	Gray	F	82	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A		
	122300	02/20/80	Pup	Gray	M	93	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A	48	20
	122301	02/20/80	Pup	Gray	M	100	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A		
	122317	10/16/80	2-3yr	Black	M	?	M-99 2.5	Left shoulder	40	2.5	1.0	60	20+
Watana	122308	04/24/80	3-4yr	Gray	F	91	M-99 2.5	Top back	17.0	8.0	5.0	47	25+
	122309	04/19/80	Pup	Gray	F	79	M-99 2.0	Chest cavity	4.0	4.0	.8	52	20+
	122310	04/23/80	2yr	Gray	M	101	M-99 2.0	Left side	26.0	5.0	1.5	52	20+
							2.0	Back					
		03/06/81				107	M-99 2.5	Rump	4.0	2.5	1.0	62	20+
		05/10.81				102	M-99 2.5	Shoulder	10.0	2.5	-	62.8	19.4
	122311	04/23/80	2yr	Gray	M	112	M-99 2.0	?	?	5.0	2.0	50	20
	122323	03/07/81	Pup	Gray	F	93	M-99 2.5	Shoulder	9.0	2.5	1.0	-	-
	122324	03/07/81	Pup	Gray	F	90	M-99 2.5	?	3.25	2.5	?	53	20+
		05/10/81	Yrl	Gray		78	M-99 2.5	Back	3.0	2.5	1.0	54.4	16.8
	122325	03/07/81	Pup	Gray	M	111	M=99 2.5	Shoulder	2.0	2.5	1.5	50	20+
		05/10/81	Yrl			99	M-99 2.5	Side	8.0	2.5	2.0	55.7	17.7
	122344	05/10/81	Yrl	Gray	M	64	M-99 2.5	Back	9.0	2.5	1.0	52.2	17.8
	122345	05/10/81	Yrl	Gray	M	-	M-99 2.5	Side	10.0	2.5	?	-	-
	122346	05/10/81	Yrl	Gray	F	77	M-99 2.5	Side	5.0	2.5	?	56.0	18.4

* Recapture

Table 2. Summary of numbers of location observations of radio-collared wolves by individual and pack affiliation during 1980 and 1981 in the Susitna Hydroelectric Project area.

Pack Name	Accession Number	No. Radio Locations	No. Wolf Sightings	No. Pack Days
Fish Lake	122326	10	8	14
	122327	7		
	122329	8		
	122300	10		
	Subtotal	35		
Susitna	122295	110	536	126
	122296	9		
	122302	81		
	122303	9		
	122305	33		
	122306	39		
	122330	14		
	122331	21		
	Subtotal	316		
Susitna-Sinona				
	122229	27	94	33
	122312	3		
	122313	11		
	Subtotal	41		
Tolsona	122220	78	798	83
	122315	41		
	122316	25		
	122210	21		
	122328	8		
	Subtotal	173		
Tyone	122215	31	323	77
	122216	11		
	122298	42		
	122299	37		
	122300	41		
	122301	13		
	122317	5		
	Subtotal	180		
Watana	122308	88	436	104
	122309	14		
	122310	61		
	122311	18		
	122323	50		
	122324	43		
	122325	48		
	122344	25		
	122345	42		
	122346	41		
	Subtotal	430		
Totals	37	1,175	2,255	437

Pack Histories

Histories of individual radio-collared wolves and their respective packs which either occupy areas to be inundated or areas where prey species would be affected are described in the following section.

Individual wolves are identified in the text by the last three digits of their assigned accession number. Data collected by Ballard et al. (1981) before the initiation of this project are included. An abstract of this latter report is provided in Appendix B.

Susitna Pack

Radio contact with this pack was established in February 1979 within the Deep Lake pack territory (Ballard et al. 1981). At that time the Susitna wolves were observed fleeing from the carcass of the Deep Lake female (#009) which they had just killed. Reasons for this conflict and the fate of an uncollared gray which had been accompanying wolf 009 are not known, particularly since this Susitna pack never returned to the Deep Lake area.

When collared, the pack was comprised of at least two adults and seven pups. On the basis of size and later capture records, a tenth wolf, an adult male was suspected to have been in the pack. Following initial capture, the pack moved to the area south of the big bend in the Susitna River. Whether these wolves had always occupied the area west of Lake Susitna and Tyone is unknown, but seems likely based on the identified gaps between territories of other packs for the period 1975 through 1978 (Ballard et al. 1981). By late spring 1979, the pack numbered six or seven. Pack losses between fall and spring were probably the result of one or two wolves being shot and at least one dispersal.

The pack was first observed at the 1979 den site on 13 April. At least six pups were raised but were not observed until 3 August.

Between late summer and October 1979 the pack declined to 10, possibly due to dispersal.

During December and January 1979-80, large concentrations of Nelchina caribou were found within the Susitna pack territory as they began migrating towards the Wrangell Mountains. In late January 1980, wolf 229, a yearling male, and at least two gray associates appeared to follow the caribou migration and dispersed to the east. This group was subsequently referred to as the Susitna-Sinona pack and its history from January 1980 through mid-October 1981 is provided in the Susitna-Sinona portion of this report. By early February 1980, the original Susitna pack numbered seven.

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

On 8 March while during a study of predation rates, wolf 295 (the adult gray female of the Susitna pack) was tracked to a location 2 miles (3.2 km) south of Vermillion Lake. She was alone. By backtracking her in the snow for several miles to the west to the confluence of Sanona and Tyone Creeks, seven additional wolves were located in one area. This was more than had been observed in the Susitna pack during the previous 2 weeks. A check of other wolf radio frequencies revealed that radio-collared members of the Tyone pack, which was comprised of two adults and six pups, were also present. A search was made for other radio-collared members of the Susitna pack and wolf 296, the light adult gray male which on the basis of tail posture and leadership in the pack was assumed to be the alpha male, was found dead 0.5 miles (0.8 km) north of Tyone Creek. A subsequent examination of wolf 296 revealed puncture marks on the neck and shoulders. In addition, at least seven distinct wolf trails radiated from the area, leaving little doubt that wolf 296 had been killed by other wolves. Following blood in the snow wolf 296 was backtracked to the location where the struggle had begun. At this site a fresh adult moose kill was discovered.

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

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

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

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

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

Based upon ground and aerial observations, it was concluded that the Susitna pack had come upon a moose kill made by the Tyone wolves. The moose kill was located on the territory boundary of each pack . Therefore, in addition to competition for possession of the kills, the conflict may have involved a territorial dispute. The Susitna area appeared to have a relatively poor availability of prey in comparison to the Tyone pack territory during this winter. Comparison of prey abundance between the two areas will be discussed in the predation rates section of this report. Although the literature indicates that conflict with and between pack members occasionally results in wolf mortality, all reported incidences have involved only one mortality.

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

During the 1980 denning season, two of four remaining pack members (#'s 295 and 305) were fitted with activity radio transmitters. In addition, ground observations at the den site were made from 1 May through 6 June 1980. Methods and results from this study period are being prepared for publication by James Foster, Woodland Park Zoo and Warren Ballard, Alaska Department of Fish and Game. Preliminary results of this 1 month study are presented in the summer activities section of this report.

The pack moved the pups to the first rendezvous site, located approximately 0.75 miles west of the den site between 4 and 6 June. A second rendezvous site, located approximately 5 miles to the northwest, was briefly occupied between 1 and 7 August.

No pup mortality was observed in 1980. In addition no trapping or hunting mortality occurred in 1980 due to poor snow conditions, and, thus, the pack was still comprised of 10 wolves by the end of February 1981.

During March and April 1981 wolf 295 was frequently observed alone away from the remainder of other members. By mid-April pack size had declined to 6 wolves, probably due to either dispersal, unreported harvest, or both. Radio contact with wolves 305 and 306 was lost between February and late March 1981. In mid-April wolves 330 and 331 (both yearlings) were captured and radio-collared while accompanying wolf 302 and one uncollared gray.

On 10 May wolf 331 was observed on the northern edge of the Susitna pack territory accompanied by two gray wolves from the Watana pack (#'s 310 and 323) and four unradio-collared grays which could have come from either pack. Both Watana wolves (see Watana section, this report) were well outside of their normal home range. During this brief observation, members of the two packs interacted with one another apparently with no mortality or injury to any individuals.

After members of the two packs had been observed together, wolves 330 and 331 were not subsequently observed with the remaining Susitna Pack members. Instead, they slowly dispersed to the west, generally inhabiting the upper reaches of the Black and Oshetna Rivers through mid-summer. Table 3 summarizes the individual movements of wolves 330 and 331 from 10 May through mid-November 1981. From 10 to 26 May both wolves traveled independently. The number of associates accompanying both wolves suggested that 1-2 other grays from the Susitna Pack were also in the process of dispersing. During 1981 the Nelchina caribou herd calved in the Oshetna and Black River area. Both wolves were frequently observed in close proximity to caribou and we suspect that they preyed heavily upon them.

By mid-October wolves 330 and 331 had separated. Wolf 331 was observed near the mouths of Coal Creek and on Clearwater Creek during October, accompanied by one uncollared gray. By mid-November wolf 331 and we assume the uncollared gray (determined to be a 2 yr. old yearling male) were found near Stephan Lake;

Table 3. Summary of individual movements of wolves 122330 and 122331 from the Susitna Wolf Pack from 10 May thru mid-November 1981.

WOLF 122330						WOLF 122331					
Dates & Time	Distance between (obs. & appx. direction traveled		Final Location	# Wolves observed	Misc. Note	Dates & Time	Distance between (obs. & appx.) direction traveled		Final Location	# Wolves observed	Misc. Note
5/10-5/26 1730-1730	32	W	Gilbert Ck	1 gray	alone	5/10-5/11 1730-1235	15	SW	Lone Butte	3 gray	killed calf moose
						5/11-5/12 1235-1750	8	E	Tyone Ck	3 gray	
						5/12-5/13 1750-1800	7	SW	up Tyone Ck	2 gray	near beaver house
						5/14 0740	-	-	---	3 gray	chasing caribou
						5/13-5/16 1800-0915	16	WSW	Lake Oshetna R	2 gray	
5/26-5/29 1730-1400	25	S	Roaring Ck.	1 gray	alone on calf caribou kill 2.5 mi from 331	5/16-5/29 0915-1400	14	SW	Landslide Ck	No	caribou present 2.5 mi from 330
						5/29-5/30 1400-1500	0	-	Landslide Ck	No	" " "
5/29-6/4 1400-2105	25	N	Gilbert Ck	3 gray	Wolf 331 present	5/30-6/4 1500-2105	27	N	Gilbert Ck	3 gray	Wolf 330 present
6/4-6/5 2105-1900	8	NE	Clarence Lk Ck	3 gray	Wolf 331 present	6/4-6/5 2105-1900	same as wolf 330				
6/5-6/6 1900-1100	3	SW	---	2 gray	" " "	6/5-6/6 1900-1100	"	"	"	"	
6/6- 6/11 1100-0852	36	ESE	Susitna Lake	3 gray	" " "						
6-11-6/12 0852-1913	35	W	upper Bl. R.	2 gray	Wolf 331 present & 3 caribou 1 moose present	6/11-6/12 0852-1913	"	"	"	"	
6/12-6/13 1913-1118	6	NE	Bl. R.	3 gray	Wolf 331 present & 100 caribou present	6/12-6/13 1913-1118	"	"	"	"	
6/13-6/15 1118-1408	12	SW	Gold Ck.	3 gray	Wolf 331 present & 4 caribou present	6/13-6/15 1118-1408	"	"	"	"	
6/15-6/16 1408-0958	6	NE	Oshetna R.	3 gray	" " "	6/15-6/16 1408-0958	"	"	"	"	
6/16-6/19 0958-1127	10	NW	Bl. Lk.	3 gray	" " "	6/16-6/19 0958-1127	"	"	"	"	
						6/19-8/20 1127-1455	40	NW	Mouth of Coal Ck.	2 gray	
6/19-10/17 1127-1540		NW	Brushkana Ck.	1 gray	alone	8/20-10/17 1455-1515	18	NW	Mouth L. Clear Water Ck.	2 gray	
10/17- 1540			Brushkana Ck.	1 gray	alone	10/17-11/ 1515		WSW	Stephan Lake	2 gray	uncollared gray ID as ♂

approximately 76 miles to the west from the Susitna Pack territory. During the same time interval wolf 330 was observed alone at Brushkana Creek where he remained through November. Whether both of these wolves have completed their dispersal is not yet known.

Wolf 295 was first observed at the wolf den, which had been utilized in 1979 and 1980, on 23 May 1981. Since she had not been radio-located earlier in the month we do not know the exact date of when she regularly began visiting the site; however, she was observed within 3 miles of the den in late March. Between 23 May and 29 May wolf 295 was observed at the den site accompanied by from 1 to 2 grays (including female wolf 302). From these observations we assumed she had whelped pups or was in the process of doing so. At 10:30 a.m., on 30 May wolf 310 from the Watana Pack was located at the Susitna den site. No other radio-collared wolves were at the site. Interestingly, on 28 May wolves 310, 344, 345 and one uncollared gray had been observed within 2.5 miles of the Susitna den (see Watana Pack Section). After 28 May the three Watana wolves were no longer observed together and wolves 344 and 345 appeared to disperse from the area. Wolf 295 and one uncollared gray were observed resting approximately 8 miles northwest of the den site, on the same day, while 302 was observed alone, 5 miles north of the den. By 4:30 p.m., wolf 295 had returned to the den site while 302 remained about 2 miles NE from the den. Because wolf 310 had been observed at the Susitna den, we speculated that either he had been accepted into the Susitna Pack or that some sort of conflict was occurring.

On 31 May at 1515 wolf 310 was again located at the Susitna den, while wolves 295 and 302 were located 5 miles north of the den. By 0750 hr., on 1 June wolf 302 had returned to the den site while wolf 295 was observed bedded approximately 9 miles northwest of the den site. At 1738 the same day, however, wolves 295 and 310 were both present at the den site and wolf 302 could not be located. On both 2 and 3 June wolf 302 was again at the den site while wolf 295 was observed approximately 6.5 miles bedded

to the northwest within about 0.5 mile of wolf 310's location. Between 3 and 6 June both wolves 295 and 302 were periodically observed at the den site while the location of 310 was unknown. On 6 June wolf 310 was observed alone at the Susitna 1980 rendezvous site while wolves 295 and 302 were located approximately 3 miles north of the den, separated by about 2 miles. Wolf 344 also from the Watana Pack was also present in the area but he was not accurately located. The next day wolf 302's location had not changed and upon intensive searching from fixed-wing aircraft, we observed that she was dead. Wolf 302 was examined on 8 June. Her carcass was found lying on its right side at the base of a clump of small black spruce. Several puncture wounds were evident along the sternum of the chest cavity. At least one and perhaps two of the punctures had pierced a lung. There were also puncture holes on the inside of both rear legs. Except for the punctures which pierced the lung, the wounds did not appear fresh. Based upon the size of the puncture marks and the recent interactions with wolf 310, it appeared wolf 302 had been killed by other wolves, probably 310.

Following the death of 302, wolf 295 did not return to the den site and was observed either alone or accompanied by 2 uncollared grays through the remainder of June. Wolf 310, however, was again observed at the Susitna den on 9 and 10 June accompanied by one uncollared gray.

During July and early August no radio-locations were obtained on either wolf 295 or 310 due to poor weather conditions. By 20 August 1981 both wolves were observed together. Between late August and mid-October they were continually observed together and we suspected that perhaps a bond had been formed. The fate of the two remaining uncollared members of the Susitna Pack (excluding wolves 330 and 331) is unknown.

Unfortunately, because of poor weather and work schedules, we were unable to examine the Susitna den until late August. At that time we were unable to find any significant evidence con-

firming the presence of pups; however, one pup scat was found at the entrance to the rendezvous site, located several hundred yards to the northwest. Because of wolf 295's frequent presence at the den during late May we suspect that pups were present and that they and wolf 302 had been killed by wolf 310. Since no pups had been observed from aircraft, they probably died before they were old enough to spend much time outside of the den and few, if any, scats would have been present.

Reasons for the conflict between wolf 310 and the Susitna Pack are not known and can only be speculated upon. However, the Susitna pack appears to have disintegrated in part due to abnormal family structure. To our knowledge, when wolf 310's presence was first confirmed, the Susitna pack was without an alpha male and was comprised of yearlings and two-year-olds (in 1980 the alpha male was killed by the Goose Creek Pack and in 1981 the alpha male was shot by aerial trappers). Thus many of the pack members were of an age when dispersal normally occurs (Ballard et al. 1981). Perhaps these relatively young wolves were unable to defend the den site from an older and perhaps more aggressive wolf, such as 310. If wolf 310 did in fact kill the Susitna pups, it is uncertain why wolf 295 and 310 would then start accompanying one another.

At the time this report was prepared wolves 295 and 310 appeared to be the only wolves occupying the Susitna territory.

From February 1979 through mid-October 1981 the Susitna pack occupied an area of 561 mi^2. Their territory ranged from Sinona Creek on the west to the headwaters of the West Fork of the Gulkana River on the north to Minnesota Lake on the east and to Moose Lake on the south.

Susitna-Sinona Pack

As mentioned in the Susitna Pack history section, wolf 229, which had originally been captured and radio-collared as a pup in April

1979, was a regular member of the Susitna Pack until late December 1979. In December 1979 and January 1980, wolf 229 and at least two other unradio-collared grays from the Susitna pack appeared to follow migratory caribou eastward to the Gakona River and did not return to the Susitna Pack. From 6 to 9 January 1981 they moved 24 miles northeast to the West Fork of the Gulkana River and by 11 January had moved an additional 17 miles east to an area just north of Hogan Hill. After that date they remained in that area and by 25 January were accompanied by a fourth uncollared gray. In mid-April 1980 wolf 229 was recaptured and its transmitter was replaced. We also attempted to capture a second wolf which we suspected was an adult pregnant female, but the wolf escaped by running into a hole at the old Sinona den site which had been used by the original Sinona Pack in 1978 (Ballard et al. 1981).

During May and June 1980 we frequently radio-located the wolves in the vicinity of the old Sinona den site, but subsequent ground examination in September 1980 suggested it had not been used and thus we were unable to locate a den site. We did conclude, however, that the pack denned because in mid-October the pack was comprised of 4-5 wolves, 2 of which were judged to be pups-of-the-year. At that time two additional wolves were captured and radio-collared; a female pup (#312) and a 2-3 year-old adult male (#313). We suspected that a third wolf had been struck by a dart but it escaped.

Following the capture of wolves 312 and 313 only four wolves were observed in the pack. On 19 November 1980 wolf 312 was killed by a trapper, leaving the pack with 3 wolves, for the remainder of the winter.

On 31 March 1981 wolf 313 was observed alone at the 6,000 foot elevation of Nathlie Mountain, approximately 36 miles from the pack territory. By 13 April, however, he was observed alone back in the pack area, but apparently soon left again since we could not locate its radio signal. Sometime between 13 April and 23

July 1981 wolf 313 traveled to the Tolsona Pack area, a straight line distance of approximately 52 miles, where he became a regular member of that pack. As of mid-October 1981, wolf 313 was still associated with the Tolsona Pack, but its radio signal was deteriorating quickly. While wolf 313 was dispersing, wolf 229 apparently also began to disperse.

Wolf 229 was last located in the Susitna-Sinona pack area on 23 April 1981. Subsequently, we lost radio contact with him until 4 August 1981, when he was observed alone, traveling west approximately 3 miles west of the big bend in the Maclaren River, a straight line movement of approximately 56 miles. His subsequent whereabouts were unknown as of mid-October 1981.

From February 1980 to April 1981 the Susitna-Sinona Pack occupied an area of 466 mi^2. The area was bounded by the main fork of the Gulkana River on the west, the Copper River on the south, the Gakona River on the east, and a line from Roundtop Mountain to the Chistochina Hills on the north. This area corresponds very closely to the Sinona II Pack territory which existed from 1977 through mid-winter 1979 (Ballard et al. 1981). During winter 1979 most members of the Sinona II Pack were ground shot with possibly one or two wolves surviving. However, one of the remaining wolves was radio-collared and it began making long distance movements from its normal area, a characteristic of a wolf in the process of dispersing. Therefore, we suspected the area to be vacant, except perhaps for one lone wolf. We concluded that the temporary establishment of this pack represented the colonization of a vacant territory by a group of dispersing wolves. The status of this pack as of mid-October 1981 was unknown but a trapper reported observing a single wolf in the area which could be the third unaccounted for pack member.

Tolsona Pack

Prior to mid-June 1978 contact with this pack consisted of public sightings, track counts and harvest records. These data indi-

cated that in early fall 1977 the pack had numbered at least 11. By the end of winter, trappers had reduced the pack to three individuals.

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

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

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

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

During winter 1979-80 the pack suffered attrition due to trapping and perhaps from dispersal even though portions of their territory were included in an area closed to hunting and trapping. Radio contact was temporarily lost when wolf 220's radio transmitter failed prematurely. Contact with this pack was not reestablished until early June 1980 when they were discovered at the Nickolson Lake den site which had been used by the Mendeltna pack in 1977. Wolf 220 was recaptured in July 1980 and at that time the pack was comprised of a minimum of two black adults, seven gray adults and six pups. In late June the pack moved to the Nicholson Lake rendezvous site which had been used as a den site by the Mendeltna pack in 1977. This movement was the result of an attempt to ground capture and radio collar one wolf. On 6 July wolf 220 was recaptured by helicopter darting.

By late fall 1980, the pack numbered 16 (4 blacks and 12 grays) suggesting that seven pups may have been raised.

Based upon the presence of an adult black wolf in the Tolsona pack from summer 1978 to 1980 and the known expansion of this pack's territory into the Mendeltna area, it is suspected the black wolf may have been a survivor of the Mendeltna pack (Ballard et al. 1981). As mentioned in the Mendeltna pack section, following winter 1977-78 all but two black wolves were accounted for according to wolf sealing documents. Perhaps, following drastic reduction in numbers, these two blacks dispersed and became integrated with the Tolsona pack which in spring 1978 was thought to contain only three wolves.

Through early winter 1980-81 our counts suggested that 16 or 17 wolves were present in the Tolsona Pack. Number and coloration varied through winter ranging from 4 blacks and 12 gray wolves to 5 blacks and 10 gray wolves. In mid-October 1980 two additional wolves were captured and radio-collared; wolf 315, a black adult female believed to be the alpha female in 1980 and wolf 316, a yearling male.

During winter 1980-81 the Tolsona pack frequented the west and northern portions of its territory more frequently than it had during the winters of 1978-79 and 1979-80. Reasons for the shift in distribution appear to be related to the winter distribution of caribou during those years. During winters 1978-79 and 1979-80, large numbers of caribou wintered on the Lake Louise flats east of Old Man Lake. However, during winter 1980-81 caribou appeared to be more abundant west and north of Old Man Lake. Wolf radio-location data suggest that the Tolsona wolves rarely utilized the southeastern portion of their territory during this relative absence of caribou.

During early and mid-winter 1980-81 no mortalities due to either hunting or trapping were observed primarily because of poor snow and weather conditions, which were not favorable for tracking wolves from fixed-wing aircraft. By March 1981, however, our counts of this pack varied from 10 to 13 wolves, suggesting that some had either dispersed or had been trapped. Radio contact with wolf 316 was lost during this time period. Since wolf 316 was a yearling in October 1980 and because yearlings frequently disperse at this time of year (Ballard et al. 1981), we suspect dispersal accounted for most of the losses.

On 14 April 1981 two additional members of the Tolsona Pack were captured and radio-collared; wolf 210 an adult male which originally had been captured as a yearling in June 1978 and was last observed in September 1978, and wolf 328 a young adult female. Wolf 328 apparently dispersed immediately after capture because radio contact was not established until 2 June 1981, when she was

observed alone on an old moose kill several miles north of the Susitna River gauging station; a straight line movement of approximately 44 miles from her capture location. She remained in that area for 3-4 days, killing at least one calf moose. Radio contact was again terminated until 4 August 1981 when she was observed on the East Fork of the Susitna River where contact was again lost. We suspect that she may have continued traveling northward into GMU-20 north of the Alaska Range. The straight line distance from her capture location to the last observation in August was approximately 72 miles. We suspected that several other Tolsona Pack members also dispersed because by 5 June the largest number of adult wolves counted was 8 (5 grays and 3 blacks).

Tolsona Pack members were first observed at the Nickolson Lake den site, also utilized in 1980, on 14 May 1981. On 4 June at approximately 1400 hrs., the den site was approached by a photographer and the site was immediately abandoned by the wolves. Between 1400 hrs., on 4 June and approximately 1800 on 5 June the pack had moved the pups from the den site to the Nickolson Lake rendezvous site, approximately 1 mile to the west. At that time 3 pups (2 blacks and 1 gray) were observed. Five pups (3 blacks and 2 grays) were observed on 6 June while the largest number, 6 (3 blacks - 3 grays), was observed on 11 June. Pups were first observed with adults away from the rendezvous site on 20 August 1981 at an adult caribou kill.

During mid-July 1981 wolf 313 from the Susitna-Sinona Pack was detected with the Tolsona Pack. Wolf 313 apparently was in the process of dispersing from the Sinona Pack because in late March 1981 he was observed alone in the Wrangell Mountains (see Susitna-Sinona Pack history). Thus between 31 March and at least 23 July 1981 the wolf had moved a minimum straight line distance of 40 miles to join the Tolsona Pack. He remained with the pack through summer and fall 1981 when his radio prematurely failed. Counts of the pack in mid-October suggest that the wolf is still present and therefore it appears the wolf has been successfully accepted into the pack.

Apparently there was no pup mortality in 1981 because by late fall the pack numbered between 14-15 wolves (8 original adults, 6 pups and wolf 313).

From June 1978 through October 1981 the Tolsona pack occupied an area of 981 mi^2 (2,541 km^2). Their range extended from Tazlina Lake to Lake Louise, west to Tyone Creek and then east several miles past Tolsona Creek. At this time no other pack territories were believed to overlap the Tolsona territory.

Tyone Creek Pack

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

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

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

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

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

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

Wolf hunting and trapping within this pack's territory was closed in both 1978-79 and 1979-80 so that wolf numbers would remain stable for the predation rate studies. However, five wolves, three of which were radio-collared (#215, 216 and 301), were removed from the pack. One of these was legally ground shot when the pack ventured out of the closed area in January 1980. In March 1980, four others were killed illegally by aerial hunters. These mortalities reduced the pack to four pups by late March 1980.

Following the removal of the alpha male and female from the pack, the remaining pups were apparently unable to kill either moose or caribou. From mid-March through December these wolves were never observed on a fresh kill and revisited many of the old kills made prior to the reduction in pack numbers. In mid-April the pack began exhibiting an erratic movement pattern: on 14 April they were observed at Kosina Creek approximately 20 miles (32 km) northwest of the original territory boundary, then on 25 April they were observed on the middle fork of the Susitna River ap-

proximately 50 miles (80 km) north of the territory boundary. In both cases, however, the pack returned to the old pack territory within a few days of the observation. Obviously the pack did not den in 1980 but the pups did show a tendency to linger around the old 1979 den site.

By late June 1980 the pack of four was joined by an uncollared black wolf. By mid-July the three radio-collared wolves began exhibiting a propensity to travel independently of one another. Radio contact with wolf 299 was lost after 24 October 1980 when it was located at Boulder Creek above the Denali Highway. On 17 January 1981 wolf 299 was killed by a trapper 10 miles southwest of Fairbanks.

Wolf 298 continued to frequent the old Tyone Creek territory except on 27 August she was observed approximately 40 miles (64 km) to the south at the head of Chitina Creek accompanied by one gray and one black. Following this observation wolf 298 was always observed with one black wolf in the old territory. This black was captured and radio-collared (#317) on 16 October and was determined to be a young adult male, suggesting that a bond had been formed. In late December 1980, the carcasses of three wolves were found on a lake bed in the vicinity of the area occupied by wolves 298, 317 and the uncollared gray. We were unable to find the radio-collared wolves following this observation and, therefore, we assumed they had been killed. Neither the kills or the radio-collars were reported to the Department.

Between 26 August and 18 September 1980 wolf 300 dispersed approximately 65 miles (104 km) northeast to the vicinity of Dickey Lake. This young male remained in the vicinity of Dickey Lake through early fall and by 23 October was accompanied by an uncollared black wolf. We originally suspected this uncollared wolf was a female and that a pair bond had been formed because the wolves were occupying an area which was believed to be vacant (Ballard et al. 1981). Between 24 November 1980 and 19 March 1981 we lost radio contact with wolf 300. On 31 March 1981, he

was located approximately 3 miles east of Crosswind Lake and was accompanied by 3 black and 5 gray wolves having moved a straight line distance of 38 miles to the south. Subsequent observations suggested wolf 300 had joined an existing pack located near Fish Lake. Additional history of wolf 300 from 31 March through mid-October 1981 is provided in the Fish Lake Pack section of this report.

As mentioned earlier following the removal of the adult pair in March 1980, the remaining four pups were never observed on a fresh ungulate kill. They did revisit old kills which had been made prior to march 1980. Even following the separation of the four yearlings in late summer, none were subsequently observed on a fresh ungulate kill until 31 March 1981 after wolf 300 had joined the Fish Lake Pack. These observations suggest that young wolves are unable to successfully hunt and kill ungulates without the experience and leadership provided by adults. Young wolves (10 months) were able to survive without adults, however, they subsisted on old kills and small game.

Prior to the removal of the adult wolves from the Tyone Creek pack in March 1980, the pack had occupied a relatively small territory of 364 mi^2 (943 km^2) from November 1978 through March 1980. Following the apparent deaths of wolves 298 and 317 and the dispersal of wolves 299 and 300, the Tyone Creek Pack Area was believed to be vacant. This speculation was at least partially confirmed by the dispersal of Susitna wolves 330 and 331 during summer 1981.

Fish Lake Pack

Radio contact with the Fish Lake Pack was established in mid-March 1981 when wolf 300, originally from the Tyone Pack, as described in the previous section, dispersed into the area. With the addition of wolf 300 and we assume the uncollared black, the Fish Lake Pack numbered 9 wolves (3 blacks and 6 grays). Wolf 300 was fitted with a new transmitter in mid-April 1981 at which

time three additional pack members were radio-collared (#326-an adult gray female, #327-a pup gray male, and #329-a pup black female).

On 23 May 1981 wolves 300 and 326 were observed near Fish Lake at what from the air appeared to be a den site. No pups were observed at the area and ground examination in September suggested that although the area had been heavily frequented by wolves, it was not a den site as suspected.

Evidence that the Fish Lake pack successfully produced pups in 1981 was not obtained until 23 September when 2 gray and 1 black pup were observed with 4 adults. Throughout fall 1981 the radioed adult members of the pack were rarely observed together. Wolves 300, 326 and 327 all exhibited a tendency to periodically travel independently from the main body of the pack.

From March through fall 1981 the Fish Lake Pack occupied a rather small area of 346 mi^2 which must be considered representative only of the pack's summer home range. Boundaries of the area are depicted in Fig. 4.

Watana Pack

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

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

In late April and early May 1980, three adults (#308, 310 and 311) and one pup (#309) were captured and radio-collared near Watana Creek. They were first observed at a den site on 13 May where at least six pups were raised. Prior to parturition the pack was known to be comprised of at least five and perhaps as many as eight wolves. Between 8 and 14 July pups were moved to a rendezvous site approximately 1.0 mile WNW of the den site. No other rendezvous sites were observed and the pups began traveling with the adults regularly by late September. During September wolf 311 was shot by a hunter on Watana Creek. Radio contact with wolf 309 was lost after 12 August either due to dispersal or radio failure. By late December, 13 wolves still remained in the pack suggesting that pup survival was high and no further adult mortality had occurred. From April through December the Watana pack occupied an area of 400 mi^2 (1036 km^2).

On 7 March 1981 an additional three wolves were captured and radio-collared (#323-pup gray female, #324-pup gray female, and #325-pup gray male).

Wolf 310 was observed dispersing from the Watana Pack on 6 March 1981 when he was observed alone on the Susitna River above the big bend, 18 miles from the eastern boundary of the Watana Pack. He returned to the pack at Fog Creek by 24 March and remained with them at least through 17 April.

On 18 April wolf 308, which was pregnant, was recaptured and fitted with an activity transmitter for den site studies to be conducted in early summer. Wolf 308 was first observed at the den site (same site used in 1980) on 6 May 1981. On 10 May both wolves 324 and 325 were recaptured and also fitted with activity transmitters. However, only three (#'s 308, 324 and 325) wolves from the Watana Pack could be located near the den area.

Late on 10 May 1981 wolves 310 and 323 apparently with several uncollared members of the Watana Pack were observed with wolf 331 and perhaps other uncollared gray wolves from the Susitna Pack

(see Susitna Pack history this report). The Watana wolves were approximately 26 miles east of the Watana Pack's eastern boundary. At that time, four wolves, including 310 which was recaptured, were fitted with activity transmitters for the Watana den study (#344-yearling gray male, #345-yearling gray male, and #346-yearling gray female).

Wolf 308, the alpha female, was first observed at the Watana den site, (same site used in 1980) on 6 May 1981. A blind for ground observation was established at the site on 7 May. The daily activities and food habits of the pack from 8 May through 1 July will be discussed in food habits and activity patterns section of this report. No attempt was made to observe pups from fixed-wing aircraft in an effort to minimize disturbance. Consequently pups were not observed from fixed-wing aircraft until 1 July 1981 when 3 pups were observed at a rendezvous site, located 0.8 miles north-northwest of the den site. The move occurred between 21 June and 1 July. Six pups were raised during 1981. Pups remained at the rendezvous site at least through 24 August 1981. By fall 1981 the pack numbered 15.

Elevation and Seasonal Usage of Habitat Types

Habitat use was examined by plotting radio location data for the Watana Pack on 1:63,000 scale vegetation maps provided by the Agricultural Experiment Station in Palmer, Alaska. Data points which did not specifically fall within one habitat were tallied as in an ecotone between the two types. Results of this analysis are provided in Table 4. According to this analysis 8 of 24 habitat types occurring in the area were not used, either singly or in combination as an ecotone by the Watana wolf pack during the study period (4/80-10/81). The unused types included snow and ice, wet sedge grass, closed balsam poplar, open balsam poplar, willow shrub, grassland, disturbed, and lakes. Because most of the sampling period occurred during warm months the non-use of lakes is misleading. Wolf packs frequently make kills on or at the edge of lakes and streams during winter.

Table 4. Habitat type use by month of occurrence for the Watana wolf pack in Southcentral Alaska from April 1980 through mid-October 1981.

Habitat Type (Monotype)	Months												Total %
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
low shrub					3	3				3		9	10.5
Woodland black spruce				1	6	4		3	1	1		16	18.6
Closed tall shrub					2	1						3	3.5
Open tall shrub										2		2	2.3
Open black spruce				1	3	1				1		6	7.0
Birch shrub					4	1	3		1			9	10.5
Open mixed forest			1							1		2	2.3
Closed birch forest					1							1	1.2
Closed mixed forest					1							1	1.2
Mat-cushion tundra				1								1	1.2
Subtotal	0	0	1	3	20	10	3	3	2	8	0	50	583

Ecotones	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
woodland bl. spruce-open bl. spruce					3	3						6	7.0
open w. spruce - open black spruce		1										1	1.2
closed m. for. - woodland bl. spruce										1		1	1.2
sedge-grass t - open tall shrub									1			1	1.2
woodland bl. sp. - low shrub					3	1	1					5	5.8

Table 4. (cont'd)

Ecotones	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
open white sp. - open bl. sp.					1							1	1.2
closed mix f. - woodland bl. spruce						1						1	1.2
birch shrub - open bl. spruce					1							1	1.2
birch shrub - low shrub					3					2		5	5.8
low shrub - open t. shrub					1	1				1		3	3.5
woodland bl. sp. - sedge sh. tundra					1							1	1.2
open birch forest - open white spruce			1									1	1.2
sedge grass t. - mat-cushion tundra							1					1	1.2
birch shrub - sedge grass tundra									1			1	1.2
closed birch f - woodland white sp.				1								1	1.2
birch shrub - open tall shrub	1											1	1.2
sedge grass t. - low shrub			1									1	1.2
closed birch f. - low shrub						1						1	1.2

Table 4. (cont'd)

Ecotones	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
open tall sh. - woodland bl. sp.					1							1	1.2
closed mixed for. - open mixed for.				1								1	1.2
rock - sedge grass tundra			1									1	1.2
Subtotal	0	2	2	2	15	7	2	0	2	4	0	36	42.5
Total	0	2	3	5	35	17	5	3	4	12	0	86	100.8

Of the 18 habitat or ecotone types used by the Watana wolf pack, 10 were monotypes. Wolves were located in the monotypes on 58% of the occasions they were located, assuming the radio-location data and the boundaries of the habitat types were accurate. Of the 10 monotypes, low shrub, woodland black spruce, closed tall shrub, open black spruce, and birch shrub accounted for 86 percent of the use. Thirty-six (43%) of 86 locations occurred in ecotone areas. As the vegetation maps do not show many ecotones present, ecotone use might have been even higher. Of the 21 classified ecotone areas 17 (81%) had only one use occurrence. However, 20 (56%) of 36 used involved one of the shrub habitat types. Overall, shrub habitat types accounted for 50 percent of all use.

Elevation and slope for each radio location of Watana wolf pack members is provided in Table 5. The average monthly elevation occupied by pack members ranged from, 2,207 feet in April to 3,350 feet in November. Of the 96 locations, 34 (35%) were located within the area to be inundated by the Watana impoundment. Sixty-three percent of all locations occurred at or below the 2,500 foot level. Sample sizes were too low to compare seasonal changes in elevational use.

Slopes at each radio-location were classified as follows: flat (F) - 0° to 10°, gentle (G) - 11° to 30°, moderate (M) - 31° and above, and riverine (R), occurring along stream or river. Based upon the latter classification, the 96 locations for the Watana Pack were as follows based on increasing order of occurrences: F - 15 (16%), R - 19 (20%), M - 35 (37%), and G - 27 (28%). On a year-round basis there did not appear to any selection for either slope (x^2=7.54, P>0.1) or aspect (x^2=12.2, P>0.1) by the Watana wolf pack.

Food Habits

During 1980 and 1981 six radio-collared wolf packs were observed on 83 kills. Moose comprised 57 percent of the kills, while

Table 5. Elevation and aspect usage by members of the Watana Wolf Pack from April 1975 to mid-October 1981 in the Susitna River Basin of south-central Alaska.

Month	Elevation (N) x	Range	Exposure	# of Occurrences F	N	S	E	W	NE	SE	SW	NW	impoundment
Jan	2475	2150-2800	2	1					1				
Feb	2575	2550-2600	2			1				1			0
March	2850	2150-3300	3			1	1				1		1
Apr	2207	1750-2600	7			2		2		3			4
May	2295	1600-3900	38	8	5	7	2	2	2	4	5	3	18
June	2484	1600-3300	22	1	6	3	1	3		4	4		8
July	2516	2450-2600	3	1							1	1	0
Aug	2367	2000-2800	3			1	1					1	1
Sept	2983	2500-3400	6		1		2			1	1	1	0
Oct	2614	1900-3500	7		2	1	2		1	1		1	1
Nov	3350	2700-4000	2						1			1	0
Dec	3200		1		1								0
Totals			96	10	16	16	8	6	5	14	12	8	34

caribou comprised 33 percent. Other prey such as snowshoe hare, beaver, muskrat, and other small mammals comprised the remaining 11 percent. Moose calves comprised 51 percent of the moose kills while for caribou, calves comprised only 7 percent of the kills. Detailed descriptions of individual pack food habits follow.

Fish Lake Pack - From 19 March through 26 October 1981 members of the Fish Lake Pack were observed on five kills and on two other occasions the wolves were in the process of making a kill when observed (Table 6). The confirmed kills were as follows: 2 caribou, 1 adult moose, and 2 small mammals. Because of the location of this pack on the Lake Louise flats, we would suspect that caribou would comprise a large portion of this pack's diet during 1980 and 1981. Although we were unable to locate a den site, we were able to locate a rest area and collected 19 scats which contained mostly caribou (40%) remains (Table 7). The importance of caribou prey to this pack undoubtedly fluctuates depending on their availability.

Susitna Pack - During 1980 and 1981 this pack was observed on 23 kills which were comprised of 10 caribou (43.5%), 11 moose (47.8%) and 2 small mammals (8.7%) (Table 8). In 1979, however, only 9 percent of the kills (n=22) were comprised of caribou. During 1979 caribou were essentially unavailable to this pack while in 1980 and 1981 fair numbers of caribou wintered within this pack's territory.

Scats were collected at the Susitna den and rendezvous site in 1980 and at the den site in 1981 (Tables 9, 10 and 11). Moose was the most important single summer food item in both 1980 and 1981, comprising 33.3 and 28.6 percent, respectively, of the diet. However, as a group small mammals were equally important, 35% in 1980 and 41% in 1981, with beaver constituting the most important small mammal food item. Moose were also the most important food item at the 1980 rendezvous site. There did not appear to be any major changes in summer food habits from 1980 and 1981.

Table 6. Chronological summary of kills at which the Fish Lake wolf pack was observed from 19 March 1981 through 26 October 1981 in GMU-13 of southcentral Alaska.

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
3/31/81	9:25am	Yes	Moose-adult	90%	9 wolves
4/20/81	4:00pm	Yes	Beaver or muskrat		1 wolf
5/22/81	11:45am	?	Injured bull moose at bay		No sign of kill on 5/23
5/23/81	pm	Probable	Injured bull caribou at bay		1 wolf
9/23/81	10:22am	Yes	Caribou-calf	20%	9/23 1 wolf
9/23/81	10:02am	Yes	Caribou-adult	10%	9/23 2 wolves
10/26/81	2:39pm	Yes	Small mammal F		10/26 7 wolves

Table 7. Summary of incidence of food remains in wolf scats collected at a Fish Lake pack rest area during summer 1981 in southcentral Alaska.

Food Item	Item in 19 Adult Scats		Items in 0 Pup Scats		Items in 19 Combined Scats	
	#	%	#	%	#	%
Moose, adult	0	0	0	0	0	
Moose, calf	3	13.04	0	0	3	13.04
Caribou, adult	4	17.39	0	0	4	17.39
Caribou, calf	1	43.5	0	0	1	4.35
Caribou, age unknown	4	17.39	0	0	4	17.39
Moose or caribou	1	43.5	0	0	1	4.35
Microtine	3	13.04	0	0	3	13.04
Bird	2	8.70	0	0	2	8.70
Wolf	1	4.35	0	0	1	4.35
Unknown	4	17.39	0	0	4	17.39
Total	23	100.00	0	0	23	100.00

Grouped Data for 19 Scats

Food Item	#	%
Ungulate	13	56.52
Small Mammal	3	13.04
Other	3	13.04
Unknown	4	17.39
Total	23	100.00

Table 8. Chronological summary of kills at which the Susitna wolf pack was observed from January 1980 through December 1981 in Game Management Unit 13 of southcentral Alaska 1/.

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments	
1/23/80	1:00pm	Yes	Moose - adult	75%	1/22 or 1/23	7 wolves
1/25/80	11:08am	No				
1/27/80	12:23pm	Yes	Caribou - adult M	90%	1/26	7 wolves
1/28/80	9:23am	No				
1/29/80	11:05am	Yes	Caribou - adult	100%	1/28	7 wolves
2/01/80	2:32pm	No				
2/03/80	12:03pm	Yes	Caribou - adult	100%	2/2	7 wolves
2/05/80	10:30am	No				
2/07/80	2:48pm	No				
2/10/80	11:50pm	No				
2/12/80	2:00pm	Yes	Caribou - assumed adult	100%	2/11 or 2/12	7 wolves
3/12/80	9:35am	No				4 wolves
3/14/80	12:20pm	Yes	Caribou - adult M	90%	3/13	4 wolves
3/16/80	12:30pm	No	-	95%	Still on kill of 3/14	4 wolves
3/18/80	10:45am	No				
3/20/80	10:45am	Yes	Caribou - adult	100%	3/18	4 wolves
3/22/80	3:40pm	Yes	Moose-assumed calf	100%	3/20 or 3/21	4 wolves
3/25/80	11:30am	Yes	Moose - calf	90%	3/23 or 3/24	4 wolves
3/27/80	8:45am	No				
4/15/80	12:30pm	Yes	Caribou - ?	90%	4/13-14	1 wolf
5/18/80	7:45 pm	Yes	Moose - adult or L. yearling	50%	5/17-18	3 wolves
5/25/80	1:00pm	Yes	Caribou - adult	5%	5/25	1 wolf
6/2/80	11:30am	Yes	Beaver	0%	6/2	4 wolves
6/23/80	7:10pm	Yes	Moose - adult?	50-75%	5/22-23	1 wolf 2/
8/7/80	12:15pm	-	Moose - ?	100%	old	2 wolves
8/26/80	9:30am	Yes	Moose - calf	0%	8/26	8 wolves
11/19/80	12:40pm	Yes	Caribou - ?	95%	11/18	7 wolves
5/11/81	12:35pm	Yes	Moose - calf			3 wolves
5/23/81		Yes	Moose - nb calf	0%	5/23	Had cow w/nb calf at bay.
5/28/81	6:46pm	Yes	Moose - nb calf	50%		2 wolves
5/29/81	12:00pm	Yes	Caribou - calf	25%		1 wolf
6/5/81	6:05pm	?	Unknown	old kill		Also had cow w/nb calf at bay
6/9/81	4:46pm	Yes	Moose - adult	75%		1 wolf

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

2/ Possible bear kill.

Table 9. Summary of incidence of food items in wolf scats collected at the Susitna wolf den occupied in late spring and summer 1980 in GMU-13 of southcentral Alaska.

Food Item	Item in 45 Adult Scats		Items in 34 Pup Scats		Items in 79 Combined Scats	
	#	%	#	%	#	%
Moose, adult	3	5.36	2	5.00	5	5.21
Moose, calf	8	14.29	17	42.50	25	26.04
Moose, age unknown	2	3.57	0	0	2	2.08
Caribou, adult	5	8.93	2	5.00	7	7.29
Caribou, calf	2	3.57	1	2.50	3	3.13
Caribou, age unknown	1	1.79	0	0	1	1.04
Moose or caribou	7	12.50	3	7.50	10	10.42
Beaver	11	19.64	3	7.50	14	14.58
Muskrat	6	10.71	5	12.50	11	11.46
Snowshoe hare	4	7.14	1	2.50	5	5.21
Microtine	1	1.79	3	7.50	4	4.17
Vegetation	1	1.79	1	2.50	2	2.08
Unknown	5	8.93	2	5.00	7	7.29
Totals	56	100.01	40	100.00	96	100.00

Grouped Data for 79 Scats

Food Item	#	%
Ungulate	53	55.21
Small Mammal	34	35.42
Other	2	2.08
Unknown	7	7.29
Total	96	100.00

Table 10. Summary of incidence of food remains in wolf scats collected at the Susitna wolf pack rendezvous site occupied during summer 1980 in GMU-13 southcentral Alaska.

Food Item	Items in 0 Adult Scats		Items in 13 Pup Scats		Items in 13 Combined Scats	
	#	%	#	%	#	%
Moose, adult	0	0	1	6.67	1	6.67
Moose, calf	0	0	10	66.67	10	66.67
Moose, age unknown	0	0	1	6.67	1	6.67
Bird	0	0	1	6.67	1	6.67
Vegetation	0	0	1	6.67	1	6.67
Unknown	0	0	1	6.671	1	6.67
Totals	0	0	15	100.00	15	100.00

Grouped Data for 13 Scats

Food Item	#	%
Ungulate	12	80.00
Small Mammal	0	0
Other	2	13.33
Unknown	1	6.67
Total	15	100.00

Table 11. Incidence of food remains in wolf scats collected at the Susitna den utilized in late spring and early summer 1981 in GMU-13 of southcentral Alaska.

Food Item	Items in 41 Adult Scats		Items in 0 Pup Scats		Items in 41 Combined Scats	
	#	%	#	%	#	%
Moose, adult	1	1.59	0	0	1	1.59
Moose, calf	17	26.98	0	0	17	26.98
Caribou, adult	6	9.52	0	0	6	9.52
Caribou, calf	3	4.76	0	0	3	4.76
Beaver	10	15.87	0	0	10	15.87
Muskrat	2	3.17	0	0	2	3.17
Snowshoe hare	2	3.17	0	0	2	3.17
Microtine	10	15.87	0	0	10	15.87
Unidentified small mammal	2	3.17	0	0	2	3.17
Bird	3	4.76	0	0	3	4.76
Fish	0	0	0	0	0	0
Vegetation	2	3.17	0	0	2	3.17
Unknown	5	7.94	0	0	5	7.94
Totals	63	100.00	0	0	63	99.9

Grouped Data for 41 Scats

Food Item	#	%
Ungulate	27	42.86
Small Mammal	26	41.27
Other	5	7.94
Unknown	5	7.94
Total	63	100.00

Susitna-Sinona Pack - During 1980 and 1981 members of this pack were only observed on 5 kills (Table 12) because they were only periodically monitored. The observed kills were comprised of 2 caribou, 2 moose and 1 snowshoe hare. Prior to the establishment of this pack in spring 1979 the area had been occupied by another pack referred to as the original Sinona Pack. Interestingly, the original Sinona Pack was observed on only one (2.6%) caribou out of 39 kills (Ballard et al. 1981). Again, the importance of caribou as a prey item is probably dependent on both caribou distribution and population status. Although caribou migrated through this area prior to 1980, very few overwintered in the area as they did in 1980 and 1981. Although this pack denned in 1980, we were unable to locate a den site and therefore no wolf scats were collected for summer food habits studies.

Tolsona Pack - From 6 January 1980 through October 1981 members of the Tolsona Pack were observed on 19 kills (Table 13). Moose accounted for 9 kills (47%) and caribou for 7 kills (37%), while bear and snowshoe hare comprised 3 kills. In 1979, however, caribou comprised 8 (67%) of 12 kills. The difference in the importance of caribou to the Tolsona Pack again appears to be related to caribou distribution.

Summer food habits were determined by examination of scats collected at den and rendezvous sites in 1980 and 1981 (Tables 14, 15 and 16). In 1980 (Table 14) ungulate prey comprised 79 percent of the prey remains with calf moose comprising almost half (48%) of the identified prey items, while caribou of all ages comprised 8 percent of the items. In 1981, ungulate prey were also the most important prey item (54% of total combining den and rendezvous scats), however, caribou comprised 36 percent of the food items. Small mammals were an important prey item in both years; 33 percent in 1980 and 42 percent in 1981.

Tyone Creek Pack - During 1980 this pack was observed on 11 kills (Table 17), 10 (91%) of which were moose. Following the loss of the adult male and female in early spring 1980 remaining

Table 12. Chronological summary of kills at which the Susitna-Sinona wolf pack was observed from mid-April 1980 through August 1981. 1/

Date of Observation	Time	Species and Age	Percent	Estimated Date of Consumed Kill	or Comments
1/9/80	11:40am	Caribou - ?	75%	1/8	2 wolves obs.
1/29/80	10:30am	Moose - calf	75%	1/28	3 wolves
9/26/80	9:05am	Moose - adult F?	100%	?	3 wolves
10/14/80	9:15am	Prob. snowshoe hare		10/14	4-5 wolves
3/16/81	4:30pm	Caribou - ?	100%		1 wolf

1/ Wolf 313 joined Tolsona Pack by mid-July 1981.

Table 13. Chronological summary of kills at which the Tolsona wolf pack was observed from 6 January through 17 February 1980 and July 1980 through 8 September 1981 in Game Management Unit 13 of southcentral Alaska.

Date of Observation	Time	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
1/6/80	2:45pm	Caribou - Adult	90%	1/5 4 wolves
1/9/80	10:45am	Caribou - ?	90%	1/8 11 wolves
1/25/80	10:06am	Moose - Calf	75%	1/24 12 wolves
1/27/80	10:54am	Caribou - ?	95%	1/26-27 12 wolves
1/29/80	11:15am	Moose - Calf	100%	1/28-29 12 Wolves
2/7/80	3:36pm	River Otter	-	2/7 12 wolves
2/9/80	11:05pm	Moose - 2 yr.	80%	2/8 12 wolves
2/10/80	10:20am			Still on kill of 2/9 11 wolves
2/14/80	9:35pm	Unk.-poss. beaver	-	2/14 8 wolves
2/16/80	1:20pm	Moose - Calf	75%	2/15-16 11 wolves
2/17/80	12:05am			Still on kill of 2/16 11 wolves
8/27/80	3:30pm	Caribou - Ad M	15%	8/26-27 4 wolves
10/16/80	11:00am	Snowshoe hare	-	10/16 15 wolves
1/09/81	10:00pmm	Attempting to kill calf moose		
1/13/81	11:20pm	Moose - adult	100%	15 wolves
1/16/81	10:02am	Caribou - ?	95%	15 wolves
1/21/81	10:15am	Moose - calf	75%	1/20/81 7+ wolves
1/22/81	10:00am			Leaving kill 15 wolves
1/24/81	10:25am	Caribou - ?	95%	
5/23/81	am	Moose-newborn calf	< 5%	5/23/81 1 wolf
6/2/81	7:00pm	Moose - ?	80-90%	Kill appeared to have been buried and dug up - possible bear kill? 1 wolf present
6/4/81	7:18pm	Moose - newborn calf	50%	1 wolf
6/5/81	6:35pm			same wolf present at kill
8/20/81	1:45pm	Caribou - adult	95%	12 wolves

Table 14. Incidence of food remains in wolf scats collected at the Tolsona wolf rendezvous site (old Mendelta 2nd den) utilized by pack members during summer 1980 in GMU-13 of southcentral Alaska.

Food Item	Item in 113 Adult Scats		Items in 104 Pup Scats		Items in 217 Combined Scats	
	#	%	#	%	#	%
Moose, adult	32	19.63	1	0.85	33	11.74
Moose, calf	62	38.04	74	62.71	136	48.40
Moose, age unknown	4	2.45	1	0.85	5	1.78
Caribou, adult	15	9.20	3	2.54	18	6.41
Caribou, calf	5	3.07	4	3.39	9	3.20
Caribou, age unknown	3	1.84	2	1.69	5	1.78
Moose or caribou	3	1.84	9	7.63	12	4.27
Beaver	5	3.07	0	0	5	1.78
Muskrat	4	2.45	0	0	4	1.42
Snowshoe hare	4	2.45	6	5.08	10	3.56
Microtine	7	4.29	4	3.39	11	3.91
Unidentified small mammal	7	4.29	0	0	7	2.49
Bird	5	3.07	1	0.85	6	2.14
Fish	1	0.61	0	0	1	0.36
Vegetation	0		2	1.69	2	0.72
Unknown	6	3.68	11	9.32	17	6.05
Totals	163	100.00	118	100.00	281	100.11

Grouped Data for 217 Scats

Food Item	#	%
Ungulate	218	77.58
Small Mammal	37	13.17
Other	9	3.20
Unknown	17	6.05
Total	281	100.00

Table 15. Incidence of food remains in wolf scats collected at the Tolsona wolf den site (old Mendelta rendezvous site) utilized by pack members during late spring and early summer 1981 in GMU-13 of southcentral Alaska.

Food Item	Item in 59 Adult Scats		Items in 5 Pup Scats		Items in 64 Combined Scats	
	#	%	#	%	#	%
Moose, adult	4	4.82	0	0	4	4.44
Moose, calf	18	21.69	2	28.57	20	22.22
Moose, age unknown	0	0	0		0	0
Caribou, adult	9	10.84	2	28.57	11	12.22
Caribou, calf	12	14.46	0	0	12	13.33
Caribou, age unknown	0	0	0	0	0	0
Moose or caribou	7	8.43	0	0	7	7.78
Beaver	6	7.23	0	0	6	6.67
Muskrat	4	4.82	1	14.29	5	5.56
Snowshoe hare	7	8.43	0	0	7	7.78
Microtine	6	7.23	2	28.57	8	8.89
Unidentified small mammal	4	4.82	0	0	4	4.44
Bird	0	0	0	0	0	0
Fish	2	2.41	0	0	2	2.22
Vegetation	0	0	0	0	0	0
Wolf	0	0	0	0	0	0
Unknown	4	4.82	0	0	4	4.44
Totals	83	100.00	7	100.00	90	99.99

Grouped Data for 64 Scats

Food Item	#	%
Ungulate	54	60.00
Small Mammal	30	33.33
Other	2	2.22
Unknown	4	4.44
Total	90	99.99

Table 16. Incidence of food remains in wolf scats collected at the Tolsona wolf rendezvous site (old Mendelta 2nd den) occupied summer 1981.

Food Item	Item in 16 Adult Scats		Items in 15 Pup Scats		Items in 31 Combined Scats	
	#	%	#	%	#	%
Moose, calf	0	0	1	4.35	1	2.33
Moose, age unknown	4	20.00	3	13.04	7	16.28
Caribou, adult	6	30.00	0	0	6	13.95
Caribou, calf	1	5.00	1	4.35	2	4.65
Caribou, age unknown	1	5.00	0	0	1	2.33
Moose or caribou	0	0	1	4.35	1	2.33
Beaver	2	10.00	0	0	2	4.65
Muskrat	0	0	1	4.35	1	2.33
Snowshoe hare	1	5.00	1	4.35	2	4.65
Microtine	3	15.00	3	13.04	6	13.95
Unidentified small mammal	2	10.00	5	21.74	7	16.28
Bird	0	0	1	4.35	1	2.33
Unknown	0	0	6	26.09	6	13.95
Totals	20	100.00	23	100.00	43	100.00

Grouped Data for 31 Scats

Food Item	#	%
Ungulate	18	41.86
Small Mammal	18	41.86
Other	1	2.33
Unknown	6	13.95
Total	43	100.00

Table 17. Chronological summary of kills at which the Tyone Creek wolf pack (2 adults, 6 pups) was observed from January through December 1980 in Game Management Unit 13 of southcentral Alaska.

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
1/9/80	12:20pm	Yes	Moose - calf	95%	1/7-8
1/11/80	11:30am	No		Still on kill of 1/9	
1/23/80	11:30am	No			
1/25/80	10:35am	Yes	Caribou - adult M		
1/27/80	11:51am	No			
1/29/80	11:25am	Yes	Moose - calf	95%	1/28
2/01/80	2:06pm	No			
2/03/80	10:56am	No			
2/05/80	10:00am	No			Dug up old kill
2/07/80	3:05pm	No			Visited caribou kill of 1/25/80
2/09/80	10:50am	No			Visited old unidentified kill
2/12/80	2:20pm	Yes	Moose - calf	50-70%	2/11 or 2/12
2/14/80	10:30am	No		100%	still on kill of 2/12
2/16/80	5:22pm	No			
2/17/80	1:00pm	No			
2/18/80	10:10am	No			
2/20/80	8:50am	Yes	Moose - adult F	75%	2/19
2/22/80		No			
2/24/80	12:00 m	Yes	Moose - calf	60%	2/23/or 2/24
2/25/80	2:30pm	No		95%	Still on kill of 2/24
2/27/80	9:15am	No		100%	Still on kill of 2/24
2/29/80		No		100%	Still on kill of 2/24
3/02/80		No		100%	Still on kill of 2/24
3/04/80	10:15am	No			
	4:30pm	No			
3/06/80	11:00am	Yes	Moose - calf	5%	3/6
3/08/80	10:30am	Yes	Moose - adult F	25%	3/8 killed 2 Susitna pack members and consumed two ptarmigan
			Moose - calf	>5%	3/8
3/09/80	11:45am	No			Still at kill of 3/8
3/10/80	9:45am	No			Still at kill of 3/8
3/12/80	10:00am	No		60%	Still at kill of 3/8
3/14/80	11:00am	Yes	Moose - adult	60%	3/13
3/16/80	1:00pm	Yes	Moose - calf		3/16
3/27/80	9:30am	No			Return to kill of 2/24 2/
3/29/80	9:05am	No			Return to old kill 2/
3/31/80	2:27pm	No			Return to kill of 3/14 2/
4/4/80	12:55pm	No			Return to kill of 3/8 2/
4/6/80	11:13am	No			Return to kill of 3/14 2/
4/8/80	10:04am	No			On old moose kill 2/

2/ Pack of four pups.

pack members were not observed on a fresh ungulate kill until the following year after the four remaining pack members had become integrated into other packs. No scats were collected in 1980 or 1981 because the pack did not den.

Watana Pack - During 1980 and 1981 moose comprised a majority (74%) of the 19 kills observed (Table 18). Calf moose comprised 29 percent of the moose kills, however, moose of unknown age and adults each comprised 36 percent of the moose kills.

Summer food habits of the Watana Pack during 1980 and 1981 as determined from analysis of scats collected at den and rendezvous sites are presented in Tables 19 through 21. At the den site, calf moose comprised the single most important food items during both 1980 and 1981, 47.5 and 28.9 percent, respectively. Occurrence of adult moose increased from 18.4 to 38.7 percent from the 1980 den to the 1980 rendezvous site, suggesting that movement to the latter area may have been related to moose distribution. No scat data were available from the 1981 rendezvous site. Regardless, ungulates comprised the bulk of the food occurrences; 71 and 52 percent for 1980 and 1981, respectively. Small mammals appeared to be more important in 1981 since their occurrence rose from 9.2 to 31.1 percent.

Summary of Food Habits

Table 22 summarizes summer food habits of all packs studied as determined from analysis of scats collected at den and rendezvous sites during 1980 and 1981. Moose of all ages were the most important summer food item during both years of study. However, the importance of calf moose is believed to be over-emphasized by scat analysis (Ballard et al. 1981), perhaps because of the higher of surface to volume ratio of smaller animals (Floyd et al. 1978).

Studies of wolf food habits in GMU-13 since 1975 have suggested that moose are the single most important food item (Ballard et

Table 18. Chronological summary of kills at which the Watana wolf pack was observed from mid-April 1980 through 30 October 1981 in Game Management Unit 13 of southcentral Alaska.

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
5/13/80	1:16pm	Moose - adult		-	? Could have been a tagging mort. At least 1 wolf present.
5/14/80	3:35pm				Return to kill of 5/13.
6/2/80	4:30pm	Caribou - adult		50%	6/1 4 wolves
6/13/80	12:50pm	Moose - ?		100%	Old kill from past winter.
9/10/80	4:50pm	Moose - adult?		25%	9/9
9/16/80	2:30pm	Caribou- ?		50%	9/15-16
1/17/80	12:11pm	Moose - adult		50%	2+ wolves
3/6/81	9:15am	Moose - ?		90+%	1 wolf (310) 1/
3/7/81	2:30pm	Moose - adult ?		75%	7 wolves
5/14/81	8:55am	Moose - adult		50%	1-2 weeks old? 3 wolves 1/
5/17/81	2:15pm	Had cow w/ 2 yearlings		cornered	3 wolves 1/
5/23/81		Moose - newborn calf			3 wolves 1/
5/24/81	6:20pm	Moose - adult		75%	Old kill 3 wolves 1/
5/27/81		Moose - yearling		100%	3 wolves 1/
6/1/81	9:25am	Moose - calf		50%	2 wolves
6/2/81	7:45pm	Caribou - adult		60-75%	1 wolf
6/3/81	12:50pm	Still on ill			2 wolves
6/5/81	7:30pm	Suspect wolves departing from kill made by black bear			5 wolves
6/6/81	8:50pm	Caribou - ?			Old kill made by black bear several days earlier
6/7/81	9:00am	Moose - ?			Probable kill 1 wolf
6/13/81	12:59pm	Unknown sp.			Kill in thick alder 2 wolves
6/14/81	10:43am	Wolves in same location at pm on 6/13. Bear within 35 m.			
6/17/81	12:55pm	Wolves in same location as 6/13. Bear close by.			
6/19/81	10:30pm	1 wolf returned to location of 6/13.			
6/19/81		Moose - calf		50%	Wolves had cow surrounded
6/21/81	5:20pm	Moose - adult		100%	1 wolf

1/ Wolves 310, 344 and 345 had dispersed from Watana Pack.

Table 19. Incidence of food remains in wolf scats collected from the Watana pack den occupied during late spring and early summer 1980 in GMU-13 of southcentral Alaska.

Food Item	Item in 33 Adult Scats		Items in 104 Pup Scats		Items in 137 Combined Scats	
	#	%	#	%	#	%
Moose, adult	12	34.29	14	13.21	26	18.44
Moose, calf	16	45.71	51	48.11	67	47.52
Moose, age unknown	0	0	7	6.60	7	4.96
Beaver	0	0	9	8.49	9	6.38
Snowshoe hare	0	0	4	3.77	4	2.84
Bird	3	8.57	0	0	3	2.13
Vegetation	0	0	4	3.77	4	2.84
Wolf	0	0	3	2.83	3	2.13
Unknown	4	11.43	14	13.21	18	12.77
Totals	35	100.00	106	100.00	141	100.00

Grouped Data for 137 Scats

Food Item	#	%
Ungulate	100	70.92
Small Mammal	13	9.22
Other	10	7.09
Unknown	18	12.77
Total	141	100.00

Table 20. Incidence of food remains in wolf scats collected at the Watana pack rendezvous site which was used by the Watana pack during summer 1980 in GMU-13 of southcentral Alaska.

Food Item	Item in 33 Adult Scats		Items in 23 Pup Scats		Items in 56 Combined Scats	
	#	%	#	%	#	%
Moose, adult	17	48.57	7	25.93	24	38.71
Moose, calf	8	22.86	5	18.52	13	20.97
Moose, age unknown	0	0	3	11.11	3	4.84
Moose or caribou	2	5.71	4	14.81	6	9.68
Beaver	2	5.71	0	0	2	3.23
Vegetation	1	2.86	4	14.81	5	8.06
Wolf	1	2.86	0	0	1	1.61
Unknown	4	11.43	4	14.81	8	12.90
Totals	35	100.00	27	100.00	62	100.00

Grouped Data for 56 Scats

Food Item	#	%
Ungulate	46	74.19
Small Mammal	2	3.23
Other	6	9.68
Unknown	8	12.90
Total	62	100.00

Table 21. Incidence of food remains in wolf scats collected at the Watana pack den occupied during late spring and summer 1981 in GMU-13 of southcentral Alaska.

Food Item	Item in 73 Adult Scats		Items in 31 Pup Scats		Items in 104 Combined Scats	
	#	%	#	%	#	%
Moose, adult	15	15.46	0	0	15	11.11
Moose, calf	26	26.80	13	34.21	39	28.89
Moose, age unknown	8	8.25	3	7.89	11	8.15
Caribou, adult	3	3.09	1	2.63	4	2.96
Caribou, calf	1	1.03	0	0	1	0.74
Beaver	8	8.25	4	10.53	12	8.89
Muskrat	4	4.12	4	10.53	8	5.93
Snowshoe hare	5	5.15	3	7.89	8	5.93
Mircotine	8	8.25	2	5.26	10	7.41
Unidentified small mammal	4	4.12	0	0	4	2.96
Bird	1	1.03	0	0	1	0.74
Vegetation	1	1.03	1	2.63	2	1.48
Unknown	13	13.40	7	18.42	20	14.81
Totals	97	99.98	38	100.00	135	100.00

Grouped Data for 104 Scats

Food Item	#	%
Ungulate	70	51.85
Small Mammal	42	31.11
Other	3	2.22
Unknown	20	14.81
Total	135	99.99

Table 22. Comparison between years of food remains in wolf scats collected at den and rendezvous sites in 1980 and 1981 from GMU-13 of southcentral Alaska.

Food Items	1980 727 Scats		1981 290 Scats	
	# Items	% Occurrences	# Items	% Occurrence
Adult Moose	105	12.00	24	6.15
Calf Moose	369	42.17	87	22.31
Moose, Age Unknown	22	2.51	21	5.38
Adult Caribou	30	3.43	31	7.95
Calf Caribou	13	1.49	19	4.87
Caribou, Age Unknown	8	0.91	5	1.28
Moose or Caribou	31	3.54	9	2.31
Beaver	48	5.49	37	9.49
Muskrat	26	2.97	24	6.15
Snowshoe Hare	55	6.29	21	5.38
Microtine	40	4.57	37	9.49
Unidentified Small Mammal	15	1.71	20	5.13
Bird	16	1.83	8	2.05
Fish	1	0.11	2	0.51
Vegetation	22	2.51	5	1.28
Wolf	4	0.46	1	0.26
Unknown	70	8.00	39	10.00
Total	875	100.00	390	100.00

al. 1981). These studies suggested that wolves were selecting adult moose during half the year except for the months of January through July, when short and long yearling moose comprised a disproportionate percentage of the kill (op. cit.). This trend appears to have continued in 1980 and 1981 as well, except that caribou appear to have increased in importance as a prey item.

Table 23 compares the percentage of moose, caribou, and miscellaneous prey observed annually for different radio-collared wolf packs studied in GMU-13 from 1975 through 1981. According to this comparison, the annual percentage of observed caribou kills has varied from 4 to 30 percent. Excluding 1978 when the main body of the Nelchina caribou herd wintered in the Wrangell Mountains, and few were available to GMU-13 wolves during winter, the importance of caribou in the diet of wolves appears to have increased since 1978; average of 18 percent caribou for 1975 through 1977 in comparison to 26 percent caribou for 1979 through 1981. Some of the annual difference in percent occurrence of caribou could be attributed to the studying of different packs where caribou have always been relatively more available to wolves. However, caribou distribution is probably at least in part a function of their density. The Nelchina herd reached a record low of approximately 10,000 in 1973 (Pitcher, pers. comm.). By 1981 the population had increased to approximately 22,000 (op. cit.). We suspect the increase in the caribou population generally has made caribou more available to wolves throughout the Unit. If true, this would suggest that as the herd grows larger, caribou will also become more important as wolf prey. Assuming wolf populations in GMU-13 increase slightly or remain stable, a larger caribou population may have some positive benefits for moose in that a larger percentage of the may will be caribou, relieving the moose population from some predation mortality.

Table 23. Comparison by wolf pack of the annual percentage of observed wolf prey from 1975 through 1981 in the Susitna and Nelchina River Basins of southcentral Alaska.

	% Moose Kills							% Caribou Kills							% other kills							Total Kills						
Year	1975	1976	1977	1978	1979	1980	1981	1975	1976	1977	1978	1979	1980	1981	1975	1976	1977	1978	1979	1980	1981	1975	1976	1977	1978	1979	1980	1981
Pack																												
Brushkana	100	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	4	-	-	-	-	-	-
Butte Lake	75	100	-	-	-	-	-	25	0	-	-	-	-	-	0	0	-	-	-	-	-	4	1	-	-	-	-	-
Deadman	100	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	3	-	-	-	-	-	-
Deep Lake	-	50	33	60	-	-	-	-	50	67	20	0	0	0	-	0	0	20	0	0	0	-	6	3	10	-	-	-
Delta	100	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	2	-	-	-	-	-	-
Ewan	42	33	-	-	-	-	-	50	67	-	-	-	-	-	8	0	-	-	-	-	-	12	6	-	-	-	-	-
Fish Lake	-	-	-	-	-	-	29	-	-	-	-	-	-	43	-	-	-	-	-	-	29	-	-	-	-	-	-	7
Hogan Hill	100	89	100	90	-	-	-	0	11	0	0	-	-	-	0	0	0	10	-	-	-	12	9	3	10	-	-	-
Jay Creek	-	50	100	100	-	-	-	-	50	0	0	-	-	-	-	0	0	0	-	-	-	-	2	4	4	-	-	-
Key Creek	60	82	-	100	-	-	-	10	18	-	0	-	-	-	0	0	-	0	-	-	-	10	11	-	7	-	-	-
Maclaren	82	100	-	-	-	-	-	18	0	-	-	-	-	-	0	0	-	-	-	-	-	11	1	-	-	-	-	-
Mendeltna	-	57	55	-	-	-	-	-	14	28	-	-	-	-	-	29	17	-	-	-	-	-	7	29	-	-	-	-
Middle Fork	-	-	100	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	5	-	-	-	-
Saint Anne's	-	-	-	75	67	100	-	-	-	0	0	0	0	-	-	-	20	25	33	0	-	-	-	5	8	3	6	-
Sinona	100	100	80	75	-	-	-	0	0	0	0	-	-	-	0	0	20	25	-	-	-	11	19	5	4	-	-	-
Susitna	-	-	-	-	86	41	67	-	-	-	-	9	53	17	-	-	-	-	5	6	17	-	-	-	-	22	17	6
Sinona-Susitna	-	-	-	-	-	50	0	-	-	-	-	-	25	100	-	-	-	-	-	25	0	-	-	-	-	-	4	1
Tolsona	-	-	-	100	17	45	67	-	-	-	0	67	27	33	-	-	-	0	17	27	-	-	-	-	3	12	11	9
Tyone	-	-	80	100	100	91	-	-	-	0	0	0	9	-	-	-	20	0	0	0	-	-	-	5	1	11	11	-
Watana	-	-	-	-	-	60	80		-	-	-	-	40	13	-	-	-	-	-	0	7	-	-	-	-	-	5	15
Totals	80	77	69	83	71	61	63	19	19	17	4	21	30	26	1	3	14	13	8	9	11	69	62	59	47	48	54	38

Table 24 lists the species, sex, age, condition, and cause of mortality for kills examined in situ during 1980. These data were combined with those collected in GMU-13 from 1970-72 and 1975 through 1979 in an effort to assess the age and condition of prey taken by wolves. Analysis of this data was provided by Ballard et al. (1981). Generally, it was concluded that wolves were preying upon relatively healthy calf and short yearling moose. During severe winters wolves preyed upon relatively healthy adult moose in proportion to the occurrence of their age class in the population while during average or mild winters older adult moose were being preyed upon.

During 1980 both the mandible and longbone were collected from moose and caribou dying from various causes. These data were jointly analyzed with those collected from 1978 through 1979 to determine the relationship in marrow fat between the two bones. A technical paper comparing mandible marrow fat with longbone marrow fat was prepared and presented at the 18th North American Moose Conference and Workshop held in Thunder Bay, Ontario. A copy of the paper is presented in Appendix C.

Predation

Winter Rates

The most serious impact of the proposed project on wolves could be reduction in prey numbers. In an effort to evaluate the affects of prey reductions on wolves it is necessary to determine the numbers and types of prey consumed.

Winter predation rates were estimated for three packs by intensive radio monitoring and back tracking. A detailed discussion follows:

Table 24. Age, sex, condition (as determined by percent fat) and cause of mortality of moose and caribou kills examined in GMU 13 of southcentral Alaska during 1980.

Accession Number	Age	Sex	Date of Collection	Approximate Location	Percent Fat		Marrow Color	Cause of Death
					Longbone	Ramus		
Species Moose								
120601	2	F	01/28/80	Kenny Lake	90.4	68.1	Pink	Accident
120602	Calf	?	02/21/80	Susitna Lake	24.0	--	Pink	Wolf predation
120603	Adult calf	?	02/21/80	Oshetna River	46.5	--	Pink	Wolf predation
120604	Calf	?	01/12/80	Sinona Creek	89.7	--	Pink	Wolf predation
120605	Adult		02/20/80	Black River	84.5	61.6	Pink	Wolf predation
120606	Calf	?	02/21/80	Little Nelchina R.	53.3	41.0	Pink	Wolf predation
120607	2	?	02/21/80	Old Man Lake	84.1	65.2	Pink	Wolf predation
120608	Calf	?	02/21/80	Little Nelchina R.				Wolf predation
120609	10	F	02/21/80	Grayling Lake	88.1	72.6	Red	Unknown
120610	Adult	F	02/04/80	Eureka	60.8	--	Pink	Potlach kill
120611	Adult	F	04/01/80	Kenny Lake	98.1	--	White	Shot
120612	Adult	F	03/18/80	Tyone Mountains	81.2	--	Pink	Wolf predation
120613	14	F	03/13/80	Black River	83.7	67.2	White-red	Wolf predation
120614	Calf	?	03/25/80	Squaw Lake	57.1	44.9	Red	Wolf predation
120615	Calf	?	03/26/80	Black River	61.2	60.0	Pink	Wolf predation
120616	12	F	03/26/80	Oshetna River	87.3	65.8	Pink-red	Wolf predation
120620	Adult	F	04/22/80	Watana Creek	83.9	54.6	Pink	Tagging
120657	Calf	F	04/30/80	Glenn Highway	5.9	9.1	Pink	Winter kill
120658	16	F	03/08/80	Sinona Creek	85.6	77.1	Pink-red	Wolf predation
120659	Calf	F	03/08/80	Sinona Creek	33.9	--	Pink	Wolf predation
120660	Adult	F	05/21/80	Glennallen	15.0	--	Pink	Winter kill
Species Caribou								
55121	Adult	F	01/27/80	Susitna Lake	90.5	--	Pink	Wolf predation
55122	Calf ?	?	02/03/80	Minnesota Lake	75.6	--	Pink	Wolf predation
55123	Adult	M	02/21/80	Tolsona Creek	29.4	--	Pink	Wolf predation

Susitna Pack

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

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

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

In an effort to roughly determine possible impacts of this wolf pack on moose, a moose survey in the pack area was conducted in late March. Four and one half hours of flight time (0.59 minutes/mi^2) were spent surveying this 462 mi^2 area. A total of 51 moose were counted: 43 adults and eight calves (15.7%). The observer subjectively estimated that he may have observed 25 per-

cent of the moose present. Assuming moose were being taken at the rate indicated (caribou comprised 66.7% of kills), this pack killed eight adults and four calves from December through April. These kills represented 19 percent of the adult moose and 50 percent of the calf moose counted in March after most of the predation had occurred. If the observer had indeed counted only 25 percent of the moose and if we include projected kills as part of the base population the projected predation loss would have been 4 percent of the adult moose and 11 percent of the calf (short yearling) moose in the area. Wolf predation appeared to be contributing to high mortality of calf (short yearling) moose in the Susitna pack territory.

Tyone Creek Pack

During early 1980 weather and tracking conditions were excellent, allowing this pack of two adults and six pups to be monitored during a 54 day period (23 January through 16 March 1980). The pack was observed on 11 kills: 3 adult moose, 7 calf moose, and 1 adult caribou (Table 17). The prey species used by this pack were similar to those observed in 1979 when they were comprised of two adults. However, in 1979 when the pack was comprised of two adults, calf moose (short yearlings) comprised only 29 percent of the kills while in 1980 when the pack numbered eight wolves, calves comprised 64 percent of the kill, possibly indicating a change in prey selectivity based on pack composition. This pack was observed on a fresh kill at the rate of 1/4.9 days with an estimated 4.9 kgs of food available/wolf/day.

As with the territory of the Susitna pack, moose in this pack area were counted in early March 1980. Four and one half hours (0.89 minutes/mi^2) were spent surveying the 302 mi^2 pack area. A total of 266 moose were counted: 221 adults and 45 calves (17%). The observer subjectively estimated that he had observed 50 percent of the moose present. The observed moose kill rate was extrapolated for the months of December through April, yielding an estimated kill of eight adult moose and 20 calf moose. These

projections comprised 4 percent of the adult moose and 44 percent of the calf moose observed during the survey. Assuming only 50 percent of the moose were observed during the survey and adding the projected kills to the base population, the percentages would have been 2 percent of the adult moose and 18 percent of the calf (short yearling) moose in the area. In either case, it appears that wolf predation on calves (short yearling) in this area was a significant mortality factor.

Tolsona Pack - From 9 January through 26 January 1981 we attempted to determine the predation rate of the Tolsona Pack on caribou by attempting to locate the pack every other day. During this period the pack numbered 14 to 15 wolves and appeared to be feeding quite heavily on caribou. A total of four kills were observed (Table 25); 2 adult caribou, 1 adult moose and 1 calf moose. Unfortunately we were unable to locate the wolves at the intensity we desired because of inclement weather. Based upon these data, this pack of 15 wolves preyed upon a moose or caribou at the rate of 1/4.5 days, and had 39 kgs. of edible prey available per day at a rate of 2.6 kgs./wolf/day. Comparison of this rate with other predation data (this study and Ballard et al. 1981) reveals that the rate was well below the rate believed necessary for the pack to maintain its size and productivity (3.6 kg/wolf/day; from Mech cited in Peterson 1977). Therefore, we believe that several kills were missed during the study period. Our observation between 23 and 24 January 1981 when the pack had killed, consumed, and traveled a minimum of 2 miles in a 24 hour period, suggests that a monitoring intensity of every other day is too infrequent for determining predation rates for packs which rely heavily on caribou. In such cases, we recommend that packs be monitored twice daily if possible.

Summer Rate

Watana Pack - During May and June 1981 an attempt was made to locate members of the Watana wolf pack daily in an effort to assess summer food habits and predation rates. At the initiation

Table 25. Daily movements, observed prey and location of the Tolsona wolf pack from 3 through 26 January 1981 in GMU-13 of southcentral Alaska.

Dates and Time	Distance between obs. & Appx. direction traveled	Final Location	I. D. of Radioed Wolves Present	# Wolves Observed	Kill Made	Species of Prey	Misc. Notes
1/3/81 - 1/6/81 1455 1055	15 mi. NE	Bobs Lake	220 315 316	14	No		
1/6/81 - 1/9/81 1055 1000	4 mi. NE	Lake Louise Rd	220 315 316	7	No		Attempts to kill calf moose
1/9/81 - 1/9/81 1000 1515	2 mi. SW	Lake Louise Rd	220 315 316	10	No		
1/9/81 - 1/10/81 1515 0945	10 mi. W	V Lake	220 315 316	2	No		
1/10/81 - 1/13/81 0945 1045	7 mi. NW	3 mi. N. Curtis Lake	220 315 316	15	No		Unable to back track due to caribou tracks
1/11/81 - 1/13/81 1045 1120	13. mi. SSW	3 mi. W. Kelly Lake	220 315 316	15	Yes	Adult moose	Estimate almost completely consumed
1/13/81 - 1/16/81 1120 10:02	14 mi. NE	Mud Lake	220 315 316	15	Yes	Caribou	Probable adult est. 95% consumed.
1/16/81 - 1/16/81 10:02 12:45	1.4 mi. W		220 315 316	15	No		
1/16/81 - 1/17/81 10:02 0919	8 mi. SE	2 mi. NW Bobs Lake	220 315 316	15	No		

Table 25. (cont'd)

Dates and Time	Distance between obs. & Appx. direction traveled	Final Location	I. D. of Radioed Wolves Present	# Wolves Observed	Kill Made	Species of Prey	Misc. Notes
1/17/81 - 1/18-81			220				
0919 12:40	4 mi. NW	2 mi. NE Marsh Lake	316 316	14	No		
1/18/81 - 1/20/81			220				
12:40 1210	7 mi. S	Mendelta Sp.	315 316	14	No		
1/20/81 - 1/21/81			220				
12:10 1015	3 mi. E	Old Man Lake	315 316	7	Yes	Calf Moose	Est. 75% consumed
1/21/81 - 1/22/81			220				
1015 1000	2 mi. N.	2 mi. N. of 1/21 location	315 316	15	No		
1/22/81 - 1/23/81			220				
1000 0948	10 mi. NE	2 mi. SW upper Tolsona Ck.	315 316	6	No		Unable to back track
1/23/81 - 1/24/81			220				
0948 1025	6 mi. ESE	Tolsona Ck.	315 316	12-13	Yes	Adult caribou	Kill made 4 mi. east of the 1/23. Kill est. consumed.
1/24/81 - 1/26/81			220				
1025 1445	3 mi. W	W. of 1/24 location	315 316	12	No		

of the study 3 members (#310, 344 and 345-see Watana Wolf Pack History section of this report) split off from the pack, leaving the main pack with 8 members.

From 10 May through 23 June 1981, the eight members of the main Watana Pack were observed on only 6 kills (see Table 16 and 32). The kills were comprised of 2 adult caribou (1 was unclassified and assumed to be an adult), 2 calf moose, 1 adult moose, and 1 unknown species. In addition to the above, pack members were known to have twice visited an adult caribou which had been killed by a black bear, revisited one old moose kill once, and visited the unknown species kill on three separate occasions. Using the live weights and estimated consumable flesh given by Peterson (1977) and Ballard (1982) a gross estimate of the kilograms of edible prey/wolf/day was derived based on the observed kill rates. Based upon the assumption that the unidentified kill was an adult moose and that the wolves were able to derive 10 percent of the edible flesh from the old revisited kills, this pack had 946 kg of prey available at 21.01 kg/day for a 45 day period. The derived consumption rate of 2.6 kg/wolf/day is well below that necessary to sustain adult denning wolves and their pups. Also, the observed kill rate of 1 kill/7.5 days is well below the winter rate of 1/4-5 days.

Peterson (1981) believed that summer wolf predation rates were lower than those of winter. Studies of two wolf packs elsewhere in GMU-13 suggested that predation rates were equal or greater than those observed during winter. We suggest that the low summer rate for the Watana Pack was the result of poor visibility and not having radio-contact with the alpha male.

During the 45-day study, radio-collared wolves from the main Watana Pack were only observed on 55 percent of the occasions they were located away from the den site (presumed hunting). Therefore, on the 45 percent of the occasions when the wolves were unobservable, they could have been present at a kill which in all likelihood also would not have been unobservable. Unfor-

tunately as the study proceeded, it became obvious that the alpha male was not radio-collared. During earlier studies (Ballard et al. 1981a, b) it had been determined that whenever a large ungulate was killed during the denning season, the alpha male was always present. Therefore we believe the kill data grossly under-represents the food habits of the Watana Pack. Poor observability and lack of having enough members radio-collared did not, however, hamper efforts at determining the food habits and predation rates for a non-denning pack.

From 10 May through 28 May 1981, wolves 310 (adult male), 344 (yearling male) and 345 (yearling male) functioned as a distinct pack away from the main Watana Pack from which they had dispersed (Table 25). Prior to wolf 310 visiting the Susitna den, the three adult wolves were observed on a total of 4 kills over a 19 day period; kill rate of 1/4.8 days. The kills were comprised of 2 adult moose, 1 yearling moose, and 1 calf moose. In addition, the wolves were observed attacking a cow moose with twin yearlings, but were unable to confirm whether they in fact made the kill. Based upon the observed kill rate, this pack of three adults had available 819.5 kgs of edible prey or 43 kgs/day (14.4 kg/wolf/day). This particular set of data do not support the hypothesis of smaller packs having lower predation rates.

A controversy exists in the literature concerning the predation rates of packs of various size. Peterson (1977) maintains that predation rates for packs of 9 or more individuals remain constant. Ballard et al. (1981) demonstrated that pack size of from 2 to 9 individuals did have differing predation rates. If large packs (15 individuals) do in fact have higher rates of predation than smaller packs, the significance of wolf preation to an ungulate population could differ from pack to pack and could have a pronounced effect on how managers manipulate wolf populations. More predation rate data on packs of various sizes is needed before this controversy can be resolved. For purposes of this report, we assumed a year-round predation rate of 1 kill/5.0 days.

Wolf Territories, Population Numbers, and Numbers to be Impacted by the Project.

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

Table 26 summarizes territory sizes for the six wolf packs which have been intensively investigated for Susitna hydroelectric studies. Territory sizes for the six packs averaged 545 mi^2 (1414 km^2) which was almost identical with sizes determined for other wolf packs in GMU 13 (Ballard et al. 1981).

Figure 4 depicts the spatial arrangement of known and suspected wolf territory boundaries in the project area during 1980 and 1981. Based upon track counts, public sightings, and radio locations of radio-collared packs and previous studies, at least six and perhaps seven wolf packs occupy portions of the Susitna River which would be directly impacted by the Devil Canyon or Watana impoundments. The packs are Portage Creek Pack, Watana Pack, Upper Talkeetna or Stephan Lake Pack, Jay Creek Pack, Tyone Creek Pack, Talkeetna River Pack and the Devil's Canyon Pack.

Additionally, two packs (Fish Lake pack and the Susitna-Sinona pack) were in part the result of dispersal from the aforementioned packs. Had these packs been at reduced densities, these dispersals may not have occurred and these pack areas could have remained vacant. It is interesting to note that even under the intensive harvest pressure exerted by ADF&G personnel from 1976-78, not all wolves were removed from along the Susitna River. At that time it was suggested that wolves occupying the Susitna

Table 26. Summary of territory sizes for wolf packs studied as part of the Susitna Hydroelectric Project studies during 1980 and 1981 in southcentral Alaska.

Area	Territory Size	
	mi 2/	(km 2/)
Fish Lake	346	943
Susitna	561	1,453
Susitna-Sinona	466	1,208
Tolsona	981	2,541
Tyone Creek	364	943
Watana	534	1,383
$\bar{x}$	545	1,412
S. D.	209	541

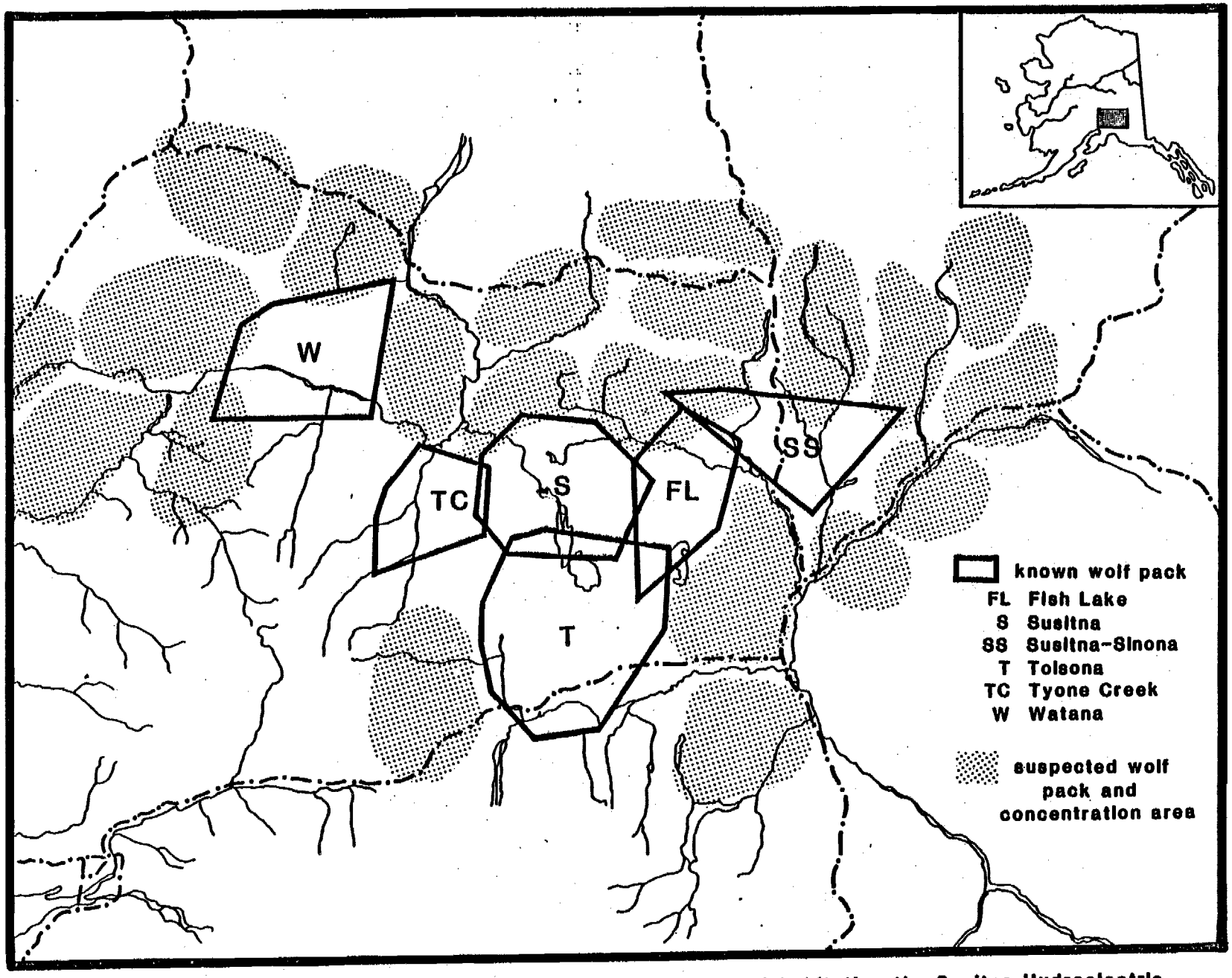


Figure 4. Suspected locations and territorial boundaries of wolf packs inhabitating the Susitna Hydroelectric Project area during 1980 and 1981.

River bottomlands provided a reserve population for emigration into areas where harvesting either eliminates packs or severely reduces population density (Ballard and Spraker 1979:57).

Wolf territories were essentially nonoverlapping during the course of any particular year (Ballard et al. 1981). What overlap did occur was either seasonal in nature or was the result of the manner territories were plotted.

Numbers of wolves estimated to occur in 13 wolf packs known to occur in the study area are presented in Table 27. Spring 1980 and 1981 estimates represent the post-hunting population while those in fall represent gains due to reproduction and dispersal prior to hunting and trapping losses. Because the Susitna River frequently serves as a travel corridor and a concentration area for wolf packs, inundation will probably cause a drastic reduction in wolf numbers due to both direct loss of prey, loss of escape cover from hunting and trapping activities, and loss of habitat. Six to seven wolf packs would be directly impacted by the project due to those factors.

Figure 5 compares the distribution of known and suspected wolf packs occupying the Susitna and Nelchina River Basins with the documented locations of radio-collared caribou from the main body of the Nelchina herd, located during 1980 and 1981. (Note: boundaries and suspected existence of wolf packs west of Kosina and Deadman Creeks are the least reliable of data presented).

Since wolves depend upon caribou for from 20 to 30 percent of their annual diet, any disruption of caribou migration or reductions in herd size due to the proposed project potentially could severely impact wolves in most of Game Management Unit 13 and in the west half of Game Management Unit 11. Of the 24-26 packs known to be present in GMU-13 in fall 1980, 6 to 7 packs would be directly impacted and an additional 15 packs could be adversely affected by reductions in either caribou numbers or migration of the main Nelchina herd as a result of the project. If caribou

Table 27. Estimate of numbers of wolves by individual pack inhabiting the Susitna Hydroelectric study area in spring and fall 1980 and 1981.

Pack Area	Spring 1980 (Post Hunt)	Fall 1980 (Prehunt)	Spring 1981	Fall 1981
Butte Lake	3-4?	3-4+	3	5
Fish Lake	?	2	9	12+
Jay Creek	6	7-8?	?	10
Keg Creek	?	?	2-3	2-3
Maclaren River	2	4-5	?	2-3
Portage Creek	?	?	?	6
Stephan Lake	2+	11	?	?
Susitna	4	10	5	4
Susitna-Sinona	4	4-5	2	?
Tolsona	9	16	13	15
Tyone Creek	4	2	0	?
Upper Talkeetna River	?	?	?	2
Watana	5	14	8	14
Total	40	77	42-43	72-74

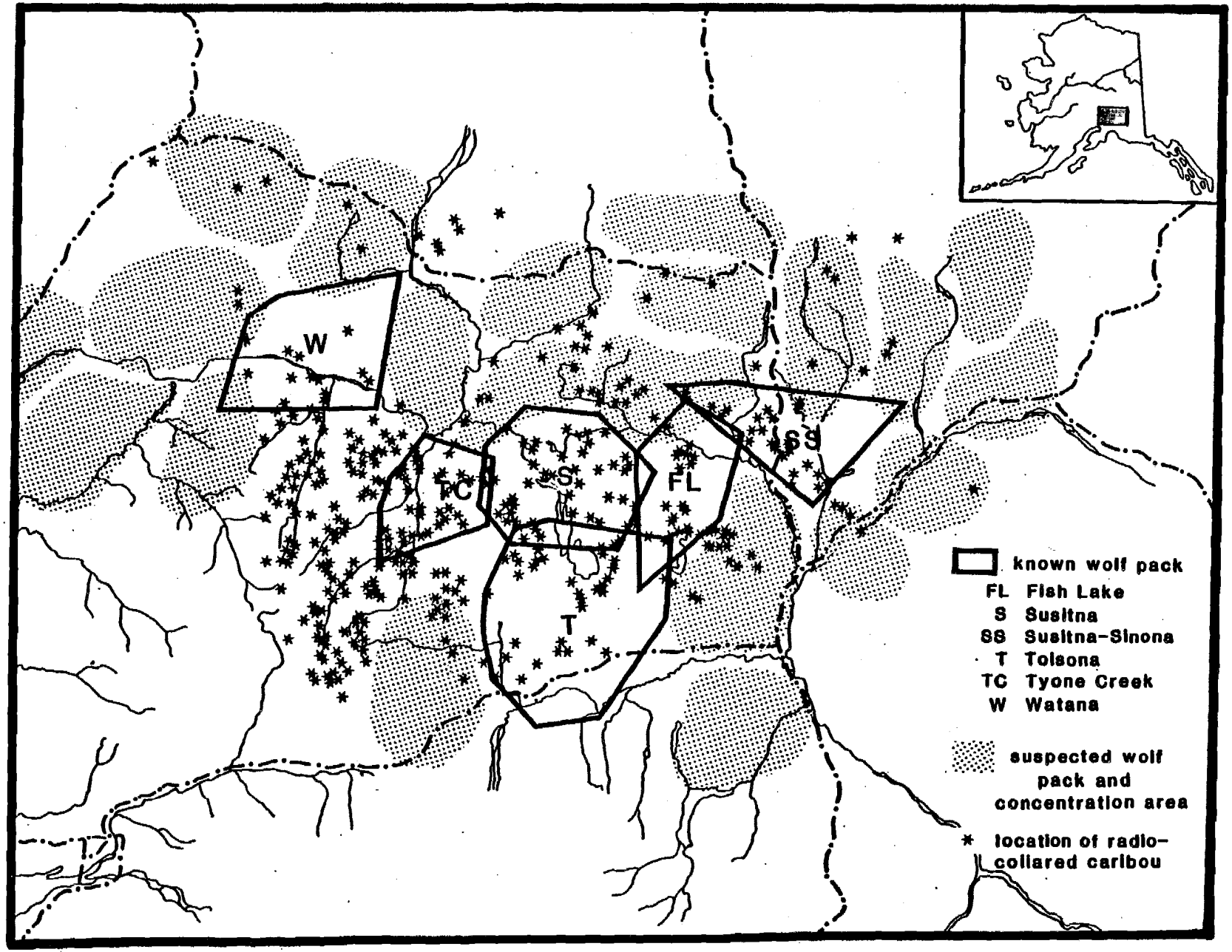


Figure 5. Distribution of main Nelchina radio-collared caribou, 14 April 1980 through 29 September, 1981 (from Pitcher 1981) in relation to known and suspected wolf packs and concentration areas within the Susitna and Nelchina River Basins of southcentral Alaska (from this study and Ballard et al. 1981).

subherds were severely impacted by the project, the approximate number of wolf packs which could be impacted can be determined from Figure 5.

Migration and movement patterns of moose are compared with known and suspected wolf territories in Figure 6. In addition to the six or seven packs which would directly be impacted by the project, a minimum of 7 to 8 additional wolf packs would be indirectly affected by either disruption of moose movements and migration and/or reductions in moose density. These impacts could be severe since wolves depend on moose for 60 to 70 percent of their annual diet. In summary, 6 to 7 wolf packs would be directly impacted by the project, an additional 7-8 packs would be indirectly impacted by either reductions in density or movements of either moose or caribou, and an additional 7-8 packs could be indirectly impacted by reductions in numbers or distribution of caribou.

Impacts of Wolves on Moose and Caribou

Based upon an intensive census of the study area in fall 1980 (Figure 7) we estimate that a portion of the wolf study area contained 1,985 moose (see Upstream Moose Report). They are censused roughly corresponds to an area which would be occupied by five wolf packs. Using the census and stratification moose data and our estimate of five wolf packs, we attempted to assess the importance of wolf predation to the study area moose population. We assumed that each pack made an ungulate kill once every 5 days and that from 60 to 70 percent of the kills were comprised of moose, 32 percent of which were calves. Based upon these assumptions we estimated that wolves were annually preying upon 11 to 13 percent of the study area's fall moose population. Percent mortality of calves present in fall ranged from 16 to 18 percent while mortality on adults of both sexes ranged from 10 to 11 percent. It should be pointed out that these calculations are based on a prey base present in November and thus the mortality figures are slightly inflated.

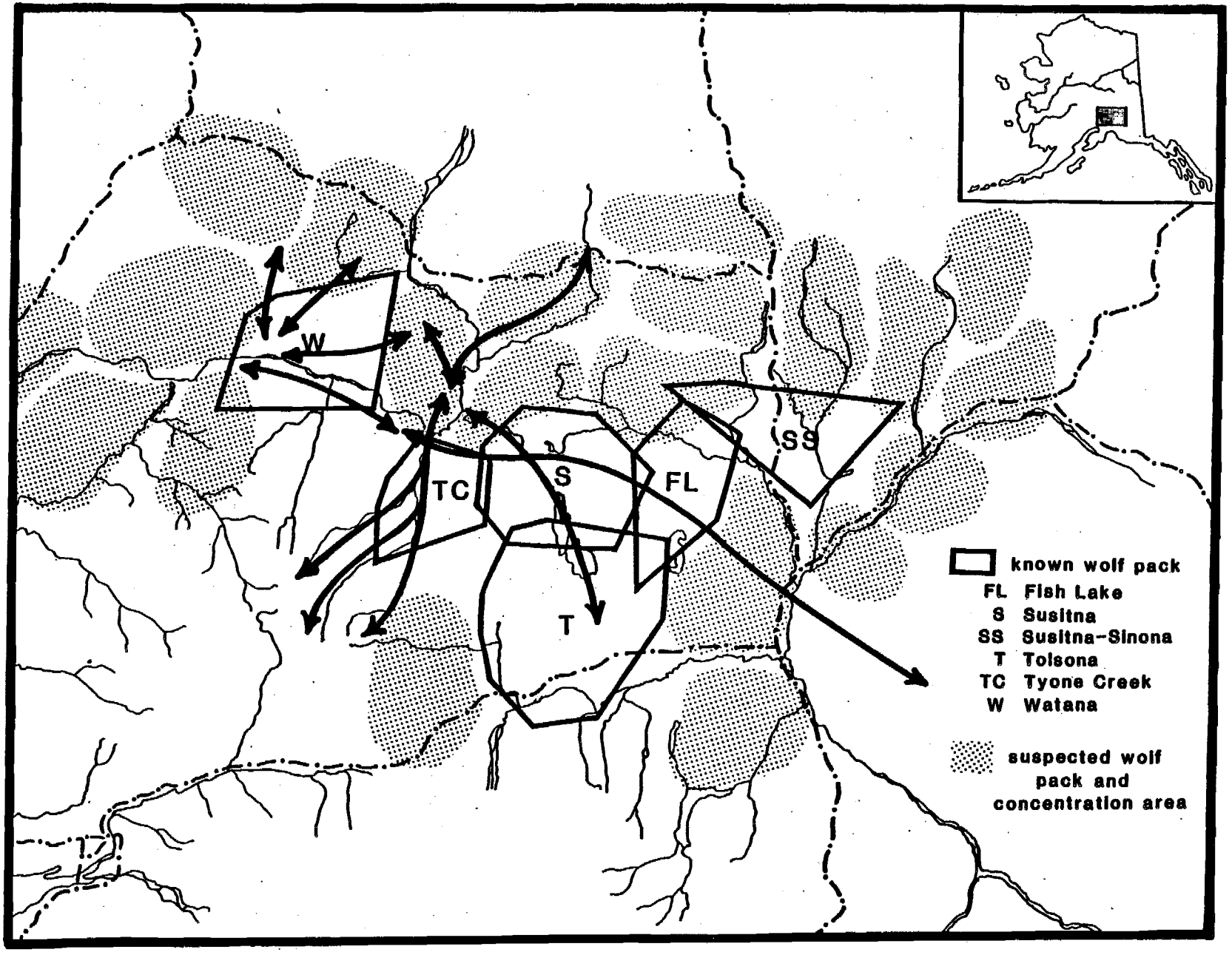
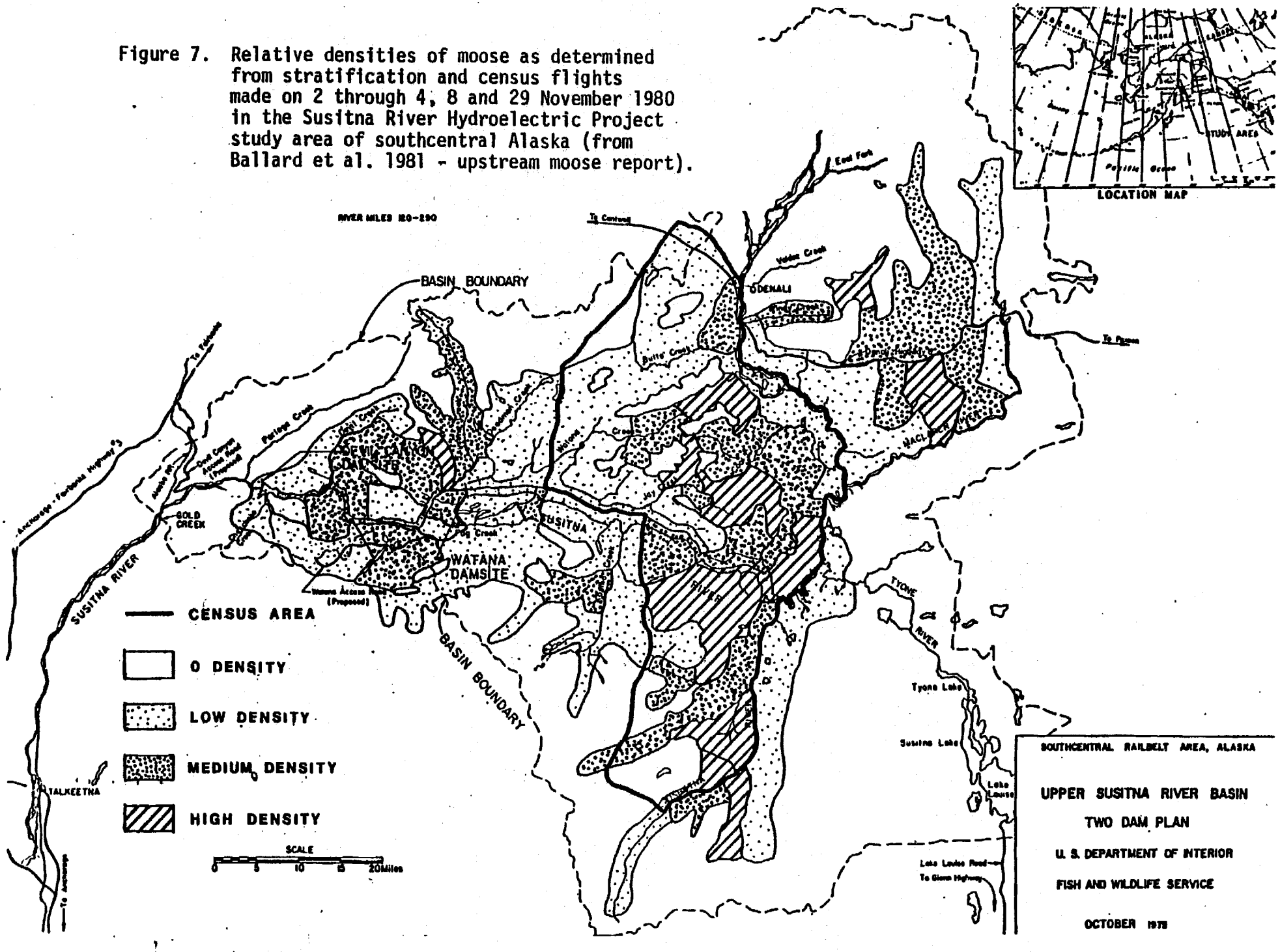


Figure 6. Migration routes and movement patterns of radio-collared moose in the Susitna and Nelchina River Basins (from Ballard and Taylor 1980; Ballard and Gardner 1981, 1981a; Ballard et al. 1981) in relation to known and suspected wolf territories (from this study and Ballard et al. 1981a).

Figure 7. Relative densities of moose as determined from stratification and census flights made on 2 through 4, 8 and 29 November 1980 in the Susitna River Hydroelectric Project study area of southcentral Alaska (from Ballard et al. 1981 - upstream moose report).



Based upon calf and yearling mortality studies conducted in and adjacent to the Susitna Study Area, it was estimated that between 9 to 24 percent of the fall calves were succumbing to wolf predation. This estimate obviously falls within that range.

Appendix D contains a copy of the yearling moose mortality study which provided an estimate of first year calf mortality ranging from 22 to 84 percent depending upon the magnitude of bear predation, wolf predation and winter kill.

Determining the level of wolf predation on caribou for the study area required a slightly different approach because of the seasonal nature of caribou distribution. Caribou population numbers between 1973 and 1981 were extrapolated by assuming a linear relationship by year from a low of 10,000 animals in 1973 to a high of 22,000 animals in 1981 (Pitcher, pers. comm.). We estimated the impact of wolf predation on caribou by assuming that 25 wolf packs occur within the range of the main Nelchina herd and its subpopulations in 1981. We also estimated a mortality rate for 1973 and 1976 when the Nelchina herd numbered approximately 10,000 and 14,500 animals, respectively and assumed that approximately 45 wolf packs occurred in the Unit during those years. Further, we continued to assume a year-round predation rate of 1 kill/5.0 days and that caribou comprised 20 to 30 percent of the annual diet. No separation between calf and adult caribou was made because existing wolf data do not suggest selection of the calf age class. Based upon these assumptions, we estimated that in 1973 when the Nelchina herd reached a record low of approximately 10,000 animals and approximately 45 wolf packs occurred in the Unit, wolf predation was estimated to account for from 7 to 10 percent annual mortality. In 1976 when the caribou population numbered approximately 14,500 and assuming 45 wolf packs, caribou losses due to wolf predation were estimated at 5 to 7 percent. If only 25 packs had been present in the 1976 such as in 1981, total caribou annual mortality due to wolf predation would have ranged from 5 to 7 percent depending upon weather caribou comprised 20 or 30 percent of the wolf diet.

In 1981 with the herd at approximately 22,000 animals and with 25 wolf packs present in its range, we estimate current caribou annual mortality due to wolf predation to range from 2 to 3 percent.

Wolf Hunting-Trapping Mortality

Table 28 summarizes wolf harvests for GMU-13 from 1971-72 through 1980-81 seasons. During this period, annual harvests ranged from 46 to 128 wolves. Method of harvest was classified into four categories: (1) trapped (snared or leg-hold trap), (2) ground shot which usually involves landing aircraft and shooting same day airborne, (3) experimental removal by ADF&G from 1976-1979, and (4) other-which includes miscellaneous forms of mortality such as auto collision and natural mortality. Aerial hunting (shooting from fixed-wing aircraft) was legal only in 1971-72.

From 1971-72 through 1975-76 ground trapping was the most common method of harvesting wolves in GMU-13, accounting for 59 percent of the total harvest. From 1976-77 through 1978-79 ground shooting (primarily hunting from aircraft) was the most common method of harvest. In 1980-81 trapping again was the most prevalent harvest method due to both poor snow conditions which did not allow wolves to be tracked from airplane and reduced wolf densities.

Figures 8 through 12 depict the kill locations of wolves harvested from regulatory year 1976-77 through 1980-81 for both GMU's 13 and 11. For all packs which would be directly influenced by inundation of portions of wolf pack territories, the harvests by year were as follows: 1976-77 - 16, 1977-78 - 21, 1978-79 - 1, 1979-80 - 11, 1980-81 - 5.

Den Sites

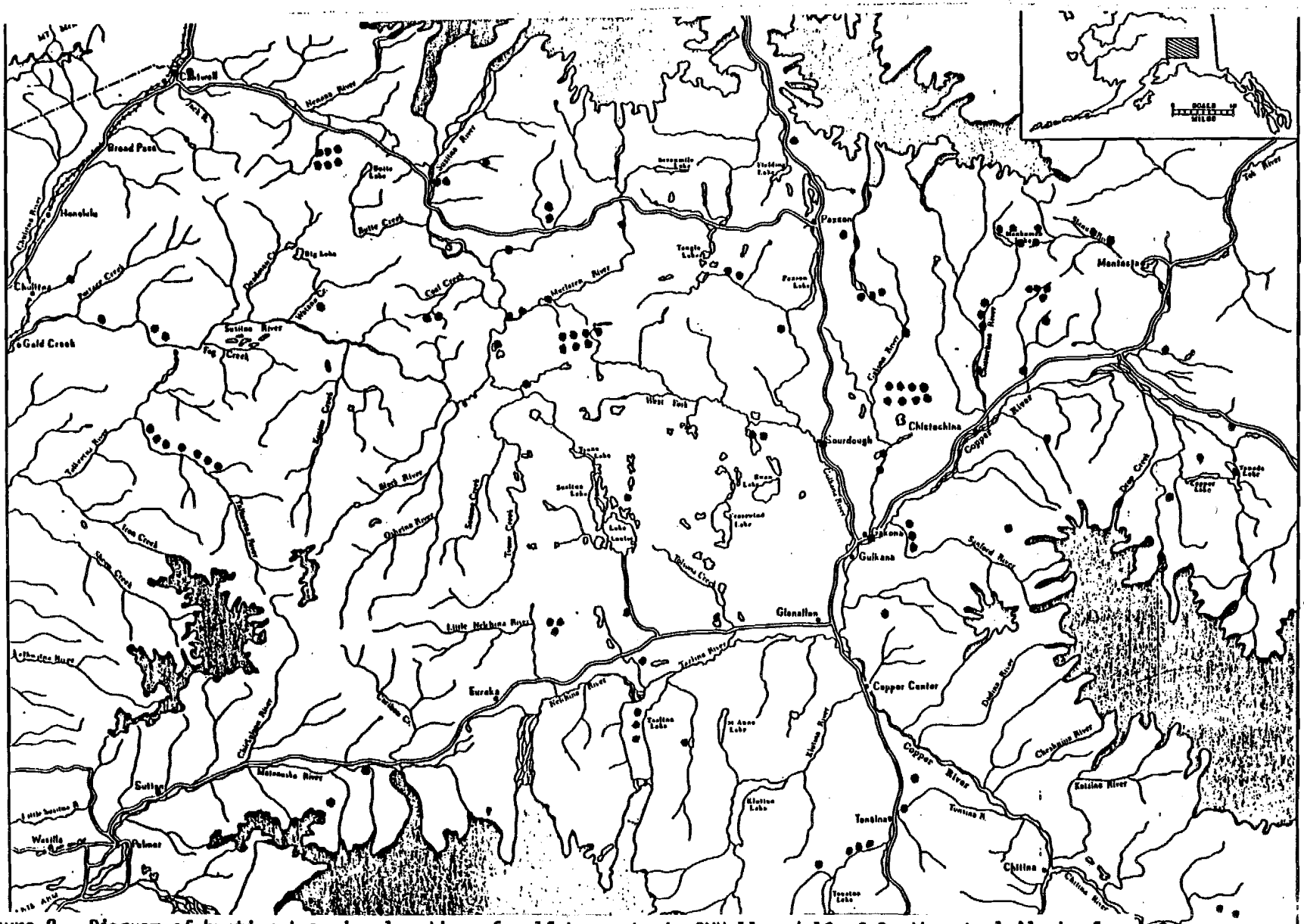
General location of both den and rendezvous sites located from 1975 through 1981 in GMU-13 are depicted in Fig. 13. Because

Table 28. Summary of reported wolf harvests for Game Management Unit 13 of southcentral Alaska by method of take from 1971 through 1980-81 season.

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

Table 28. (cont'd)

Harvest year	Method of take	GMU 13 Subunits 13A	13B	13C	13D	13E	Subunits unreported	Sub-totals	Totals
1979-80	Trapped	11	1	10	9	4		35	
	Ground shot	1	3	2	3	11		10	
	Other	2	0	0	0	0		2	57
1980-81	Trapped	7	2	5	9	7		30	
	Ground shot	3	1	2	1	9		16	
	Other	0	0	0	0	0		0	45



igure 8. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1976-77 regulatory year.

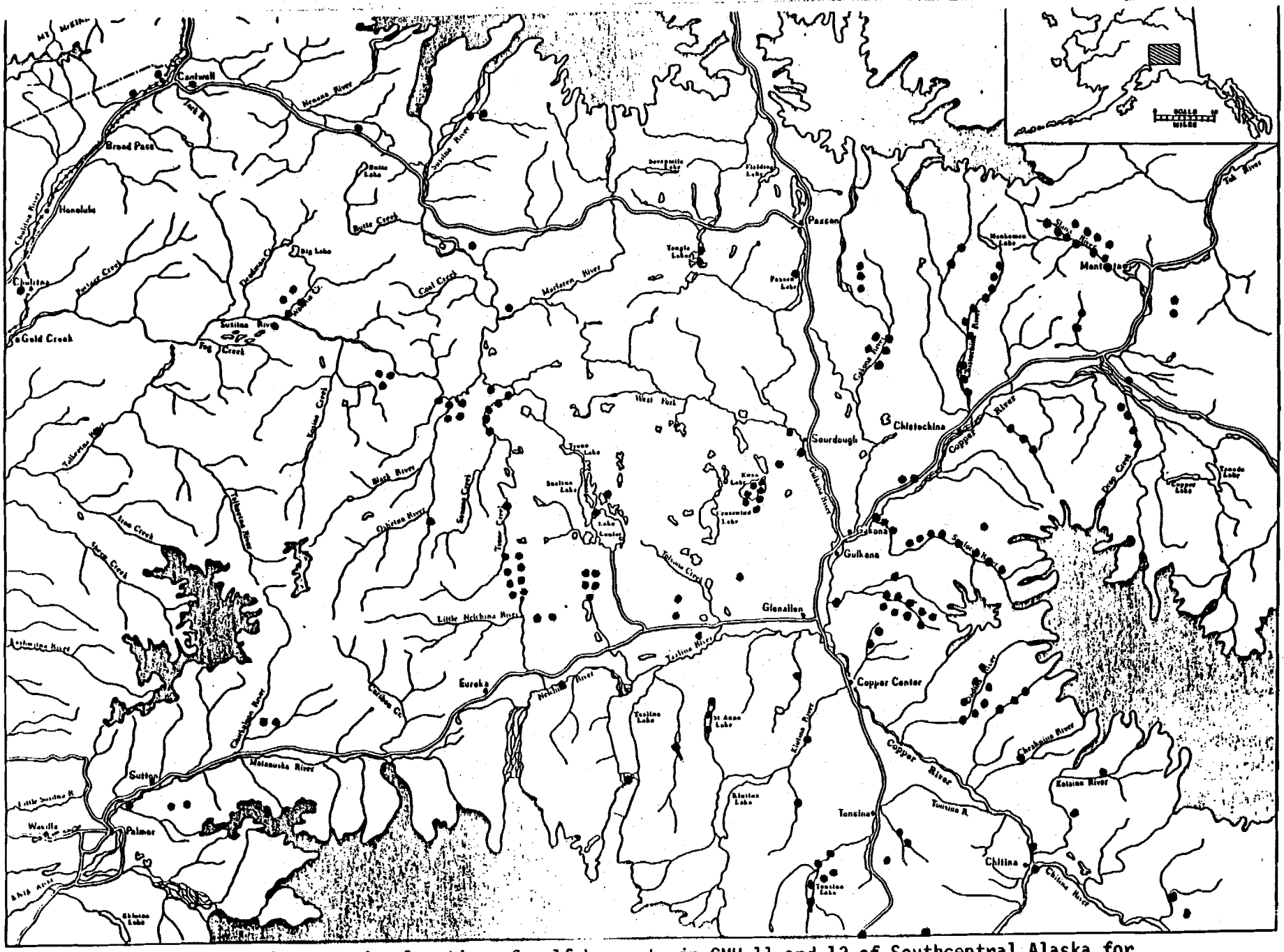


Figure 9. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1977-78 regulatory year.

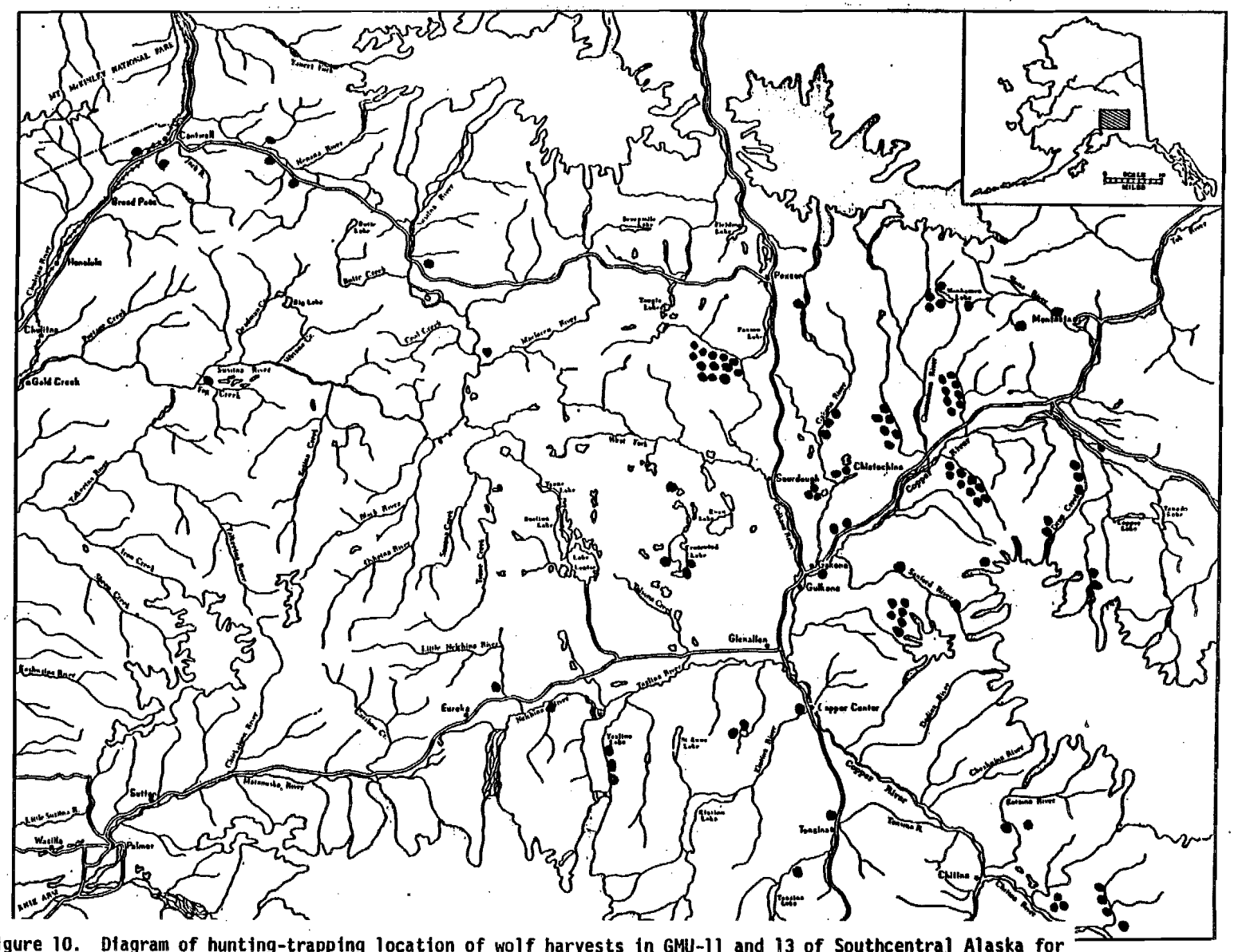


Figure 10. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1978-79 regulatory year.

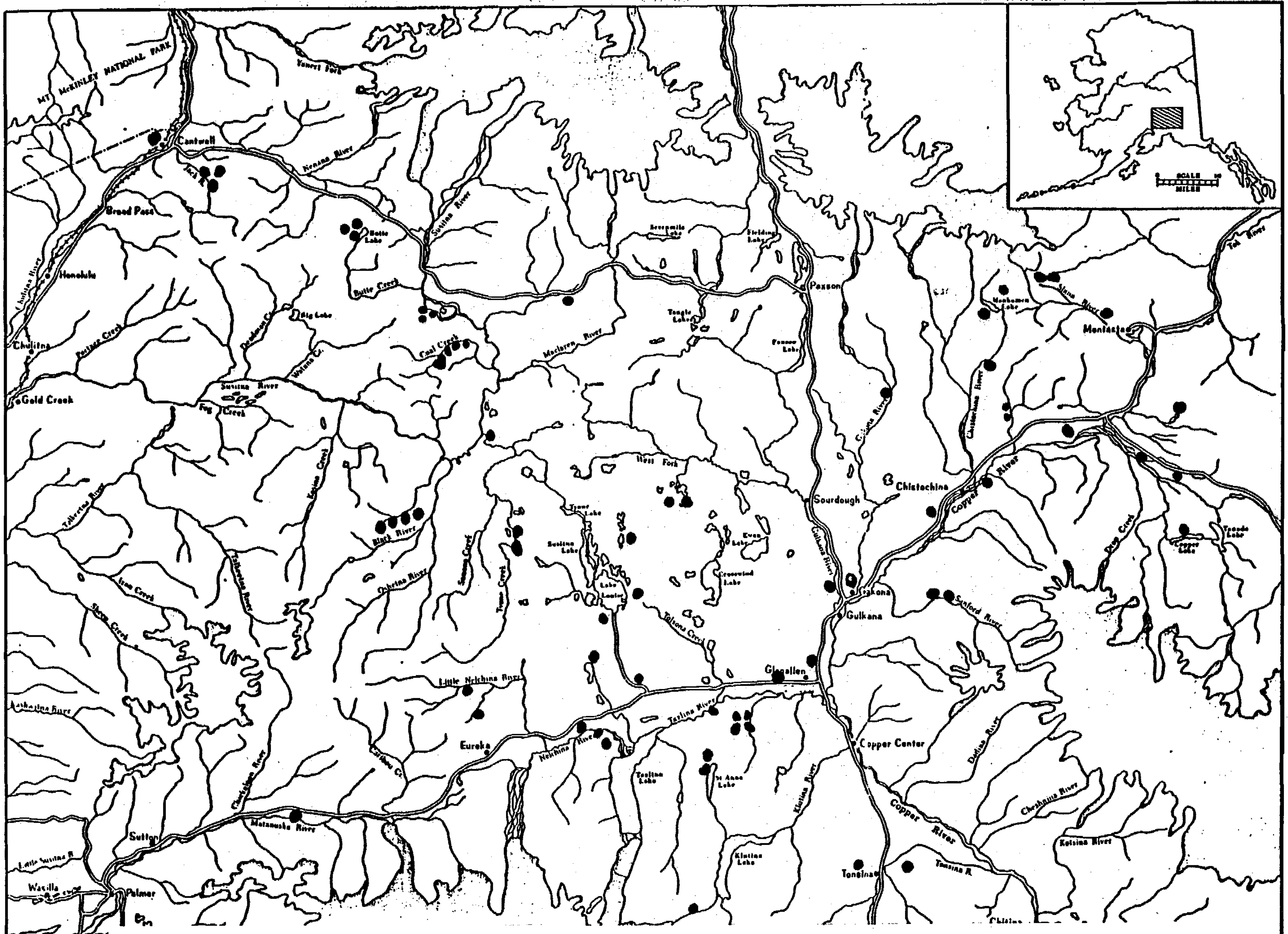


Figure 11. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1979-80 regulatory year.

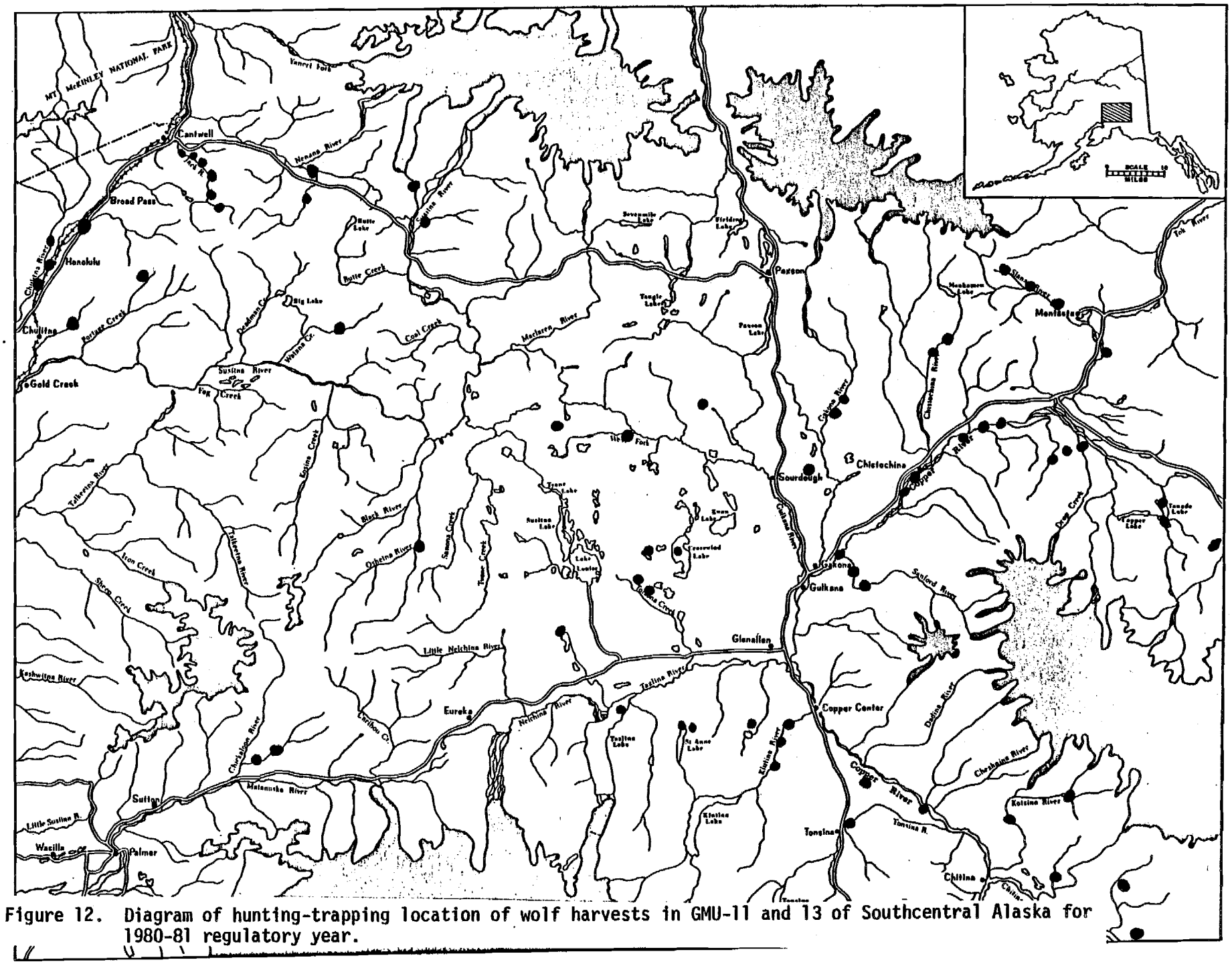


Figure 12. Diagram of hunting-trapping location of wolf harvests in GMU-11 and 13 of Southcentral Alaska for 1980-81 regulatory year.

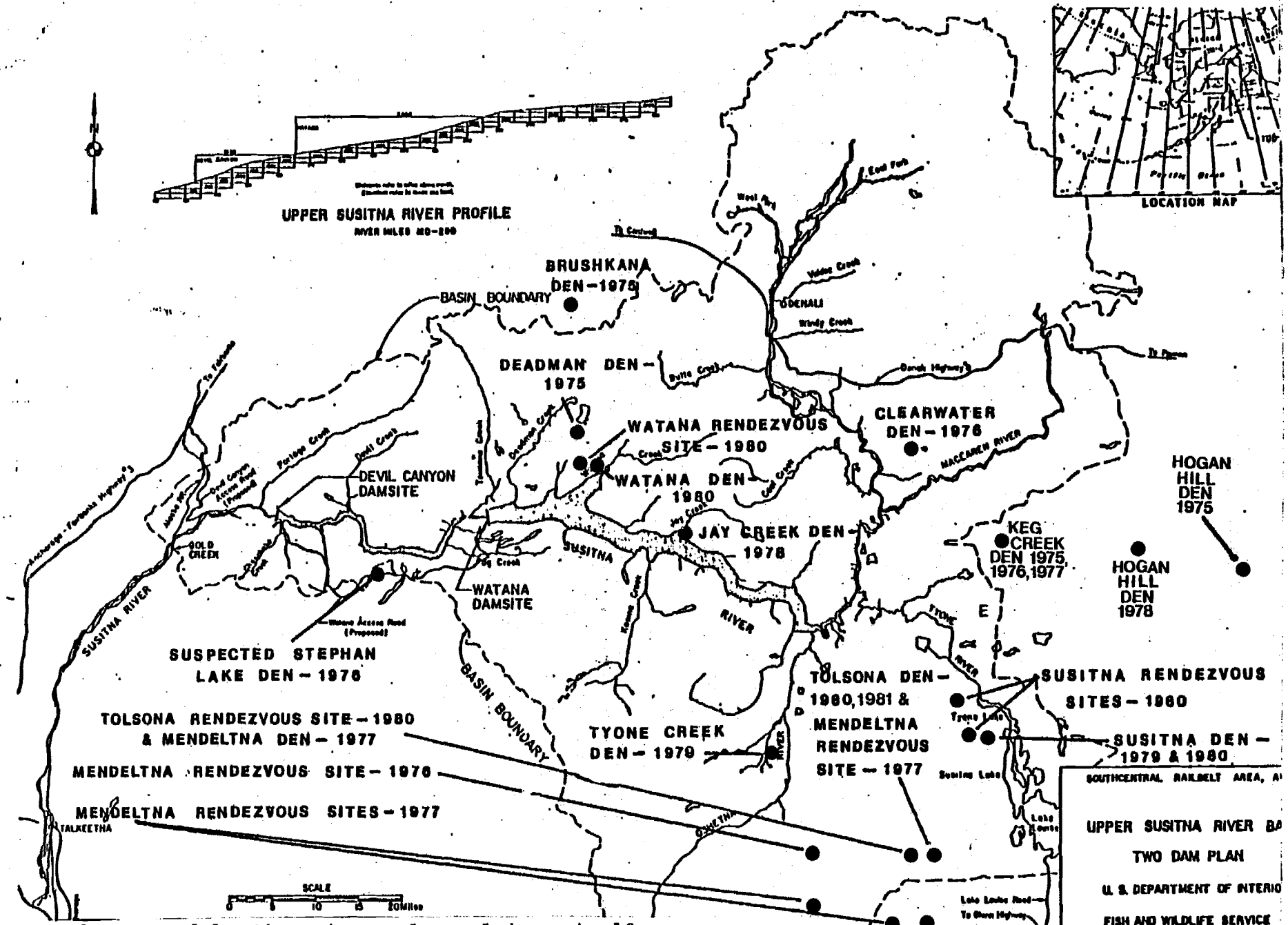


Figure 13. General location and year of use of observed wolf den and rendezvous istes discovered in the Susitna Hydroelectric Project area from 1975 through 1981.

some misinformed individuals believe wolf pups make desirable pets, more specific descriptions of den and rendezvous site locations will not be provided in these reports. This information will be retained on file in the Glennallen office and will be provided to project personnel upon request.

Many of the sites depicted in Fig. 13 have not been examined on the ground. Specific site descriptions are presented in Tables 29 through 31.

Den and rendezvous site usage by wolves in GMU-13 was fairly traditional. Of the 23 sites examined at least 6 have been used a minimum of 3 seasons. Several have been used during two seasons since 1975. The average elevation of the 23 sites was 2,550 feet (S.D.=360) ranging from 2,000 to 3,600 foot elevation. Most den sites were old red fox (*Vulpes vulpes*) dens which had been dug out by wolves. Most sites consisted of 3 to 4 large holes which generally measure from 33 to 54 cm high by 39 to 60 cm wide. Most sites are also characterized by the presence of several small holes (measuring from 15 to 29 cm wide) which are commonly referred to as pup holes but which are rarely, if ever, used. Most sites were located on slightly elevated areas with sandy soil providing good drainage. Although we found that holes were oriented towards all ordinates of the compass, most (x^2-16.50, $P<.01$) were found on south to and/or east exposures.

Thirteen of the sites we examined contained what we termed "whelping chambers" which were usually located at least several feet back from the main entrance and generally were 30 to 60 cm high, 76 to 152 cm wide and 89 x 152 cm deep. None of the chambers were lined as described by Haber (1968).

Table 32 summarizes the distances of discovered den and rendezvous sites from the upper water level of both the Devil's Canyon and Watana impoundments. Four den and 1 rendezvous sites occur within 5 miles of the average pool level of the reservoirs. The figure contained in Table 21 must be considered absolute minimums

Table 29. External characteristics of wolf den and rendezvous sites examined in GMU-13 of southcentral Alaska from 1976 through summer 1981.

Pack	Year Site Visited	Site Type	# Animals in Pack Adults	Pups	# Holes Lg.	Sml.	Years Site Known to be Used	Orientation of Holes	Elev. (ft.)	Soil Type	Proximity to Water (m)	Comments
Mendeltna	1976	Rendezvous (Old Man L.)	5	6	3	0	1976, 1977	N NE	2,700	Sand	Pothole Nearby	
Mendeltna	1976	Den (Old Man Lake)	5	6	4	1	1976, 1977	S	2,800	Sand, clay, gravel (tr.)	400	
	1977	Den (1st)	4	7	4	1						
Mendeltna	1977	Rendezvous (Kelly L.)	4	7	4	4	1977	N NE	2,900	Sand, clay tr.)	183	
Mendeltna	1977	(Nicholson Lake) Rendezvous	2	2	2	4	1977, 1980, 1981	SW	2,900	Sand with some gravel	69 (Pond) 274 (lake)	Elevated, flat, open area probably for sunning, were evident above each hole.
Mendeltna	1977	Den (2nd)	3	2	4	3	1977, 1980, 1981	E	2,850	Sand clay gravel (tr.)	50	
Tyone	1976	Den (Clearwater)	7	3	1	5	1976	S (5) N (1 pup hole)	2,700	Sand	NR[a]	
Susitna	1980	Den	4	6	3	4	1979, 1980, 1981	S	2,500	Sand	274 (pond)	
Susitna	1980	Rendezvous	4	6	3	6	1980	S	2,475	NR	46 (swamp) 183 (lake)	
Watana	1980	Den (lower holes)	3	6	1	1 (+2 unused fox holes)	1980, 1981	S	2,300	Sand	15 (standing water)	
Watana	1980	Rendezvous	3	6	2	0	1980	E	2,450	Sand	15 (standing water)	

Table 29. (cont'd)

Pack	Year Site Visited	Site Type	# Animals in Pack Adults	Pups	# Holes Lg.	# Holes Sml.	Years Site Known to be Used	Orientation of Holes	Elev. (ft.)	Soil Type	Proximity to Water (m)	Comments
Keg Creek	1976	Den	3	5	3 (dimensions of 3 holes not recorded)	2	1975, 1976, 1978	NR	2,625	Sand	Lake nearby	
Tolsona	1978	Den (Lake Louise)	3	8	2	5	1978, 1979	WSW	2,800	sand, clay	137 small pond	
Hogan Hill	1978	Den	7	5	2	1	1978	SE (2 lg) N (1 lg)	2,400	sand/clay	1000	
Hogan Hill	1978	Rendezvous	7	5	1	3	1978	SE	3,600	NR	600	
St. Anne's	1977 1978	Den (Long Lake)	8 7 (total)[b]	6	2	0	1976, 1977, 1979	SE	2,200	sand, clay	Creek nearby 1600 (lake)	
St. Anne's	1981	Den (Nickel Crk.) main den	3	6	4	0	1978, 1980, 1981	E (2)	2,250 NW (2)	sand	400 (pond)	Sand in floor of tunnel very powdery. Sand on floor of chamber very hard.
St. Anne's	1981	not used	-	-	2	0	unknown	NE	2,250	sand	300 (pond)	
Sinona	1976	Den #1	11	9	1	0	1975, 1976	NW	2,300	sand, clay		Adjacent to pond Beneath large spruce tree.
Sinona	1977	Den (1st Gakona)	2	6	3	1	1977	SW	2,000	sand, clay	NR	

Table 29. (cont'd)

Pack	Year Site Visited	Site Type	# Animals in Pack Adults	Pups	# Holes Lg.	Sml.	Years Site Known to be Used	Orientation of Holes	Elev. (ft.)	Soil Type	Proximity to Water (m)	Comments
Sinona	1978	Den (2nd Gakona)	4	6	2	3	1978	SW	2,000	NR	69 (stream)	

a NR = Not recorded
b Number of pups and adults not distinguished.
c Number of individuals at each site not determined.

Table 30. Dimensions of hole entrances and chambers for wolf den and rendezvous sites examined in GMU-13 of southcentral Alaska from 1976 through 1981.

Pack	Year Visited	Site Type	# Animals in Pack Adults	Pups	$\bar{x}$ Height (cm) by $\bar{x}$ Width (cm) of Hole Entrances Lg.	Sml.	Height (cm) x Width (cm) x Depth (cm) of Chambers	Comments
Mendeltna	1976	Rendezvous (Old Man L.)	5	6	38 x 41 s = 2.9 4.0 n = 3	No external opening for any pup tunnels	28 x 76 x 122	Holes lined with wiregrass.
Mendeltna	1976	Den (Old Man L.	5	6	49 x 60 s = 3 14.1	15 x 20	61 x NR[a] x 107	No change between 1976 & 1977 for dimensions or number of holes.
	1977	Den (1st)	4	7	n = 4	n = 1		
Mendeltna	1977	Rendezvous (Kelly L.)	4	7	37 x 44 s = 3.4 9.5 n = 4	22 x 28 s = 6.4 3.6 n = 4	NR x 152 x NR	Some tunnels and chamber lined with bunchgrass and lowbush cranberry (Viccinium vitis-idea).
Mendeltna	1977	Rendezvous (Nicholson L.)	2	2	42 x 39 s = 4.9 4.2 n = 2	17.5 x 24 s = 3.7 11.2 n = 4	NR	Holes partially lined with wheat-grass, dwarf birch and fescue.
Mendeltna	1977	Den (2nd)	3	2	46 x 43 14.1 17.1 n = 4	25 x 33 s = 12.0 3.0 n = 3	NR	Two small holes not used. Two 2 small holes and 2 large holes lined with fescue, lowbush, cran-berry & birch.
Susitna	1980	Den	4	6	48 x 49 s = 2.0 7.0 n = 3	24 x 29 s = 3.8 5.8 n = 4	NR x 122 x 135	Two small chambers (48 cm high x 46 cm wide x 61 cm deep also located in tunnel system.

Table 30. (cont'd)

Pack	Year Visited	Site Type	# Animals in Pack Adults	Pups	$\bar{x}$ Height (cm) by $\bar{x}$ Width (cm) of Hole Entrances Lg.	Sml.	Height (cm) x Width (cm) x Depth (cm) of Chambers	Comments
Susitna	1980	Rendezvous	4	6	NR	NR	48 x 86 x 89	
Watana	1980	Rendezvous	3	6	35 x 57 s = 6.0 34.9 n = 3	0	66 x 128 x 99 67 x 116 x 145	Chambers not interconnected; both chambers were used though impossible to identify main chamber.
Keg Creek	1976	Den	3	5	53 x 50 s = 6.0 7.6 n = 3	28 x 38 s = 3.5 11.3 n = 2	NR x 112 x 69 NR x 142 x 69	Both chambers located within one complex of 3 holes. Complex of 5 holes did not include a chamber.
					44.7 x 47.3 s = 3.2 12.8 n = 3	30.0 x 237.2 s = 2.4 1.5 n = 4	24 x 40 x NR NR x NR x 54	
Watana	1980	Den	3	6				
Tolsona	1978	Den	3	8	36 x 51 s = 0 7.1 n = 2	21.6 x 20.2 s = 2.3 2.9 n = 1	NR	Two large holes thought to interconnect.
Hogan Hill Main Den	1978	Den	7	5	30 x 68 s = 0 7.1 n = 2	20 x 25 n = 1	46 x 152 x NR	
Hogan Hill	1978	Rendezvous	7	5	36 x 46 n = 1	25 x 30 s = 5.0 5.5 n = 3	NR	One "small" hole though to be 1 of 2 "main" holes.
St. Anne's	1977 1978	Den (Long Lake)	8 7 tot.[b]	6	44 x 42 s = 11.0 16.0 n = 2	0	46 x 152 x 122	Two holes interconnect at a point thought to be the chamber. Interior of den not lined.

Table 30. (cont'd)

Pack	Year Visited	Site Type	# Animals in Pack Adults	Pups	$\bar{x}$ Height (cm) by $\bar{x}$ Width (cm) of Hole Entrances Lg.	Sml.	Height (cm) x Width (cm) x Depth (cm) of Chambers	Comments
St. Anne's	1981	Den Nickel Crk. (main)	3	6	33 x 5 s = 3.8 14.1 n = 4	0	33 x 104 x 152 41 x 109 x 91	Holes not lined. Large roots bitten off.
St. Anne's	1981	unknown	3	6	54 x 54 s = 2.1 10.6 n = 2	0	36 x 122 x 122 41 x 142 x 71 61 x 91 x 61	Holes inter-connected chambers separated by a large pillar of earth. Small chamber separated from one of larger chambers by small pillar of earth. Holes not lined.
Sinona	1976	Den (1st)			33 x 53 n = 1	0	33 x 229 x NR	Pillar of earth located in center of chamber.
Sinona	1976	Den (2nd)	11[d]	9[d]	0	30 x 30 n = 1	NR x 91 c 122	
Sinona	1977	Den (1st Gakona)	2	6	39 x 52 s = 1.7 5.1 n = 3	28 x 33 n = 1	NR	
Sinona	1978	Den (2nd Gakona)	4	6	36 x 54 s = 7.8 9.2 n = 2	18 x 28 s = 7.8 9.2 n = 3	NR	Porcupine scats in all holes.

a NR = Not Recorded
b Number of pups and adults not distinguished.
c This chamber probably was not the whelping chamber though it was used during 1981.
d Number of wolves at each den site not distinguished.

Table 31. Characteristics of vegetation of wolf den and rendezvous sites examined in GMU 13 of southcentral Alaska from 1976 through 1981.

Pack	Year Visited	Site Type	Pack Size Adults	Pups	% Cover Overstory	Overstory Composition	% Cover Understory	Understory Composition
Mendeltna	1976	Rendezvous	5	6	NR[a]	Black Spruce (*Picea mariana*) (100%)	NR	Willows (*Salix* spp.) Dwarf Birch (*Betula nana* and *B. glandulosa*)
Mendeltna	1976	Den (Old Man L.)	5	6	95	Balsam Popler (*Populus balsamifera*) (90%) White spruce (*Picea glauca*) (10%)	100	Grasses (Poaceae) Fireweed (*Epilobium augustifolium*) Rose (*Rose acicularis*) Indian cabbage (*Heracleum lanatum*) Wild Celery (*Rumex* spp.)
Mendeltna	1977	Den (2nd)	4	7	95	Balsam Poplar (90) White Spruce (10)	100	Grasses Rose Fireweed Indian Cabbage
Mendeltna	1977	Rendezvous (Kelly L.)	4	7	10	Spruce (100)	90	Fescue (*Festuca* sp.) (50) Dwarf Birch (tr.) Wormwood (*Artemisia*) Rose (tr.) Crowberry (*Empetrum nigrum*) (20) Lowbush Cranberry (*Vaccinium vitis-ideae*) (20) Willow (tr.)
Mendeltna	1977	Rendezvous (Nickolson L.)	2	2	10	Willows (100)	70	Grasses (10) Labrador tea (*Ledum palustre*) Fescue (tr.) Rose (tr.) Dwarf Birch (40) Willows (20) Lowbush cranberry
Mendeltna	1977	Den	3	2	95	Aspen (90) Spruce (10)	100	Grasses (70) Rose (5) Fireweed (tr.) Indian cabbage (20)
Tyone	1976	Den	7	3	NR	NR	NR	Dwarf Birch

Table 31. (cont'd)

Pack	Year Visited	Site Type	Pack Size Adults	Pack Size Pups	% Cover Overstory	Overstory Composition	% Cover Understory	Understory Composition
Susitna	1980	Den	4	6	50	Aspen (40) Spruce (40)	NR	low aspen Soapberry (Sheperdia canadeusis) (tr.) Rose (20) Fireweed (20) Grasses (15) Aspen Highbush cranberry (Viburnum edule) Crowberry
Susitna	1980	Rendezvous	4	6	Low Density	Aspen Spruce (55%)	NR	Low Aspen (10%) Soapberry (tr.) Rose (tr) Grasses (25%) Highbush Cranberry (10%) Lowbush Cranberry (tr.) Fireweed (tr.) Peas (Fabaceae) (tr.) Mosses (tr.) Cranberry (25%) Crowberry (25%) Blueberry (Vaccinium uliginosum
Watana	1980	Den (upper holes)	-	-	Low Density	Spruce (100%)	NR	Dwarf Birch (30%) Lowbush Cranberry (15%) Lichens/Sphagnum (10%) Crowberry (20%) Bearberry (Arctostaphylos spp.) Willows (tr.) Rose (tr.) Spruce Seedlings (tr.) Grasses (tr.) Labrador Tea (tr.)
Watana	1980	Den (lower holes)	3	6	Low Density	Spruce (100%)	NR	Dwarf Birch (30%) Blueberry (10%) Lowbush Cranberry (15%) Rose (tr.) Willow (tr.) Bearberry Bunchgrass (tr.) Crowberry (20%) Lichens & Mosses (10%) Labrador Tea (tr.) Birch (20%)
Watana	1980	Rendezvous	3	6	Medium Density	Spruce (100%)	NR	Dwarf Birch (20%) Blueberry (20%) Lowbush Cranberry (20%) Rose (tr.) Grasses (tr.) Fireweed (tr.) Lichens + Mosses (tr.) Crowberry (25%) Labrador Tea (tr.)

Table 31. (cont'd)

Pack	Year Visited	Site Type	Pack Size Adults	Pups	% Cover Overstory	Overstory Composition	% Cover Understory	Understory Composition
Keg Creek	1976	Den	3	5	Low Density in immediate area	Aspen	NR	Dwarf Birch Willow Grasses
Tolsona	1978	Den (Lake Louise)	3	8	40	Aspen (40%) Willow (30%) Spruce (20%)	90	NR
Hogan Hill	1978	Den	7	5	60	Aspen (70) Spruce (20) Willow (10)	70	Rose (5) Fireweed (30) Tea (5) Fescue (40) Lowbush cranberry (10)
Hogan Hill	1978	Rendezvous	7	5	90	Aspen (80) White spruce (5)	70	Tea (5) Rose (10) Aspen (10) Fireweed (20) Fescue (15) Lowbush cranberry (10)
St. Anne's	1977	Den (Long Lake)	8	6	50	Aspen (70) White Spruce (30)	80	Aspen (tr) Rose (20) Fescue (40) Lupine (Lupinus spp.) Fireweed (20) White Spruce Lowbush Cranberry (10)
St. Anne's	1978	Den (Long Lake)	7 tot.[b]					
St. Anne's	1981	Den (Nickel Crk.)	3	6	90	Aspen (75) White Spruce (25)	Sparse	Grasses Fireweed Rose Lowbush Cranberry Crowberry Lupine Dwarf Dogwood (Cornus candensis) Mosses
St. Anne's	1981	Den (Nickel Crk.) (2nd)	3	6	Low	Spruce (25) Aspen (75)	100	Grasses Fireweed Rose
Sinona	1976	Den #1			NR	Willow Paper Birch	Dense	Tea Current (Viburnum sp.) Rose Fireweed

Table 31. (cont'd)

Pack	Year Visited	Site Type	Pack Size Adults	Pups	% Cover Overstory	Overstory Composition	% Cover Understory	Understory Composition	
Sinona	1976	Den #2	11	9[c]	NR	White Spruce	Med. to Dense	Dwarf Birch	
Sinona	1977	1st Gakona Den	2	6	90	Aspen Spruce (tr)	75	Highbush Cranberry (10) Aspen (30) Spruce (5) Moss (tr.) Willow (tr.)	Lowbush Cranberry (30) Rose (10) Fireweed (10) Grasses (5) Blueberry (tr.)
Sinona	1978	Den (2nd Gakona)	4	6	NR	Aspen	NR	NR	

[a] NR = Not Recorded
[b] Numbers of pups and adults of distinguished.
[c] Number of individuals at each den site not determined.

Table 32. Summary of wolf den and rendezvous sites discovered from 1975 through 1981 occurring within a 50 mile radius of the proposed Susitna Hydroelectric Project in southcentral Alaska.

Miles from upper water-level	Site Pack Name - Type Site - Year of Documented use
5	Watana Rendezvous 80, 81
	Watana Den 80, 81
	Deadman Den 75
	Jay Creek Den 78
	Stephan Lake Den 76
15	Tyone Creek Den 79
20	Susitna Rendezvous 80
	Susitna Rendezvous 80
	Brushkana Den 75
25	Mendeltna Rendezvous 76
	Susitna Den 79 & 80
	Keg Creek Den 75, 76 & 78
	Clearwater Den 76
30	Tolsona Den 80 & Mend. Rend. 77
	Tolsona Rendezvous 80 & Mend. Den 77
35	Mendeltna Rendezvous 77
	Mendeltna Rendezvous 77
	Mendeltna Den 76, 77
40	Hogan Hill Den 78
50 +	Hogan Hill Den 75
	Sinona Den 78
	Sinona Den 77

because they pertain primarily to the area lying east of Deadman and Kosina Creeks. Further study effort is needed to locate potential and existing den sites in areas west of the above-mentioned creeks.

Most den sites discovered in GMU-13 were roughly centered within the observed territory, but several were located near territorial boundaries. Table 33 summarizes the annual distances between contiguous wolf dens discovered from 1975 through summer 1981. Average distances between den sites between years were quite similar from 1975 through 1981. Overall, for the years studied, the average distance between 38 natal dens was 28.1 miles (S.D.=8.4). This average distance compares favorably with the average distance of 25 miles computed by Stephenson and Johnson (1973) for the northcentral Brooks Range, Alaska.

Based upon the characteristics of den and rendezvous sites examined from 1976 through 1981 and the apparent abundance of such sites in the Unit, we do not believe that wolf den sites will ever become a limiting factor in the foreseeable future. Although an undetermined number of actual and potential wolf den and rendezvous sites will inundated as a result of the project, we believe that this impact to be of minor significance relative to the other identified impacts.

Summer Activity Patterns

Susitna Pack

From 1 May through 6 June activity patterns of the four adult members (two adults and two yearlings) of the Susitna pack were intensively monitored through a combination of ground observations, continuous 24 hour monitoring of radio signals from a permanent ground station, and periodical monitoring from fixedwing aircraft.

Table 33. Average distances between contiguous natal wolf dens from 1975 through 1981 in GMU-13 of southcentral Alaska.

Year of Use	Name of Continued Packs		Distance between Natal den mi.	km.
1975	Brushkana - Deadman		18.5	29.8
	Keg Creek - Hogan Hill		32.0	51.5
	Hogan Hill - Sinona		20.0	32.2
	Hogan Hill - Ewan		36.5	58.7
		$\bar{x}$	26.8	43.0
		s	8.9	17.5
1976	Clearwater - Keg Creek		19.0	30.6
	Mendeltna - St. Anne's		34.0	54.7
	Keg Creek - Deep Lake		21.0	33.8
	Mendeltna - Deep Lake		36.0	57.9
		$\bar{x}$	27.5	44.2
		s	8.7	14.0
1977	Mendeltna - St. Anne's		34.0	54.7
1978	Keg Creek - Hogan Hill		17.0	27.4
	St. Anne's - Tolsona		22.0	35.4
	Hogan Hill - Sinona		31.0	49.9
	Keg Creek - Jay Creek		41.5	66.8
		$\bar{x}$	27.9	44.9
		s	10.8	17.3
1979	Susitna - Tolsona		25.0	40.2
	Tyone - Susitna		26.5	42.6
	St. Anne's - Tolsona		22.0	35.4
		$\bar{x}$	24.5	39.4
		s	2.3	3.7
1980	Tolsona - Susitna		18.5	29.8
	Tolsona - St. Anne's		40.0	64.4
		$\bar{x}$	29.2	47.1
		s	15.2	24.5
1981	Tolsona - St. Anne's		40.0	64.4
Pooled Data		$\bar{x}$	28.1	45.3
		S.D.	8.4	13.6
		N = 19		

Two hundred twenty-seven hours of ground observations were made from a blind located on a ridge next to the den site. Presence or absence of radio-collared wolves at the den site during observation periods, which usually occurred from 0800 hours to 1600 hours, was determined by both scanning with a hand held antenna (Ballard et al. 1979) from the blind and by direct observation. Figures 14 through 16 visually depict the various family associations which were present at the den site according to hand held antenna locations. Of the three radio-collared wolves which were radio tracked from the blind, the adult female (#295) was present at the den site more often than either the adult male (#305) or the yearling female (#306) (Fig. 16). The most likely explanation for wolf 295's disproportionate presence at the den is due to nursing responsibilities. Ground observation suggested that parturition had occurred on 1 or 2 May and thus the pups were relying on female #295 for nourishment.

Figure 15 provides additional support that the alpha female (#295) occupied the den site more often than other pack members. These data suggest that although the alpha female spends more time at the den all adults share in spending time alone at the den with pups. Figure 15 suggests that on some occasions no wolves were present at the den. However, the radio signal from wolf 302 could not be received and thus this wolf's presence alone at the den may have accounted for the time gaps. The pattern for wolf 302 is expected to be similar to that of the other yearling (#306).

These data also suggest that the adult male (#305) spent the least amount of time at the den. Ballard et al. (1981) demonstrated that during the denning period adult males (or in this case the alpha males) were usually present when large ungulate kills were made. It can be inferred since wolf 305 spent the least time at the den, that much of his activity was associated with providing food for the pups. This was supported by aerial observations.

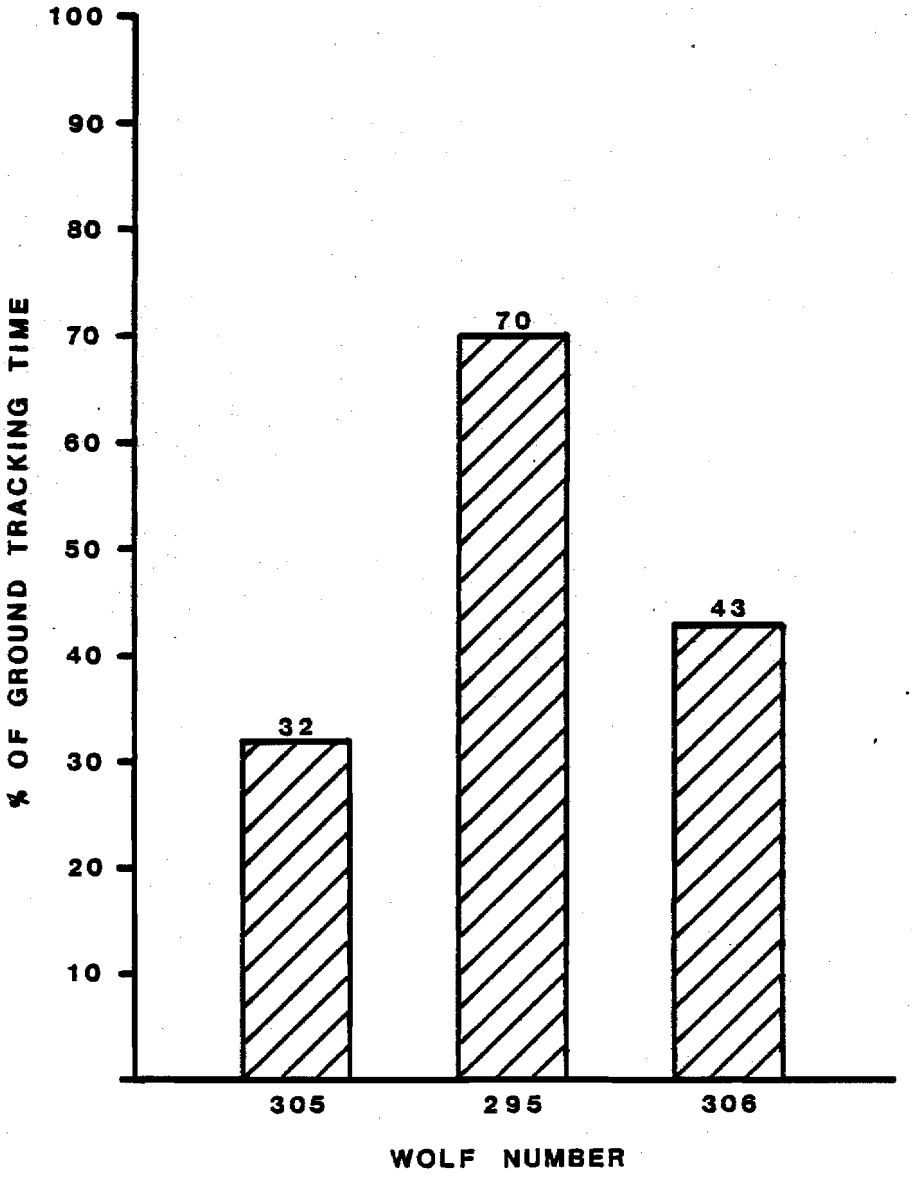


Fig. 14. Occurrence of three radio-collared wolves at the Susitna wolf pack den studied from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.

Fig. 15. Occurrence of lone adult wolves at the Susitna wolf den from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.

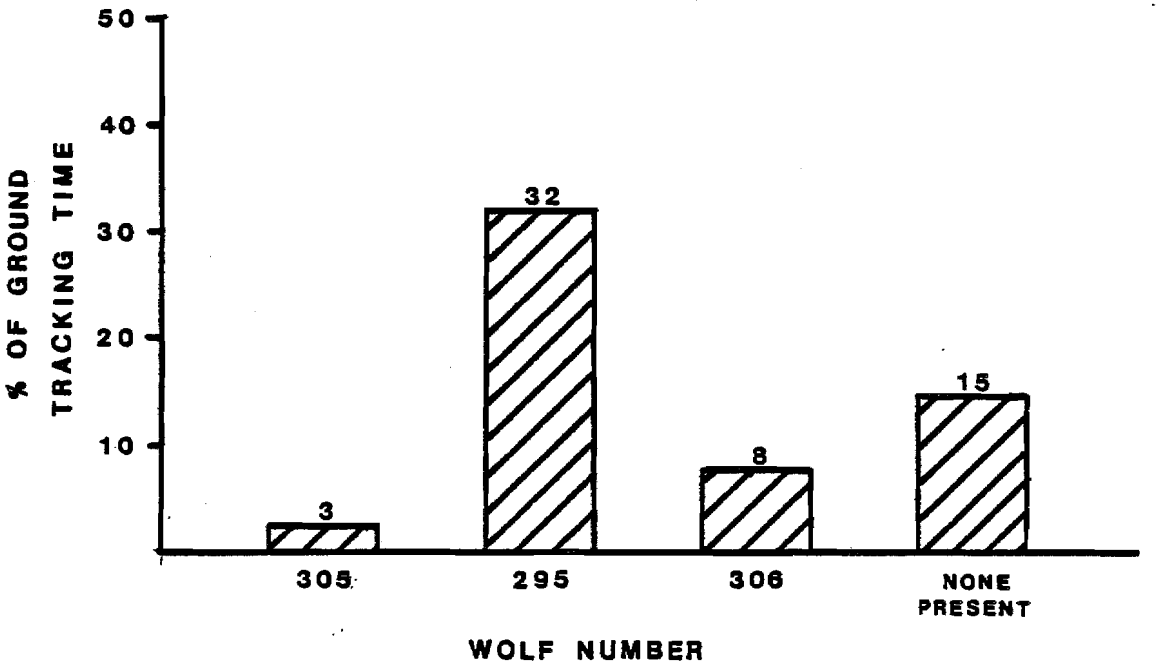
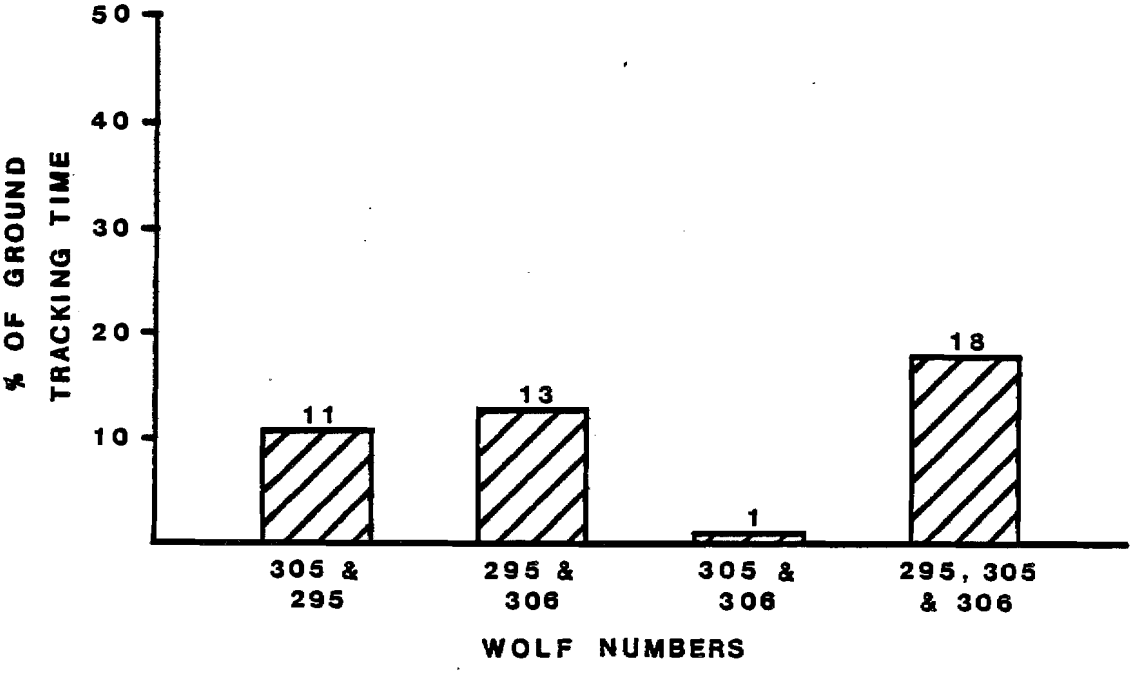


Fig. 16. Frequency of occurrence of adult wolf associations at the Susitna wolf den from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.



The den site is the focal point of wolf activity during the period of pup rearing. Fig. 16 depicts the association of various pack members while at the den. When more than one adult wolf was present at the den site, most often all three and probably all four adult wolves were present. Wolves 305 and 306 were most often absent from the den site. These data and those presented in Table 34 suggest that young adults were accompanying the adult male on hunting forays. The time of day at which these activities occur is pertinent to potential development activities which must occur close to den sites.

Continuous monitoring of signals from the permanent tracking station was not initiated until 19 May 1980 and was continued through 10 June. Comparison of ground observations with data collected on the recorder suggests that behavior of individual wolves was accurately displayed on the tape. However, ground observations were too infrequent to accurately truth all wolf activities. Also the design of the tapes does not lend itself to transfer onto computer. Thus each data point would have to be individually transferred onto computer, requiring hundreds of man-hours. Development of a tape which would allow easy transfer of data onto computer, would provide an enormous amount of data concerning wolf activity and could easily be related to energy budgets. Regardless, the techniques did allow the determination of the presence or absence of wolves at the den for 24 hour periods.

The presence or absence of the alpha female (#295) and male (#306) at the den site from 19 May through 10 June is depicted in Fig. 17. As expected, the female spent more time at the den site than did the male. These observations were also supported by ground and aerial observations (Table 34). Male 305 exhibited a pattern of remaining at the den site during mid-day hours but away from the den during evening and early morning hours. Ground observations suggested that wolf 306 exhibited a similar pattern of den occupancy. Aerial observations indicated that when away from the den, the pack was hunting. Similar to the pattern de-

Table 34. Chronological summary of Susitna radio-collared wolf observations conducted from fixed-wing aircraft in late May and June 1980 in conjunction with den site studies in GMU 13 of southcentral Alaska.

Date	Time	(Ob. No.)	I/D	Location	Activity
May 7	---	124	295	In den	Resting
		126	305	¼ mile NW	Resting
		127	302	¼ mile NW	Walking
		127	306	¼ mile NW	Walking
May 12	18:10	129	295	At den	Unobserved
	18:15	130	305	NW of den	Traveling
	18:15	130	302	NW of den	Traveling
	18:15	130	306	NW of den	Traveling
May 13	08:10	132	295	At den	Resting
	08:20	131	305	Approx. 12 mi NW	Resting
		131	302	Approx. 12 mi NW	Resting
		131	306	Approx. 12 mi NW	Resting
May 18	08:10	133	295	At den	Resting
	19:25	135	295	At den	Resting
	19:45	136	305	Approx. 10 mi NE	Resting by moose 50% consumed
		136	302	Approx. 10 mi NE	Resting by moose 50% consumed
		136	306	Approx. 10 mi NE	Resting by moose 50% consumed
May 19	14:45	134	295	At den	Resting
		134	305	200 yd NW of den	Traveling
		134	302	200 yd NW of den	Traveling
		134	306	At den	Resting
May 25	07:57	137	295	At den	Resting
		137	305	At den	Unobserved
		137	302	At den	Resting
		137	306	At den	Unobserved
	13:00	138	305	Approx. 16 mi SW	Just killed adult caribou (2 mi NW of Nelchina den)
May 30	07:02	139	295	At den	Resting
		139	305	At den	Resting
		139	302	At den	Resting
		139	306	At den	Resting
May 31	13:50	129	295	At den (100 yds West)	Resting
	13:55	140	306	Approx. 3 mi NW	Resting by moose kill
June 2	11:30	129	295	At den	Resting
		141	305	12 miles SW	Eating beaver
		142	302	¼ mile from den	Hunting beaver
		142	306		Hunting beaver

Table 34. (cont'd).

Date	Time	(Ob. No.)	I/D	Location	Activity
June 4	11:50	129	295	At den	Resting
		129	305	At den	Resting
		129	302	At den	Resting
		129	306	At den	One unidentified gray observed trotting away 600 yd west
June 6	10:21	143	295	At new den	Resting
		143	305	At new den	Resting
		143	302	At new den	Resting
		143	306	At new den	Resting
June 7	12:15	144	305	Approx. 8 mi SW	Beaver hunting area
June 10	12:15	143	295	At new den	Resting
		143	302	At new den	Resting
		143	306	No signal	
June 12	08:46	145	306	Approx. 5 mi SW	Traveling

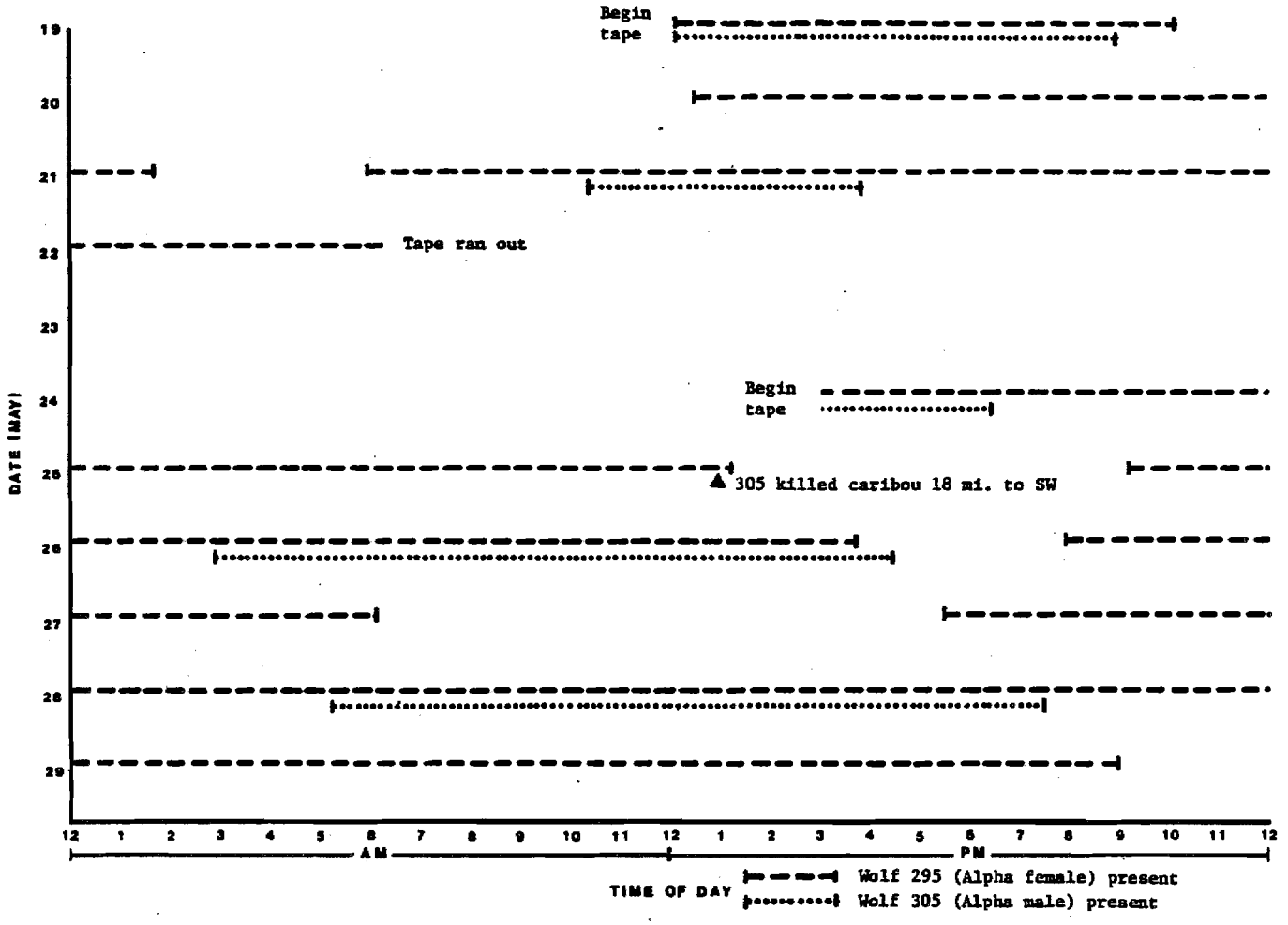


Fig.17. Presence or absence of the two adult members of the Susitna wolf pack at a den site located in in GMU 13 of southcentral Alaska from 19 May through 10 June 1980.

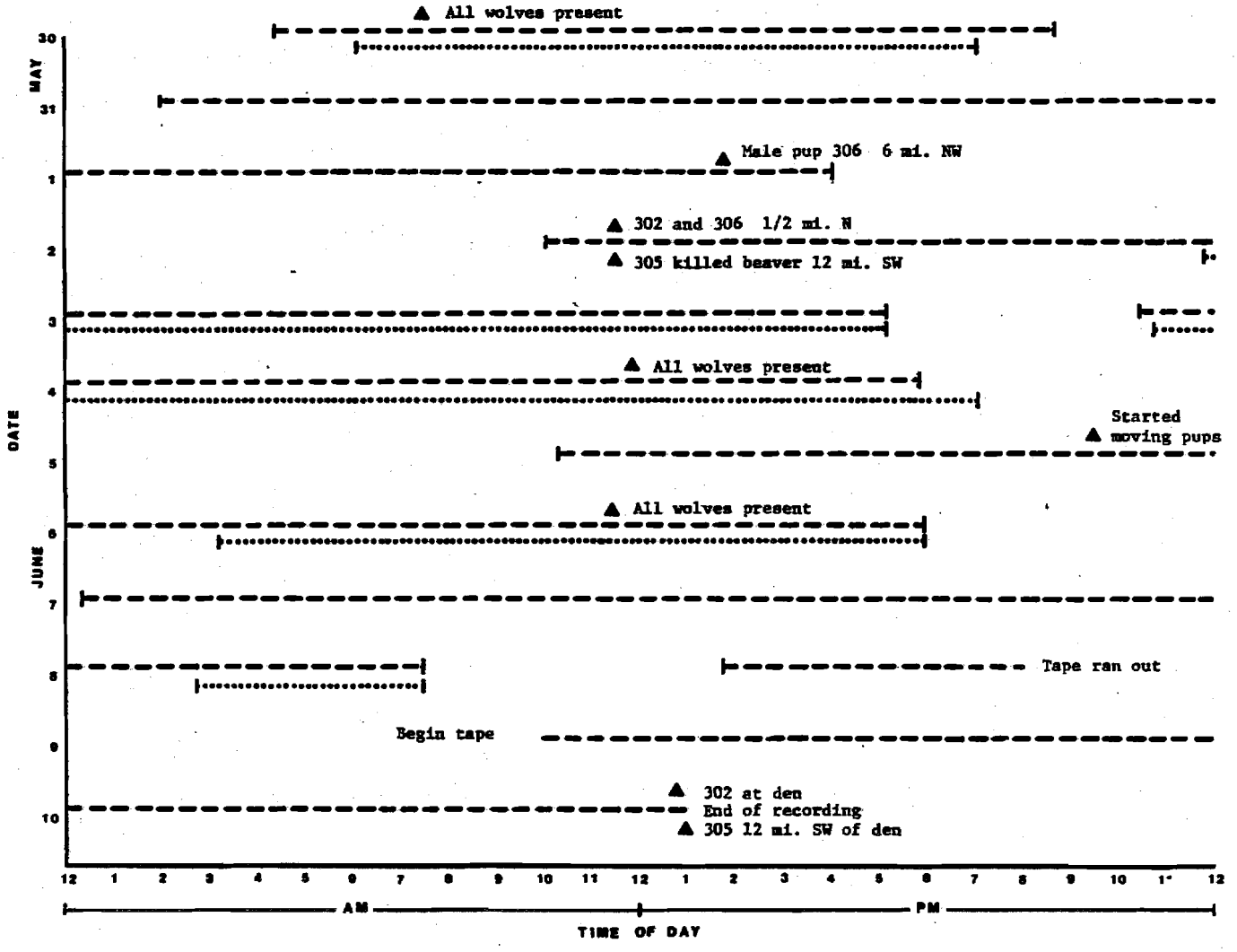


Fig.17. Continued.

scribed by Ballard et al. (1981), whenever a large ungulate kill had been made wolf 305 was usually present.

Wolf 295 remained at or close to the den site during most of the study. By late May it appeared she began making short forays away from the site, leaving yearlings to "babysit" the pups. Watana Pack - During summer 1981 from 7 May through 23 June the same procedures used the Susitna den study in 1980 were repeated with the Watana Pack except that all radio-collars had been color-coded to facilitate individual recognition from the blind. Originally, we had planned on having eight of the eleven pack members fitted with activity transmitters. However, because three of the pack members remained away from the den site and wolf 323 and 346's radio frequencies could not be received by the special receiver, only 4 radioed wolves were available for study. The four included wolf 308 - the adult alpha female, wolf 324 - a yearling female, 325 - a yearling male, 345 - a yearling male, and 346 - a yearling female.

From 7 May through 23 June 1981, a total of 369 hours of ground observations were made from a blind located just south of the den site. Ground observations were used to truth the reliability of the recorder data. At the time this report was prepared ground observations and recorder data were being transferred onto computer sheets for comparison and analysis with aerial observations and thus were not available for this report except for wolf 308.

Figure 18 depicts the attendance of wolf 308 (the alpha female) at the Watana den during late spring and summer 1981. As expected, wolf 308 rarely left the den for any significant time period. Ground observations suggested that the pups were born on 11 May. Comparison of den attendance by wolf 308 with wolf 295 of the Susitna Pack during 1980 (Fig. 17) suggested that wolf 308 spent more time at the den (1.8 hours/day away from the den in 1981 versus 5.8 hours/day in 1981 ($P<0.05$) than had wolf 295. We suspected that this was the result of pack size in that in 1980 only four adults were present and therefore it was necessary for

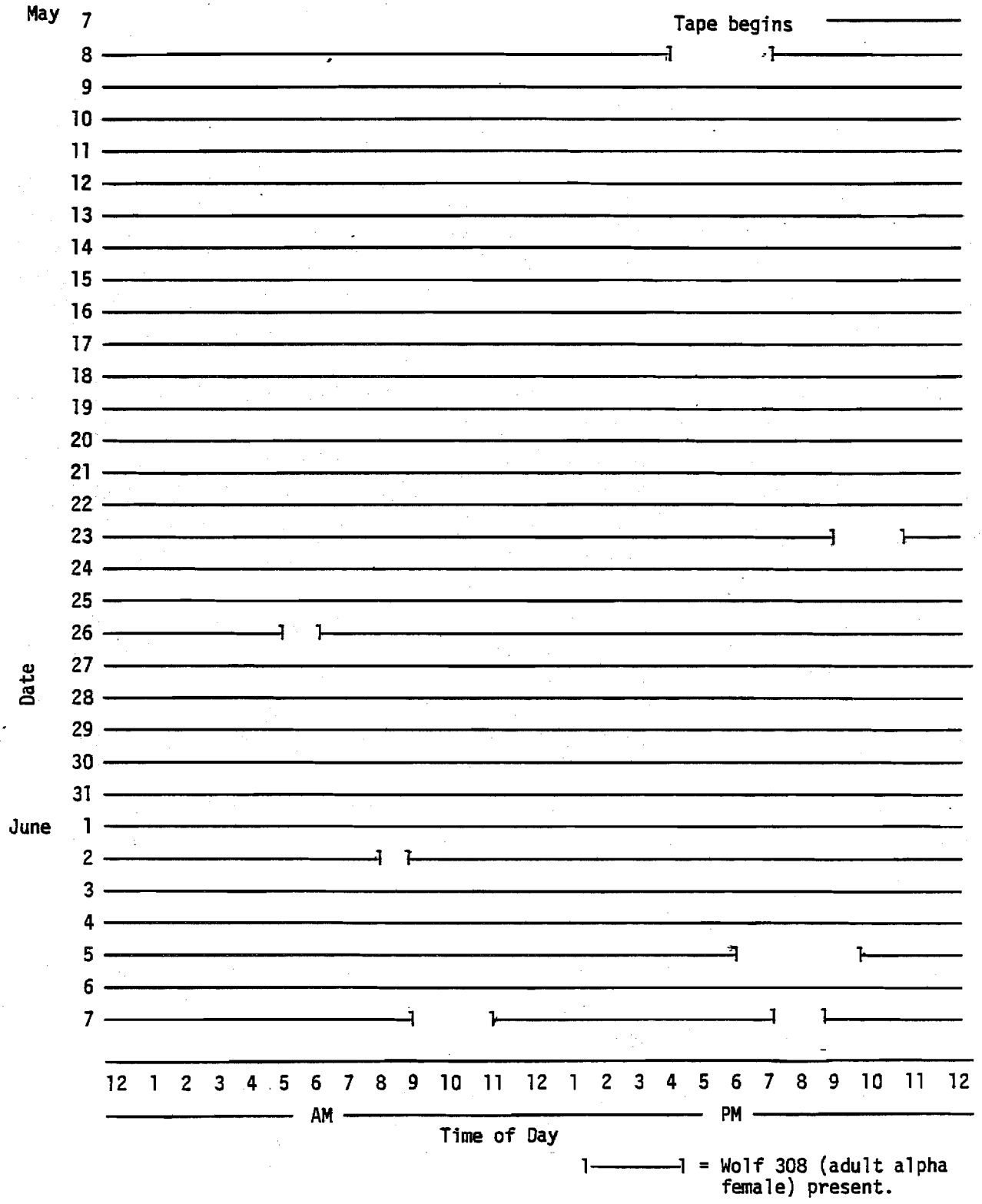


Figure 18. Presence of wolf 308 (adult alpha female) at the Watana den site from 7 May through 22 June 1981 in the Susitna River Basin of southcentral Alaska (solid line indicates presence at den).

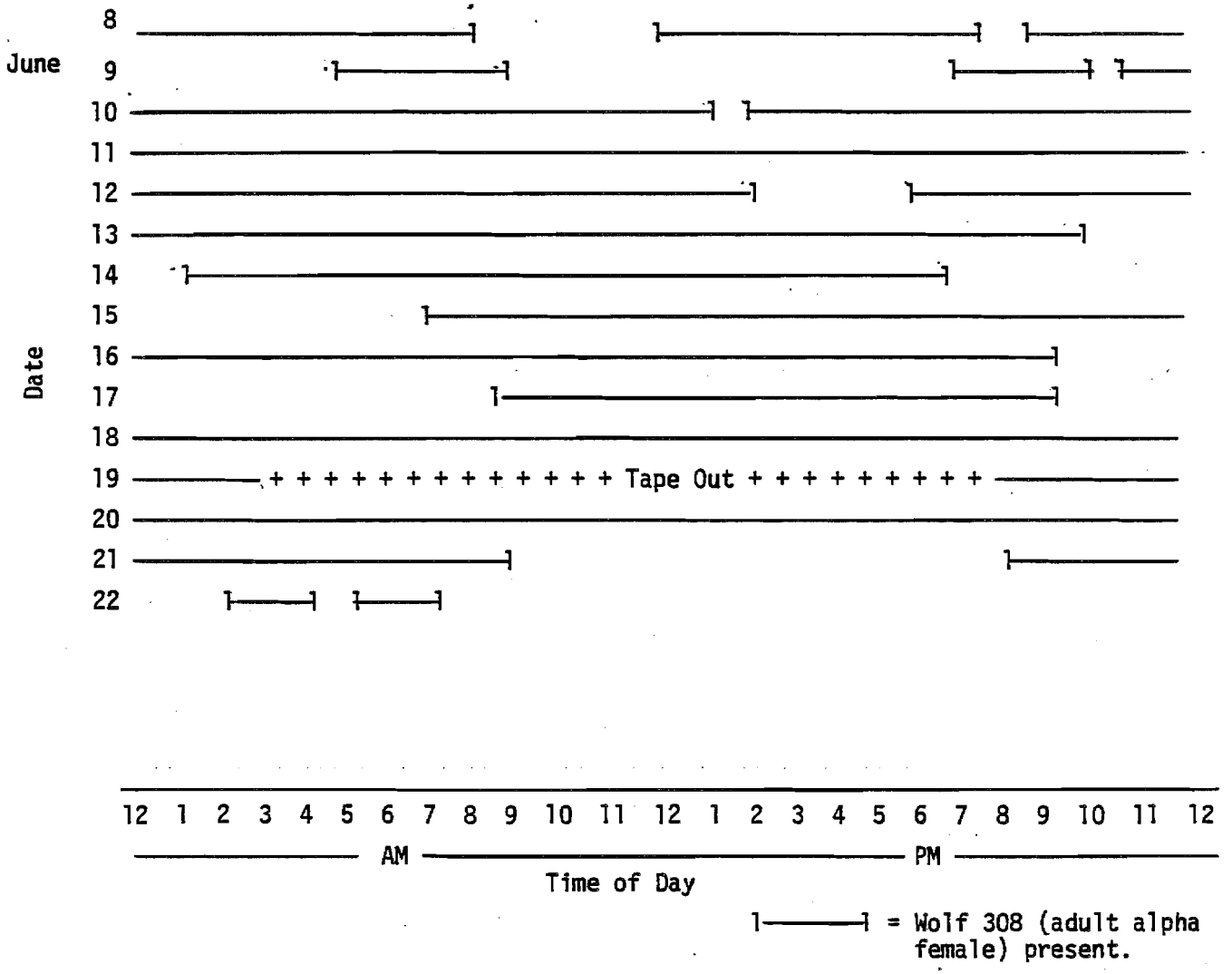


Figure 18. Continued.

the alpha female to hunt and help provide for pups. However, in 1980 the study was not initiated until 19 May. We believed the pups had been born on 1 May and thus the activity data from the two sites were not comparable. We recomputed the time spent away from the Watana den so that it corresponded with the timing sequence observed for the Susitna pack; 19 days after birth. This analysis suggested that there were no significant differences between the two sites for comparable time periods; Watana wolf 308 absent for 4.9 hours/day in 1981 in comparison to Susitna wolf 295 in 1980 which was absent 5.8 hours/day, ($t=0.54$, $P<0.005$). Therefore, the attendance of the alpha female at the den site did not appear to be a function of pack size.

In 1981, pups were first observed outside the den on 7 June. This observation corresponds with the alpha female beginning to leave the den site more frequently and for longer time periods, apparently beginning to participate in hunting forays.

Appendix E summarizes the daily movements, activity and association of all eight Watana wolves as observed from aircraft from 6 May through 22 June 1981. Ground and aerial observations of wolf 308 were closely correlated with activity data provided by the continuous monitoring system.

Daily movements of individual pack members were quite variable. Yearling female wolves appeared to spend more time and remain closer to the den site than yearling males. This higher affinity for the den site by yearling females was also supported by the dispersal of wolves 310, 344 and 345, all of which were males (two were yearlings).

Den site observations may provide a basis for recommending time periods when Susitna personnel should avoid the area. Wolves were most frequently absent from the den site during the early morning and late evening hours, but some pack members were always present. Therefore, in reality there probably are not time periods when project activities could occur without causing some

disruption and annoyment to the pack. However, if absolutely essential, the late evening - early morning hours would be less disruptive.

During 1981 the Watana wolves were subjected to relatively frequent disturbance by helicopters. Not only were our personnel ferried to and from an area ¼ mile away from the site, but helicopter pilots unaware of their location in relation to the den site flew directly over the den site on several occasions. Initially, the wolves were quite frightened by the helicopter and we feared the den site might be abandoned. However, as the study proceeded the wolves became relatively tolerant of helicopter activity and no longer fled the scene when a helicopter approached. It was, however, always a source of at least minor annoyment. From these observations it appears that denning wolves eventually get accustomed to helicopter activities. The same is not true for human disturbance on the ground.

During the 1980 study it was apparent that the blind was a source of annoyance to the Susitna pack. Between 4 and 6 June 1980 the Susitna pack moved to their first rendezvous site. At the Tolsona pack den in both 1980 and 1981, a single visit by humans caused the wolves to move the pups and abandon the site for the remainder of the year. All three of these observations were the earliest dates that wolves were observed moving from a den to a rendezvous site, obviously in response to disturbance. Subsequent observations, however, indicated that pups had not suffered any mortality as a result of this disturbance. From these observations we infer that if project personnel absolutely had to perform activities close to a den site, they could do so as early as 4 June without increasing pup mortality even though the site could be prematurely abandoned. For all other routine activities we recommend that areas within a 1.5 mile radius (Chapman 1976) of wolf dens be closed to project personnel.

POTENTIAL IMPACTS OF SUSITNA HYDROELECTRIC PROJECT ON WOLVES

The most severe impact of the proposed project on wolves would occur indirectly due to reductions or changes in the density, distribution, sex-age composition, and/or physical condition of prey. Reductions in moose or caribou density in the immediate vicinity of the impoundments would probably cause reductions in wolf densities for at least six to seven resident wolf packs which currently occupy the area. Also any disruption of moose migrations and/or reductions in migratory moose densities may also reduce wolf densities in areas where migratory moose reside.

Immediately following construction of the impoundments we anticipate temporary increases in wolf densities next to impoundment areas due to the increased availability of moose and caribou which would be displaced from the reservoirs. In turn, this may amplify the effects of wolf predation on moose and caribou and ultimately result in lower densities for all species. Increased competition between bear and wolf could be expected which would probably result in additional mortality to each species.

Aside from the indirect affects resulting from reductions in prey density, the proposed impoundments would directly eliminate wolf habitat by inundating den sites, rendezvous sites, travel corridors, and feeding areas. Loss of habitat would force wolf packs to readjust territory boundaries with neighboring packs which probably would result in an undetermined amount of mortality due to social strife. Lower wolf densities in the vicinity of the impoundments may also result in lower densities elsewhere. If populations reach low enough levels, wolves will no longer be able to disperse from the impoundment area to territories vacated by hunting, trapping and natural mortality.

Increases in human activity in the project area will probably disrupt and in some cases cause wolves to abandon den and feeding sites. Early den site abandonment could increase pup mortality. Increased human activities may result in increased hunting and

trapping activities as the occurrence of different packs become common knowledge to larger numbers of hunters and trappers and as access into the project area becomes more developed.

PROPOSED PHASE II STUDIES

Completion of Phase I studies documented a number of gaps in our knowledge of Susitna River Basin wolves and the potential impacts of the proposed project on them.

First, we believe a continuation of all of the Phase I objectives is warranted because poor snow conditions in 1980 and 1981 did not allow us to capture and study packs known to occur in the area. This is particularly true for the areas west of Kosina and Deadman Creeks. In December 1981 while this report was in preparation three new wolf packs were captured and radio-collared. Also further effort should be directed towards determining winter predation rates for large packs such as the Watana Creek Pack.

Emphasis of Phase II studies should be directed towards the interaction of all predators to their prey. More specifically we propose that a moose and caribou calf mortality study be initiated to determine the impacts of wolves relative to brown and black bears on ungulate survival. Efforts to mitigate for lost moose habitat by manipulating vegetation could fail if ungulate populations are already limited by predation. Also if predation is already limiting recruitment into adjacent ungulate population, displacement of predators from the impoundment areas could cause further population declines. We also propose that consideration be given to studying caribou mortality not only in the main herd, but perhaps more importantly, in a subherd such as the Butte Creek - Monohan flats herd where predation could be more of a limiting factor on population growth.

Wolf studies should be expanded to include downstream areas. If moose migration measures occur downstream an assessment of existing predator population should be made to determine if mitigation

measures for moose would also serve as mitigation for predator losses. Predator densities appear to be quite low in downstream areas and thus moose mitigation measures may not result in mitigation for predators.

ACKNOWLEDGEMENTS

James Foster, Woodland Park Zoo, participated in and performed the ground observations during the summer activities study as an unpaid volunteer. ADF&G biologists Donald Cornelius, Sterling Miller, Dennis McAllister and Enid Goodwin participated in tagging programs. Special appreciation is expressed to Don Cornelius for his assistance during the first year of the project.

Vern Lofstedt, Kenai Air Service, piloted the helicopter and participated in the processing of many of the immobilized animals. Alfred Lee, Lee's Air Taxi, and Kenneth Bunch, Sportsman's Flying Service, piloted fixed-wing aircraft both during tagging operations and during monitoring activities. The experience and helpful cooperation of these individuals contributed greatly to the success of this project.

We also express appreciation to Grandville Cooley, Watana Camp Manager, for his cooperation and assistance with field studies.

Karl Schneider, ADF&G, provided guidance and support throughout the project and made a number of helpful suggestions for improving this report.

REFERENCES

*Adorjan, A. S. and G. B. Kolenosky. 1969. A manual for the identification of hairs of selected Ontario mammals. Ont. Dep. Lands For. Res. Rep. Wildl. 90. 47 pp.

Alaska Department of Fish and Game. 1973. Alaska game management policies. Alaska Dept. Fish and Game. Juneau. 65 pp.

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

Baer, C. Harold, R. E. Severson and S. B. Linhart. 1978. Live capture of coyotes from a helicopter with ketamine hydrochloride. J. Wildl. Manage. 42(2):452-454.

Ballard, W. B. and K. P. Taylor. 1978. Upper Susitna River moose population study. Alaska Dept. Fish and Game. P-R Proj. Rep., W-17-10, Job 1.20R. 62 pp.

*Ballard, W. B., A. W. Franzmann, K. P. Taylor, T. Spraker, C. C. Schwartz and R. O. Peterson. 1979. Comparison of techniques utilized to determine moose calf mortality in Alaska. Proc. N. Am. Moose Conf. Workshop, Kenai, Alaska. 15:362-387.

*Ballard, W. B. and T. Spraker. 1979. Unit 13 wolf studies. Alaska Dept. Fish and Game. P-R Proj. Rep., W-17-8, Jobs 14.8R, 14.9R and 14.10R. 90 pp.

* Ballard, W. B. 1980. Wolf repopulation study. Alaska Dept. Fish and Game. P-R Proj. Rep., W-21-2. 6 pp.

*Ballard, W. B. and K. P. Taylor. 1980. Upper Susitna Valley moose population study. Alaska Dept. Fish and Game. P-R Proj. Final Rep., W-17-9, W-17-10, and W-17-11. 102 pp.

*Ballard, W. B., S. D. Miller and T. H. Spraker. 1980. Moose calf mortality study. Alaska Dept. Fish and Game. P-R Proj. Final Rep., W-17-9, W-17-10, W-17-11, and W-21-1, 123 pp.

*Ballard, W. B., T. H. Spraker and K. P. Taylor. 1981. Causes of neonatal moose calf mortality in southcentral Alaska. J. Wildl. Manage. In Press.

*Ballard, W. B., R. O. Stephenson and T. H. Spraker. 1981. Nelchina Basin Wolf Studies. Alaska Dept. Fish and Game. P-R Proj. Final Rep., W-17-9 and W-17-10.

*Ballard, W. B. 1982. Gray wolf-brown bear relationships in the Nelchina Basin of southcentral Alaska. R. Harrington and P. C. Paquet, Co. Eds. In Wolves of the World. Noyes Pub., NJ.: In Press.

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. 24 pp.

*Bishop, R. H. and R. A. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Nat. Can. 101:559-593.

Burt, W. H., and R. P. Grossenheider. 1964. A field guide to the mammals. 2nd Ed. Houghton Mifflin Co., Boston. 284 pp.

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. 233 pp.

Chapman, R. C. 1976. The effects of human disturbance on wolves (*Canis lupus*). Final Report for FY 1976. Biology and Resource Management Project. Alaska Cooperative Park Studies Unit.

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

Cowan, I. McT. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res. 250(5):139-174.

Eide, S. 1979. Wolf survey-inventory report - 1977-78, Game Management Unit 13. pp. 95. In Hinman, R. A. (Ed.) 1974. Ann. Rep. Survey-Inventory Activities, Part II. Furbearers, Wolf, Wolverine, Small Game. Ak. Fed. Aid in Wildl. Rest. Rep., Proj. W-17-10. 192 pp.

*Etkin, W. 1964. Cooperation and competition in social behavior. pp 1-34. In Etkin, W. (Ed.). 1964. Social behavior and organization among vertebrates. Univ. Chicago Press, Chicago, Illinois.

Everith, B. S. 1977. The analysis of contingency tables. John Wiley and Sons, Inc. New York. 128 pp.

Floyd, T. J., L. D. Mech and P. D. Jordon. 1978. Relating wolf scat content to prey consumed. J. Wildl. Manage. 42(3):528-532.

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.

Franzmann, A. W. and T. N. Bailey. 1977. Moose research center report. Alaska Dept. Fish and Game. P-R Proj. Rep., W-17-9. 76 pp.

Franzmann, A. W., C. C. Schwartz and R. O. Peterson. 1980. Causes of summer moose calf mortality on the Kenai Peninsula. J. Wildl. Manage. 44(3):764-768.

Fritts, S. H. and L. D. Mech. In Press. Dynamics, movements, and feeding ecology of a newly-protected wolf population in northwestern Minnesota. Wildl. Monogr.

Fuller, T. K. and L. B. Keith. 1980. Wolf population dynamics and prey relationships in northeastern Alberta. J. Wildl. Manage. 44(3):583-602.

Gasaway, W. C., P. Haggstrom and O. E. Burris. 1977. Preliminary observation on the timing and causes of calf mortality in an Interior Alaskan moose population. Proc. N. Am. Moose Conf. Workshop. 13:54-70.

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

*Haber, G. C. 1977. Socio-ecological dynamics of wolves and prey in a subarctic ecosystem. PhD. Thesis. Univ. of British Columbia. 585 pp.

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

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

Markgren, G. 1969. Reproduction of moose in Sweden. Viltrevy, 6(3):1-299.

McIlroy, C. 1974. Moose survey-inventory progress report - 1972, Game Management Unit 13. pp. 66-74. In McKnight, D. E. (Ed.). 1974. Annual report of survey-inventory activities, Part II. Moose, caribou, marine mammals and goat. Ak. Fed. Aid in Wildl. Rest. Rep., Proj. W-17-5. 269 pp.

McIlroy, C. 1976. Moose survey-inventory progress report - 1974, Game Management Units 11 and 13. pp 49-55 and 61-79. In McKnight, D. E. (Ed.). 1976. Ann. Rep. Survey-inventory activities, Part II. Moose. Ak. Fed. Aid in Wildl. Rest. Rep., Proj. W-17-7. 187 pp.

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

*Mech, L. D. 1970. The wolf:the ecology and behaviour of an endangered species. The Nat. Hist. Press. Garden City, New York. 384 pp.

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

*Mech, L. D. 1974. Current techniques in the study of elusive wilderness carnivores. Proc. XI Internat. Congress of Game Biol. 315-322 pp.

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

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

Miller, S. M. and W. B. Ballard. 1980. Estimates of the density, structure and biomass of an interior Alaskan brown bear population. In Ballard et al. 1980. Moose calf mortality study. Alaska Dept. Fish and Game. P-R Proj. Final Rep., W-17-9, W-17-10, W-17-11 and W-21-1.

*Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37(1):223-249.

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

*Neiland, K. A. 1970. Weight of dried marrow as indicator of fat in caribou femurs. J. Wildl. Manage. 34(4):904-907.

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

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

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

Peterson, R. O. 1976. The role of wolf predation in a moose population decline. First Conf. on Scientific Res. in Nat. Parks. New Orleans, Louisiana. (Unpubl.).

Peterson, R. O. 1977. Ecological studies of wolves on Isle Royale. Ann. Rep. 1976-77. 12 pp.

Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. Natl. Park Serv. Sci. Monogr. Ser. 11. 21 pp.

Peterson, R. O. 1980. Wolf-moose investigation on the Kenai Peninsula, Alaska. Quarterly Rep. #15. Kenai Nat. Moose Range.

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. 99 pp.

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

Rausch, R. A. 1969. A summary of wolf studies in southcentral Alaska. 1957-1968. Trans. N. Am. Wildl. and Nat. Resour. Conf., 34:117-131.

Rausch, R. A., R. J. Somerville and R. H. Bishop. 1975. Moose management in Alaska. Naturaliste Can., 101:705-721.

*Sergeant, D. E. and D. H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Manage. 23(3):315-321.

*Skoog, R. O. 1968. Ecology of caribou (*Rangifer tarandus granti*) in Alaska. PhD. Thesis, Univ. of Cal., Berkeley, California. 699 pp.

Snedecor, G.W. and W. G. Cochran. 1973. Statistical methods. Iowa State Univ. Press. Ames, Iowa. 593 pp.

Sokal, R. F. and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Co. San Francisco, Calif. 776 pp.

Spraker, T. H., W. B. Ballard and S. M. Miller. 1981. Brown bear studies, Game Management Unit 13. Alaska Dept. Fish and Game P-R Proj. Final Rep., W-17-10 and W-17-11, Job 4.13R.

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. 55 pp.

*Stephenson, R. O. and L. Johnson. 1972. Wolf report. Alaska Dept. Fish and Game. P-R Proj. Rept., W-17-3. 51 pp.

*Stephenson, R. O., and L. Johnson. 1973. Wolf report. Alaska Dept. Fish and Game. P-R Proj. Rept., W-17-4. 52 pp.

Stephenson, R. O. 1975. Wolf report. Alaska Dept. Fish and Game. P-R Proj. Rept., W-17-3 through W-17-7. 18 pp.

Stephenson, R. O. 1977. Characteristics of exploited wolf populations. Alaska Dept. Fish and Game. P-R Proj. Rept., W-17-3 through W-17-8. 17 pp.

*Stephenson, R. O. 1978. Unit 13 wolf studies. Alaska Dept. Fish and Game. P-R Proj. Rept., W-17-8, Jobs 14.8R, 14.9R and 14.10R.

*Taylor, K. P. and W. B. Ballard. 1979. Moose movements and habitat use along the Susitna River near Devils Canyon, Alaska. Proc. N. Am. Moose Conf. Workshop, Kenai, Alaska.

Tobey, R. 1980. Wolf survey inventory report - 1978-79, Game Management Unit 13. pp 81. In Hinman, R. A. (Ed.). 1980. Annual report of survey-inventory activities, Part IV. Furbearers, upland game, wolf and wolverine. Ak. Fed. Aid in Wildl. Rest. Rept., Proj. W-17-11. 112 pp.

Theberge, J. B., S. M. Dosenbrug and D. H. Pimlott. 1978. Site and seasonal variations in food of wolves, Algonquin Park, Ontario. Canadian Field-Naturalist, 92(1):91-94.

Troyer, W. 1976. Winter moose census, Mount McKinley National Park, 1976. U. S. Nat. Park Serv. Anchorage. 5 pp. (Unpubl.).

Troyer, W. 1977. Winter moose census, Mount McKinley National Park, 1977. U. S. Nat. Park Serv. Anchorage. 5 pp. (Unpubl.).

Troyer, W. 1978. Winter moose census, Mount McKinley National Park, 1978. U. S. Nat. Park Serv. Anchorage. 5 pp. (Unpubl.).

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

Van Ballenbergh, V. 1978. Final report on the effects of the Trans-Alaska Pipeline on moose movements. Alaska Dept. Fish and Game. 44 pp.

Van Camp, J. and R. Gluckie. 1979. A record long-distance move by a wolf (*Canis lupus*). J. Mammal. 60:236.

Voigt, D. R., G. B. Kolenosky and D. H. Pimlott. 1976. Changes in summer foods of wolves in central Ontario. J. Wildl. Manage. 40(4):663-668.

APPENDIX A. Copy of manuscript accepted by Journal of Wildlife Diseases.

COMPARISON AND ASSESSMENT OF DRUGS USED TO IMMOBILIZE ALASKAN GRAY WOLVES (*Canis lupus*) FROM A HELICOPTER

WARREN B. BALLARD[1] and ALBERT W. FRANZMANN[2]

Abstract: One hundred three Alaskan gray wolves (*Canis lupus*) were immobilized from a helicopter in the Nelchina and upper Susitna River Basins of southcentral Alaska between March 1977 and May 1981. Sixty-five wolves were immobilized with a mixture of phencyclidine HCL and promazine HCl (PP/HCl); 38 wolves were immobilized with etorphine HCl. Phencyclidine HCl is no longer commercially available and an assessment of etorphine HCl as a replacement drug was made. Etorphine HCl dosage of 2.5 mg/wolf (.063 mg/kg) proved to be a suitable replacement for PP/HCl for immobilizing wolves. The advantages and disadvantages of the drugs are discussed.

INTRODUCTION

Phencyclidine HCl[3] with promazine HC[4] (PP/HCl) has been a widely used drug combination to immobilize free-ranging gray wolves (*Canis lupus*).[2,6,7,11] Recently phencyclidine HCl was removed from the commercial market, forcing biologists to seek suitable alternatives. Fuller and Keith[5] reported successful immobilization of 12 wolves with etorphine HCl[5], 9 of which were caught

[1] Alaska Department of Fish and Game, P. O. Box 47, Glennallen, Alaska.

[2] Moose Research Center, Alaska Department of Fish and Game, Soldotna, Alaska.

[3] Sernylan ®, Bio-ceutic Laboratories, Inc., St. Joseph, Missouri.

[4] Sparine ®, Wyeth Laboratory, Inc., Philadephia, Pennsylvania.

in steel traps. Darting wolves from a helicopter has become a common method for immobilizing Alaskan wolves[2] and an assessment of a replacement drug (etorphine HCl) for phencyclidine HCl was done. This paper compares responses of 65 wolves immobilized with PP/HCl with 38 wolves immobilized with etorphine HCl. All wolves were darted from a helicopter.

MATERIALS AND METHODS

The study was conducted in the Nelchina and upper Susitna River Basins of southcentral Alaska from March 1977 to May 1981. Descriptions of the area have been reported elsewhere.[1,3,8,10]

Wolves were located for radio-telemetry studies by searching the edges of streams and lakes for wolf footprints from fixed-wing aircraft when fresh snow depths generally exceeded 8 cm. Footprints were followed until wolves were observed, at which time their location was relayed by radio to a crew in a nearby helicopter.[5]

Wolves were immobilized using a dart gun[7] fired from the helicopter. To facilitate shooting, the helicopter was equipped with a zippered canvas door which replaced the right rear window. Generally from the time wolves were first spotted from the helicopter, 1 to 5 minutes elapsed until a wolf was darted, requiring an average of 3 shots for one hit with an experienced shooter. Once darted, the wolf was observed at a distance from the helicopter until it became immobile. Usually the fixed-wing aircraft continued to observe remaining pack members so that additional

---

[5] M-99, The Lemon Co., Inc., Rockville, Maryland.

[6] Bell 206B, Bell Helicopter, Fort Worth, Texas.

[7] Cap-Chur, Palmer Chemical Co., Douglasville, Georgia.

wolves could be captured. Induction time was measured with a stopwatch and consisted of the time from injection to when the animal was immobile enough to permit handling.

From March 1977 to March 1979 a combination of 100 mg phencyclidine HCl and 50 mg promazine HCl (PP/HCl) was utilized to immobilize 65 wolves of both sexes and all age groups. Recovery time for this group was not measured; however, all were subsequently observed in the wild usually within 24 hours. From April 1980 through May 1981, 2 to 2.5 mg etorphine was used to immobilize 38 wolves of both sexes and all age classes. On this group once processing was completed, an equivalent cc dosage of the antagonist diprenorphine HCl[8] was administered either intravenously (IV) in the radial vein or intramuscularly (IM) in the hip area. Recovery time was measured with a stopwatch from when injection was complete until the wolf regained mobility. All statistical comparisons were by t-test.[9]

RESULTS AND DISCUSSION

Initially 2.0 - 2.25 mg etorphine HCl was tested on seven adult wolves ($\bar{x}$ = 0.50 mg/kg. Four of these wolves required additional dosages of M-99 to become immobile (from 0.4 to 2.0 mg additional). Average induction time was 17.3 minutes (S.D. = 8.2). With the required additional drug the dosages (x = .064 mg/kg, S.D. = .024) required for immobilization were considerably larger than those recommended by Fuller and Keith[5] for both trapped and darted wolves. Subsequently, we began using 2.5 mg etorphine for all wolves.

There was a significant reduction ($P<.001$) in induction time between initial injection of 2.5 mg ($\bar{x}$ = 6.1 min) versus 2.0 mg ($\bar{x}$ = 17.3 min). This suggests that a larger initial dose results

---

[8] M 50-50, The Lemon Co., Inc. Rockville, Maryland.

in quicker induction which was similar to that reported for moose (*Alces alces*) immobilized with etorphine.[4]

Induction time for wolves immobilized with 2.5 mg etorphine were significantly less ($P<0.001$) than those for wolves immobilized with 100 mg Sernylan (Table 1). An average of .063 mg/kg M-99 was used to successfully immobilize 25 wolves ranging in weight from 20.9 to 50.9 kg. Numbers of wolves requiring additional drug for no apparent reason after the first injection was similar between the two drugs (etorphine HCl - 2 of 30; PP/HCl - 2 of 65. Additional drug was required for four wolves (2 with PP/HCl and 2 with etorphine HCl) due to malfunction of the dart. Although initial durg costs for etorphine HCl (approximately $82.00/20 ml versus $11.00/10 ml) are substantially higher than that of PP/HCl, a reduction of 40 percent induction time significantly reduced costs per captured animal by reduced helicopter time. Therefore, overall use of etorphine HCl was no more expensive than that of PP/HCl.

An average of .144 mg/kg of the antagonist diprenophine HCl was used to reverse immobilization (Table 1.) When administered IV recovery to full mobility averaged 1.58 minutes. As expected, there was a significant (P 0.001) increase in recovery time over when the antagonist was administered IM ($\bar{x}$ = 8.4 min). Because no antagonist was available for PP/HCl, accurate comparison of recovery times between PP/HCl and etorphine HCl was not possible. However, observations of radio-collared animals immobilized with PP/HCl suggested that from 1 to 12 hours was required for full recovery[2]. In one case, the prolonged recovery resulted in one wolf drowning[2]while no mortalities occurred with those immobilized with etorphine HCl. Because of the quick recovery period, etorphine HCl is superior to PP/HCl because it did not expose immobile animals to prolonged extreme temperatures[5]which are common in habitats occupied by wolves, and it did not leave the animal susceptible to accidental death or vulnerable to hunting and trapping mortality.

Table 1. Comparison of pehncyclidine hydrochloride to etorphine hydrocholoride for immobilizing gray wolves from helicopter in the Nelchina and upper Susitna River Basins of southcentral Alaska between March 1977 and May 1981.

Drug	Sample size 1/	Dose mg/km $\bar{x}$	Dose mg/km Range	Dose mg/km St. dev.	Induction time (min.) $\bar{x}$	Induction time (min.) Range	Induction time (min.) St. dev.	Diprenorphine dose (2 mg/ml) mg/kg $\bar{x}$	Diprenorphine dose (2 mg/ml) mg/kg Range	Diprenorphine dose (2 mg/ml) mg/kg St. dev.	Recovery time (min.) $\bar{x}$	Recovery time (min.) Range	Recovery time (min.) St. dev.
Sernylan (100 mg/ml)	56	2.57	1.96 - 6.12.	.75	10.0	3-25	5.39					1-10 hours	
Sparine (50 mg/ml													
Etorphine (1 mg/ml.)	25	.063	.049 - .120	.018	6.1	2.5-11	2.37	.144	.098-.282	.047	1.58 2/	.8-3.5	.67

1/ Sample size represents data only from animals where accurate timing was available.
2/ IV only, IM average was 8.4 (N = 5), S.D. = 4.34, Range 2-212 minutes.

Etorphine has two major disadvantages associated with its use: (1) its use requires a narcotics license and (2) it is extremely toxic to humans. Although there is no substitute for extreme caution when handling etorphine, a human antidote naloxone HCl[9] should be available at all times.

In conclusion, results of this comparison suggest that etorphine is suitable and in some cases more advantageous than PP/HCl for immobilizing wolves from a helicopter. We recommend that 2.5 mg etorphine HCl be used for immobilizing wolves to be darted from helicopter and that an equivalent ml dosage (2 mg/ml) of the antagonist diprenorphine HCl be administered following processing. The dosage of etorphine HCl was much higher (0.063 mg/kg versus 0.042 mg/kg) than previously reported[5].

ACKNOWLEDGEMENTS

Appreciation is expressed to K. Schneider and G. Bos, both Alaska Department of Fish and Game (ADF&G) for reviewing the manuscript and R. Tobey (ADF&G) for assistance in the field. This study was supported in part by Alaska Federal Aid to Wildlife Restoration Projects W-17-R with additional support provided by the Alaska Power Authority.

---

[9] Narcan, Endo Laboratories, Inc. Garden City, New York.

LITERATURE CITED

1. Ballard, W. B. 1981. Gray wolf-brown bear relationships in the Nelchina Basin of southcentral Alaska. F. Harrington and P. C. Paquet, Co. Eds. Proc. Portland Wolf Symp. Portland, OR.

2. _____. R. O. Stephenson, and T. H. Spraker. 1981 Nelchina Basin wolf studies. Alaska Dept . Fish and Game. Final P-R Rept. Juneau. 201pp.

3. Bishop, R. H. and R. a. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Nat. Can. 101:559-593.

4. Franzmann, A. W. and P. D. Arneson. 1974. Immobilization of Alaskan moose. J. Zoo Anim. Med. 5(2):26-32.

5. Fuller, T. K. and L. B. Keith. 1981. Immobilization of wolves in winter with etorphine. J. Wildl. Manage. 45(1):271-273.

6. Mech, L. D. 1974. Current techniques in the study of elusive wilderness carnivores. Proc. IXth Intl. Cong. Game Biol. 11:315-322.

7. Seal, U. S., A. W. Erickson, and J. G. Mayo. 1970. Drug immobilization of the carnivora. Int. Zoo. Yearbook. 10:157-170.

8. Skoog, R. O. 1968. Ecology of caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Thesis, Univ. of California, Berkeley, CA. 699 pp.

9. Snedecor, G. W. and W. G. Cochran. 1973. Statistical methods. Iowa State Univ. Press. 593pp.

10. Taylor, K. P. and W. B. Ballard. 1979. Moose movements and habitat use along with Susitna River near Devils Canyon. Proc. N. Am. Moose Conf. Workshop. 15:169-186.

11. Van Ballenberghe, V., A. W. Erickson, and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildl. Monogr. 43:1-43.

APPENDIX B. Abstract of report summarizing wolf research activities in Game Management Unit 13 from 1975 through June 1980.

ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

STATE OF ALASKA
Jay S. Hammond, Governor

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

DIVISION OF GAME
Ronald J. Somerville, Director
Donald McKnight, Research Chief

NELCHINA BASIN WOLF STUDIES

By
Warren B. Ballard
Robert O. Stephenson
and
Ted H. Spraker

Volume III

Final Project Report
Federal Aid in Wildlife Restoration
Project, W-17-9 and W-17-10, Jobs 14.8R, 14.9R and 14.10R
with Additional Support from the Alaska Power Authority

JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Warren Ballard, Robert Stephenson, Ted Spraker, Sterling Eide, James Foster, Albert Franzmann, Art Flynn, Dan Holleman, SuzAnne Miller and John Schlotthauer

Project Nos.: W-17-9, W-17-10 and W-21-2 Project Title: Big Game Investigations

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

Job No.: 14.9R Job Title: Wolf Food Habits

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

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

SUMMARY

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

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

Wolf territories were for the most part non-overlapping. Overlaps which did occur were seasonal in nature or due to the method territories were plotted. There appeared to be changes in territory boundaries from year to year. Territory sizes for 14 in-

tensively studied packs ranged from 268 to 864 mi^2, averaging 537 mi^2. Territory size appeared to increase for larger packs and for those packs in areas of low moose density.

Wolf den and rendezvous site usage was described. The earliest that radio-collared wolves were observed at a natal den was 13 April. Wolves began visiting den sites in late April and early May. Parturition appeared to occur throughout the month of May. Natal dens were abandoned between 4 June and 1 August. Pups were observed traveling with adults between late August to mid-September of each year.

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

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

One hundred twenty five moose and 25 caribou kills were examined <u>in situ</u> to determine both cause of death and age and physical

condition of prey taken by wolves. One instance of surplus killing of caribou by wolves was reported. Percent fat of calf and short yearling moose killed by wolves was significantly higher than those of calves dying from both accidental causes and winter kill. We concluded that wolves were preying upon relatively healthy calf and short yearling moose.

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

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

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

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

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

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

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

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

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

During this study at least 26 radio-collared wolves were known to have dispersed from their original pack area. Sixty-eight per-

cent of the dispersals were males. Approximate average ages of dispersed males was 35 months, while females averaged 37 months. Dispersal was most prevalent during months of April through June. Average distance dispersed was at least 67.7 miles. The longest documented movement was 460 miles, constituting a record movement for this species.

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

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

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

APPENDIX C.

Copy of paper presented at 17th North American Moose Conference and Workshop held in Thunder Bay, Ontario.

USE OF MANDIBLE VERSUS LONGBONE TO EVALUATE PERCENT MARROW FAT IN MOOSE AND CARIBOU

W. B. Ballard , C. L. Gardner, and J. H. Westlund
Alaska Department of Fish and Game
P. O. Box 47, Glennallen, AK 99588

and

S. M. Miller
Alaska Department of Fish and Game
333 Raspberry Road, Anchorage, AK 99502

Abstract: During winters 1977 through 1980 the mandible and a longbone were collected from moose (*Alces alces*) and caribou (*Rangifer tarandus*) kills found while conducting a wolf (*Canis lupus*) moose relationships study in southcentral Alaska. Percent marrow fat for the paired samples was significantly correlated, suggesting that mandibles could be used in lieu of longbones for marrow fat analyses. Results of the study were compared with those obtained for Ontario moose and were combined for analysis. Percent fat for the paired bones was significantly correlated for both calf and adult moose; however, the slopes and intercepts for the two age classes were different, suggesting differences in fat mobilization by age class.

Marrow fat of longbones had been widely used as an index of physical condition of ungulates in North America. Prior to 1970 procedures for determining marrow fat content consisted of either crude visual estimates based upon marrow color and consistency, or extraction procedures which were relatively expensive and time consuming. Development of Neiland's (1970) dry weight for determining percent marrow fat in caribou allowed marrow fat content to be quantified with relative ease and a relatively low cost per sample.

Since 1970, Neiland's (1970) method of determining marrow fat content has been widely used on a number of ungulate species for assessing physical status. This type of information is of particular interest to students of predator-prey relationships because it allows inferences to be drawn about the physical condition of prey selected by predators. For comparison, samples from nonpredator killed ungulates are needed to determine condition of predator kills relative to the condition of other members of the population.

The most widely used bone for determining percent marrow fat of ungulates has been the femur (Cheatum 1949), although other longbones have been widely used also (Peterson 1977). Percent fat in the mandibular cavity has also received some attention as an indicator of physical condition (Baker and Lueth 1966, Purol et al. 1977 and Snider 1980).

While conducting a wolf-moose relationships study in Game Management Unit 13 of southcentral Alaska, we attempted to collect longbones from moose and caribou dead from all sources of mortality. Although we strove for collection of femurs, we often had to settle for metatarsals or metacarpals, and in many other cases no bone was collected at all. Reasons for this varied depending upon both the cause of mortality and the time available for specimen collection. On both predator- and winter-killed ungulates, which were only partially consumed, the flesh was frozen and extraction of the femur was often time consuming and expensive, particularly when kills were visited via helicopter. On heavily consumed predator kills, often the ends of longbones had been chewed and the marrow either eaten or exposed to the air rendering the sample useless. In these latter cases, no specimens were collected. On several predator kills the only remaining intact bones suitable for marrow analysis were the mandibles. Similar types of problems occurred with collection of samples of road kills. Because of these problems and the presence of mandibles at many heavily consumed predator kills, it appeared desirable to determine if a relationship existed between percent marrow fat estimated from longbones compared to that estimated from mandibles. Since mandibles are relatively easy to extract and are often collected routinely for aging purposes, establishment of a fat relationship between the two bones would result in a considerably larger sample size of condition data. The purpose of this paper is to compare the percent marrow fat of mandibles to that of longbones for moose and caribou killed primarily by predators.

STUDY AREA

The study was conducted in Game Management Unit 13 of southcentral Alaska. Detailed descriptions of vegetation, topography, weather patterns, etc., have been provided by Skoog (1968), Rausch (1969), Bishop and Rausch (1974) and Ballard (1981).

METHODS

During winters 1977 through 1980, 58 paired mandible and longbone samples were obtained from moose and caribou kills. Moose samples were comprised of 21 calves and 24 adults of both sexes, while the 13 caribou samples were adults of both sex. Ages of moose were determined by incisor eruption and cementum annuli counts according to methods described by Sergeant and Pimlott (1959). Caribou were aged on the basis of tooth wear described by Skoog (1968).

Samples were collected on an opportunistic basis but most kills were detected while making flights to monitor radio-collared wolf packs. Causes of death for the paired samples were as follows: for calf moose--8 wolf kills, 7 winter kills and 6 road or accidental kills; for adult moose--15 wolf kills, 8 road or accidental kills, and 1 from unknown causes; and for adult caribou-12 wolf kills and 1 from unknown causes.

Procedures for determining percent fat of longbones were identical to those of Neiland (1970). Mandible marrow was extracted by cutting a 10 cm longitudinal section of bone from the labial side of the mandible beginning at the 2nd or 3rd premolar. The section was cut with a bone saw and the resulting bone dust was scraped from the marrow with a spatula. Later, we simplified this process by ventrally splitting the left or right ramus with a chisel and then extracting the entire section of marrow with a spatula. This modified procedure also eliminated the need for scraping off bone dust fragments. The remainder of the procedure was identical to that for the longbone, described by Neiland (1970).

RESULTS AND DISCUSSION

Paired samples for both calf and adult moose were compared with standard least squares regression techniques (Snedecor and Cochran 1973). The best fit was by linear regression (Fig. 1, $r=.92$, $P<0.05$); however, the data appeared clumped according to age class (calf versus adult). Analysis of covariance for calf and adult moose indicated that the variances were significantly different ($F=4.11$, $P<0.001$) and, thus, comparison of slope and intercept between the two age classes was not possible. We subjected each age class to polynomial regression techniques and determined that the percent marrow fat relationship for adult moose could be expressed as a 3rd order polynomial. The relationship was also significantly related linearly and thus we chose it for adults because it allowed additional statistical tests to be performed.

Figures 2 and 3 depict the relationship between percent fat for longbones and mandibles for calf and adult moose separately. Percent marrow fat in the two bones was significantly correlated for both age classes (calves $r=.88$, $P<0.05$; adults $r=.78$ $P<0.05$) suggesting that longbone fat could be estimated from mandible fat for each age class. However, there was considerably more variation in the relationship for calves (mean square [ms]=127.8) than for adults (ms=26.7). This may have been the result of sample size since all of the adult moose were above 65% fat which would have placed them in a relatively high condition class based upon criteria established by Greer (1968) and Franzmann and Arneson (1976).

Snider (1980) compared percent marrow fat for femurs and mandibles for 29 moose from Ontario. He, like us, concluded that the two variables were significantly correlated. He combined calf

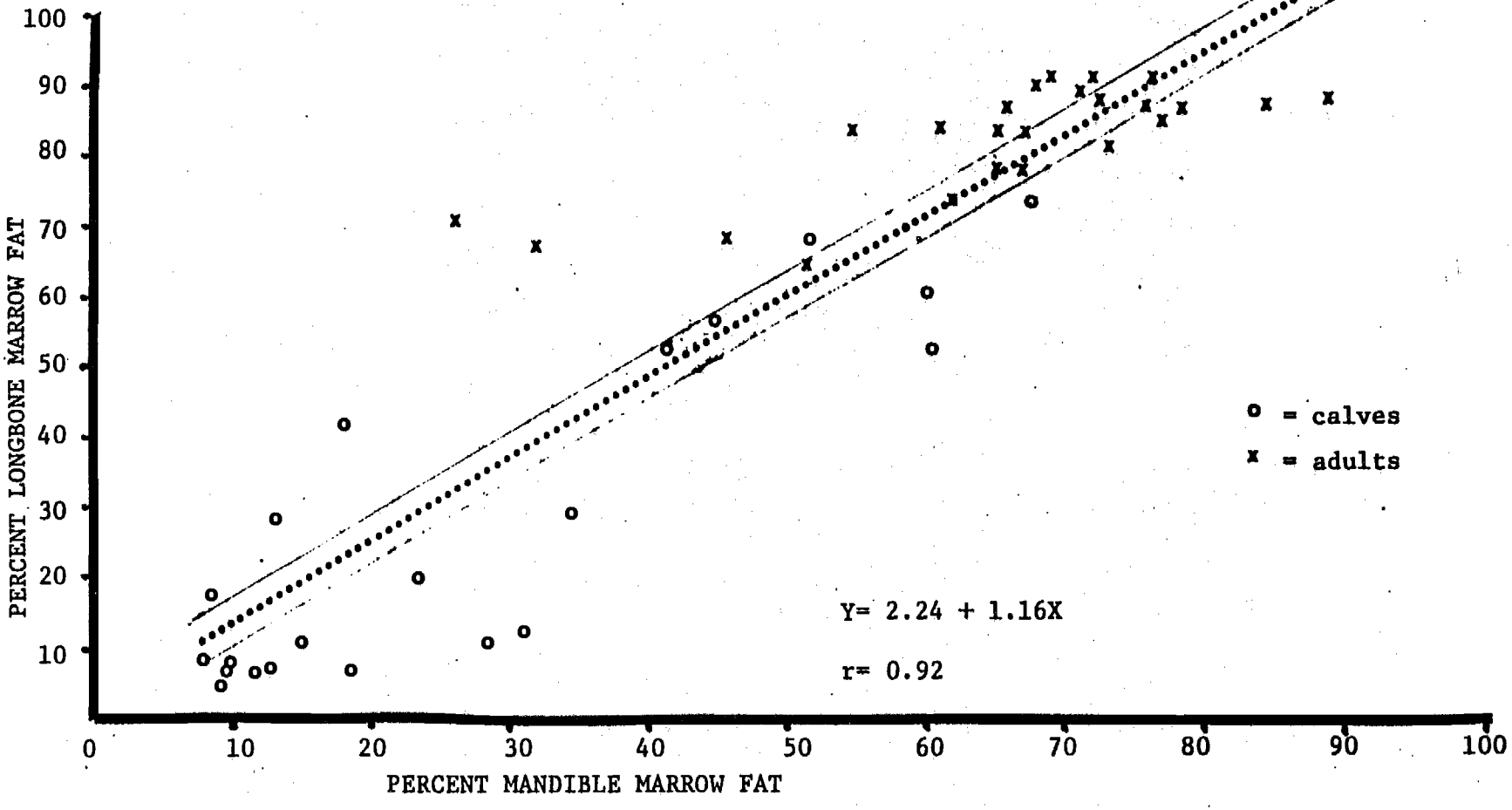


Figure 1. Relationship between percent marrow fat for mandibles and longbones from calf and adult moose in the Nelchina Basin, Alaska.

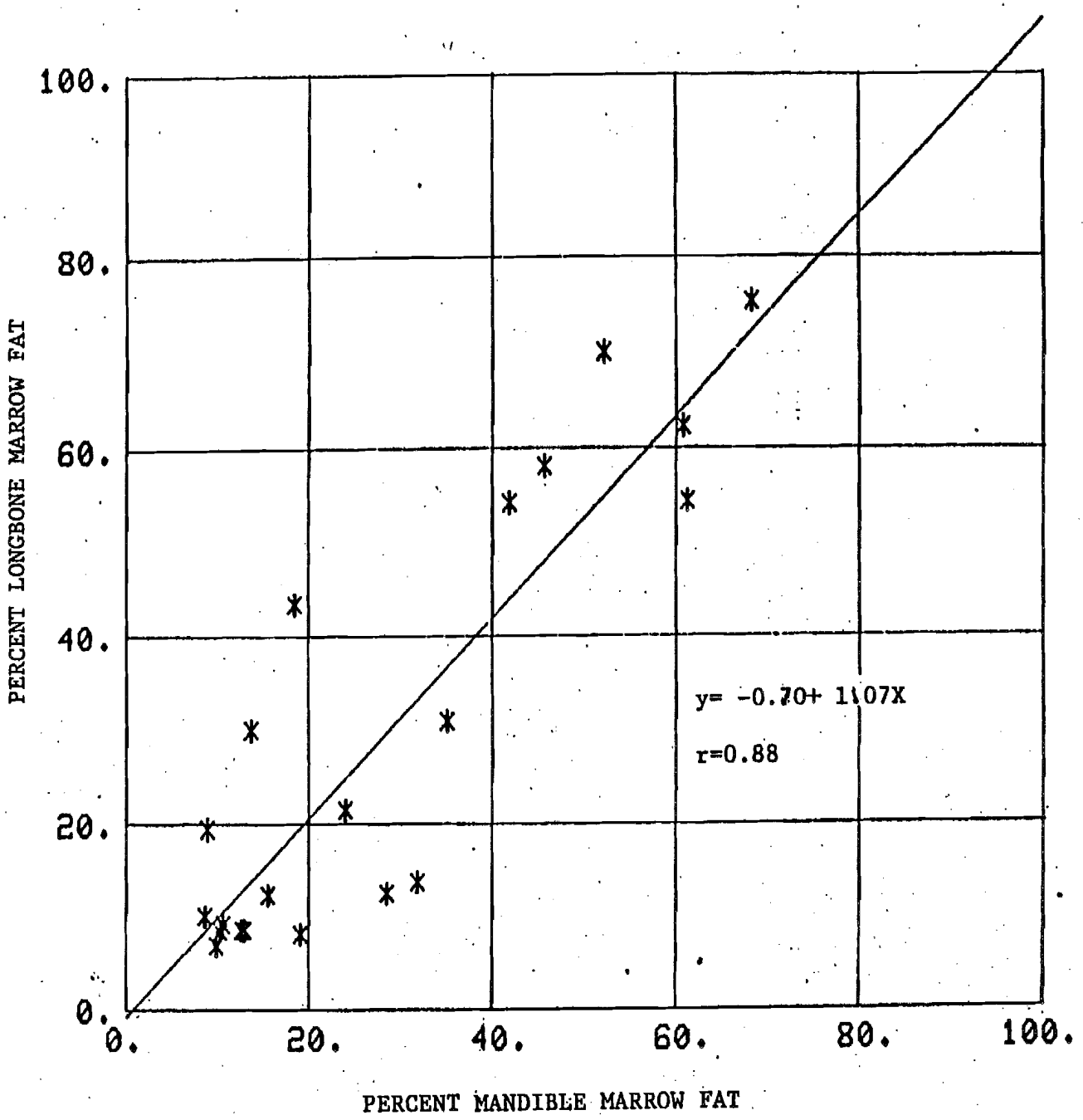


Figure 2. Relationship between percent marrow fat of mandibles and longbones for calf moose in the Nelchina Basin, Alaska.

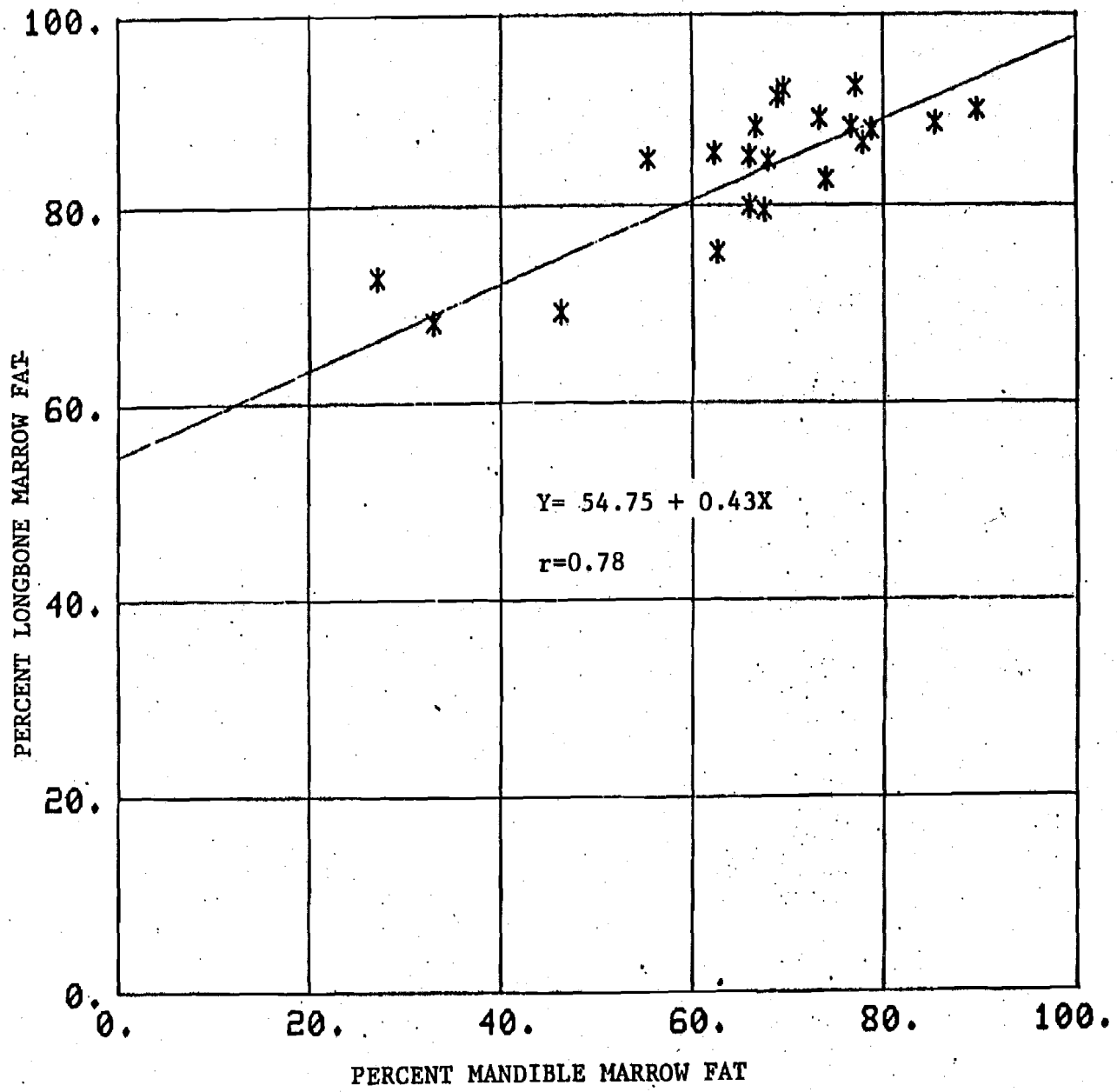


Figure 3. Relationship between percent marrow fat of mandibles and longbones for adult moose in the Nelchina Basin, Alaska.

moose (n=6) with adults (n=22) and determined that the percent fat relationship between the two bones was best expressed as a third degree orthogonal polynomial (Fig. 4) where Y= mandible fat and X= femur fat. His data were subject to an orthogonal regression. For comparison, we subjected Snider's data to the same analyses performed on Nelchina Basin moose and determined that his data also exhibited a significant linear relationship ($r=.87$, $P<0.05$) [Fig. 5]. In contrast to Nelchina data, however, the variances between age classes were equal ($F=.87$, $P>0.05$) and there were no significant differences between slopes ($F=.87$, $P>0.05$) or intercepts ($F=.32$, $P>0.05$). Reasons for the differences in homogeneity of variances between the two studies are unknown but could have been related to a combination of both studies, or differences in fat deposition and mobilization between the study moose populations.

Because of small samples sizes in each of the studies and because samples in the Nelchina study were collected primarily during winter for predator kills while those in Ontario were collected primarily in October or June mainly from road-killed moose, we combined samples in an effort to better describe the relationship between longbone and mandible fat (Table 1). The analysis assumed that there were no differences in fat mobilization between the two populations. Variances between calf and adult moose in these clumped data were not significantly different ($P>0.05$) suggesting that fat mobilization in the two bones was different for the two age classes. The relationship between longbone and mandible marrow fat for each age class was best described by linear regression (Fig. 6 and 7). However, because only three adult moose had longbone fat values of less than 60%, the relationship between the two bones at lower fat levels warrants further investigation.

Similar to samples from Nelchina adult moose, bone marrow fat from mandibles and longbones of adult caribou were also significantly correlated (Fig. 8, $r=.90$, $P<0.05$) suggesting that

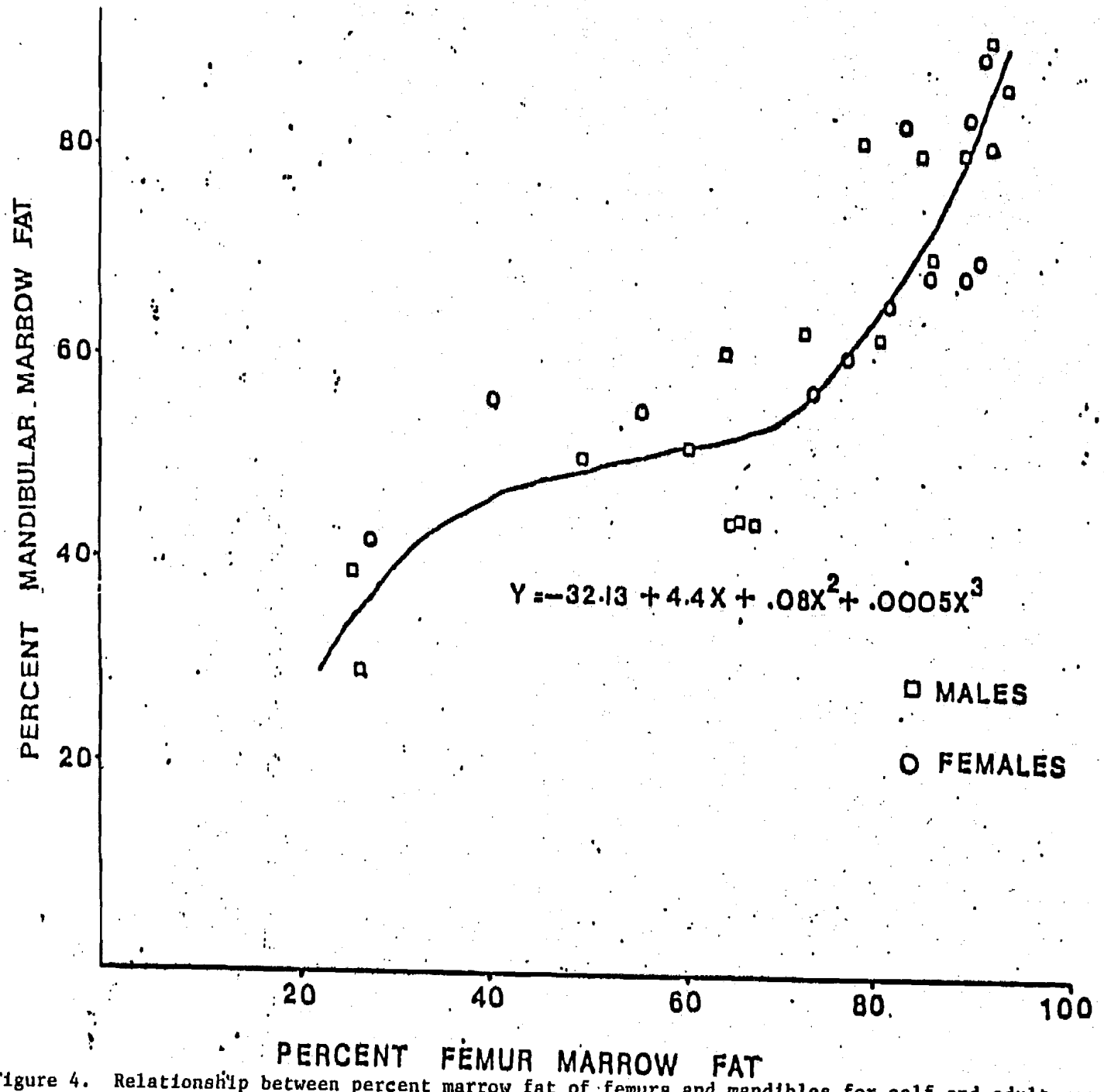


Figure 4. Relationship between percent marrow fat of femurs and mandibles for calf and adult moose in Ontario (from Snider 1980).

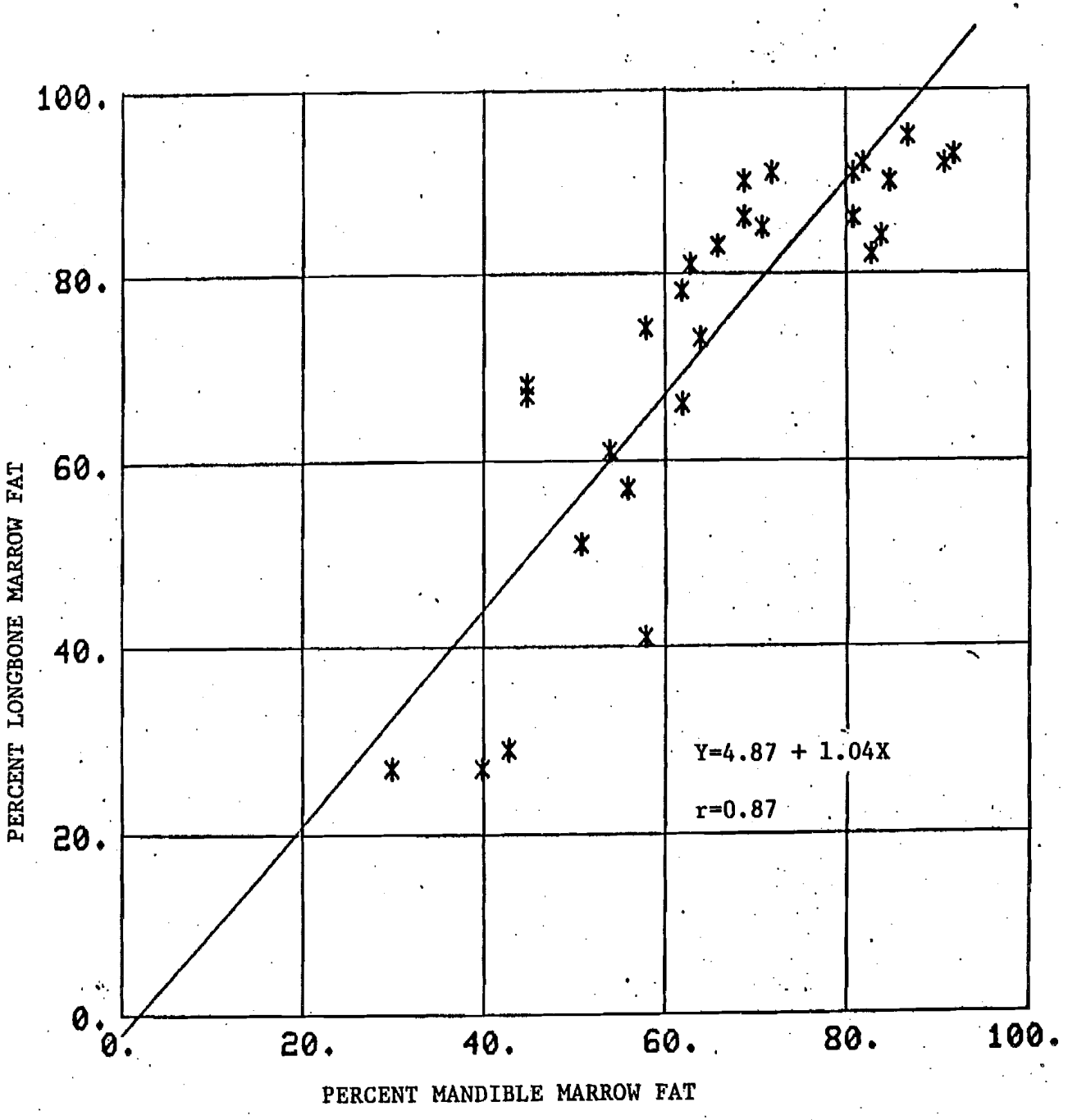


Figure 5. Relationship between percent marrow fat of mandibles and longbones for adult and calf moose in Ontario (data from Snider 1980).

Table 1. Analysis of covariance of percent marrow fat estimated from mandibles and longbones of calf and adult moose from southcentral Alaska and Ontario. 1/

Source	d.f.	S.S.	M.S.
Within			
Calves	25	3084.36	117.57
Adults	58	6094.55	105.08
	83	9178.91	110.59
Pooled Within	84	10221.90	121.69
Differences Between Slopes	1	1042.99	1042.99
Within and Between	85	30743.212	361.68
Between Adjusted Means	1	20521.31	20521.31

Significance Tests

(1) Heterscedasticity

$F = 117.57/105.08 = 1.12$ $F_{(25,58)}.25 = 1.23$

1.12 1.23 accept Ho: $_c{}^2 = {}_a{}^2$

(2) Difference in Slopes

$F = 1042.99/110.59 = 9.43$ $F_{(1,83)}.005 = 8.30$

9,43 8.30 rejects Ho: $B_C = B_a$

(3) Difference Between Intercepts

$F = 20521.31/121.69 = 168.6$ $F_{(1,84)}.001 = 11.8$

168.6 11.8 reject Ho: $_c = {}_A$

1/ Ontario data from Snider (1980).

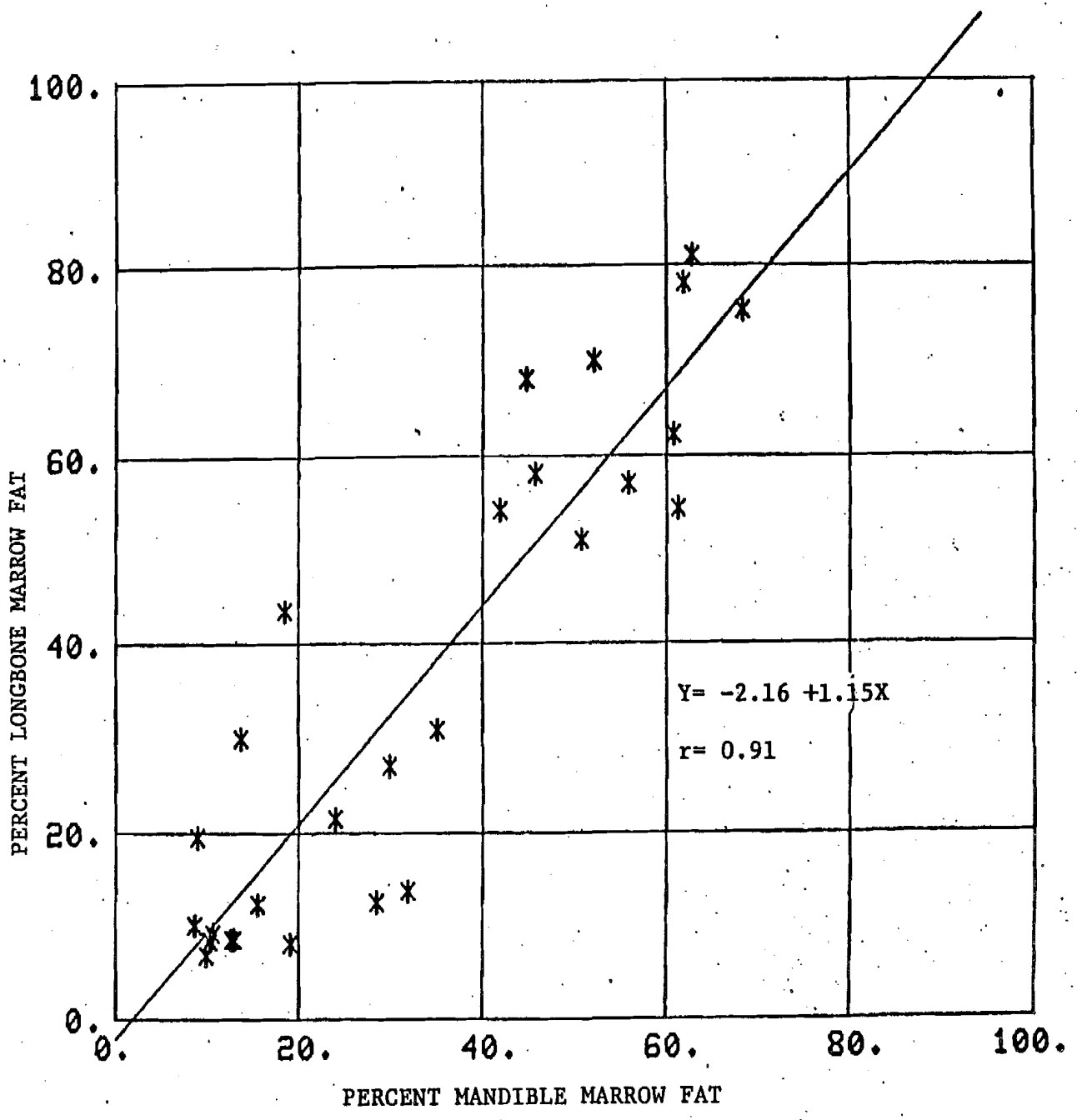


Figure 6. Relationship between percent marrow fat of mandibles and longbones for calf moose in Ontario (data from Snider 1980) and the Nelchina Basin, Alaska.

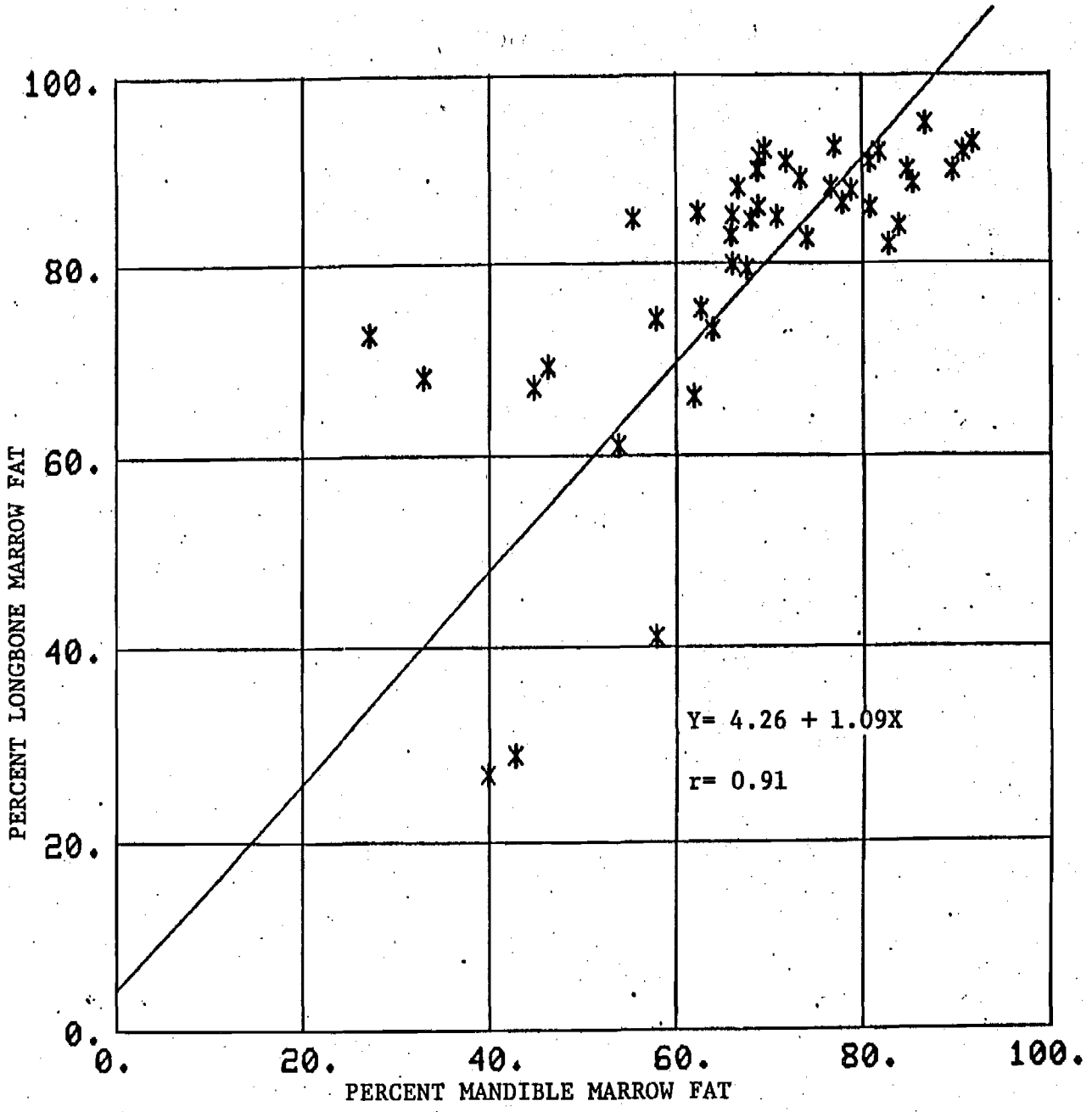


Figure 7. Relationship between percent marrow fat of mandibles and longbones for adult moose in Ontario (data from Snider 1980) and the Nelchina Basin, Alaska.

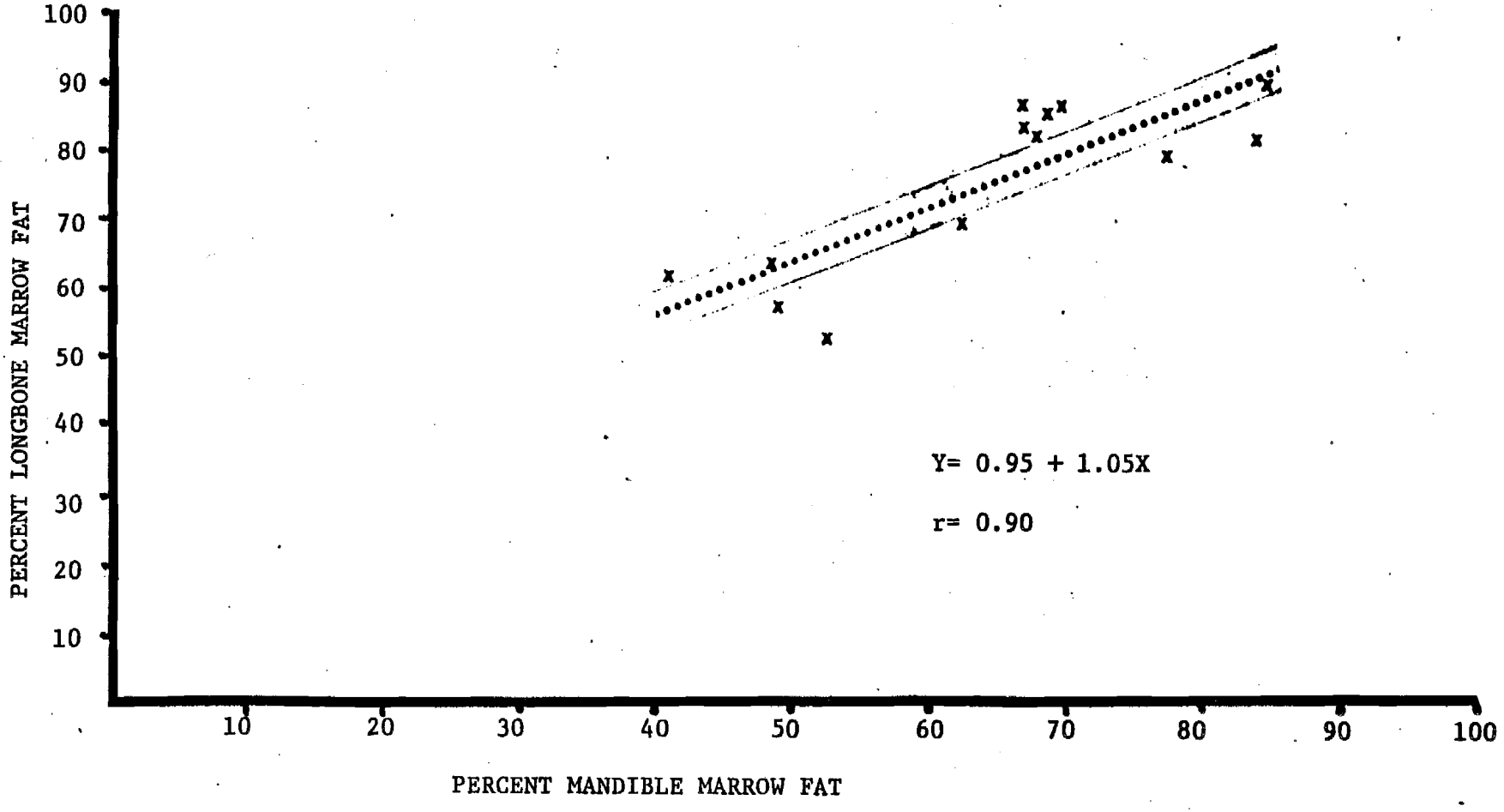


Figure 8. Relationship of percent marrow fat for mandibles and longbones for adult caribou in the Nelchina Basin, Alaska.

mandibles might be useful for estimating longbone fat in caribou. However, because sample sizes were extremely small and no samples of caribou in poor condition were collected, this relationship should be viewed with caution. Also, since no calf caribou were examined it is unknown whether a correlation exists in this age class as well.

Peterson (In Press) recently compared marrow fat levels between several longbones of individual moose and determined that fat mobilization appeared to have proceeded more quickly in proximal than in distal longbones. If correct, this may partially explain some of the variability between longbones (femurs, metatarsals, and metacarpals) and mandibles found in this study. Even with this variation, however, mandibles appear useful for determining the percent marrow fat in longbones and consequently appear useful as an indicator of condition. Although results of this study suggest a positive relationship exists between marrow fat mobilization in mandibles and longbones, we suggest that biologists collect paired samples from ungulate kills in other populations to determine if relationships are similar. If this relationship is confirmed, then biologists should consider using the mandible in lieu of longbones for marrow fat analyses. Use of mandibles will allow biologists to greatly increase sample sizes for marrow fat analysis with minimal effort at relatively small additional costs.

ACKNOWLEDGEMENTS

Appreciation is expressed to Charles Lucier and Enid Goodwin, both Alaska Department of Fish and Game (ADF&G) employees, for processing marrow samples. Donald McKnight, Karl Schneider, and Karen Wiley (all ADF&G) reviewed the manuscript and made many helpful suggestions. We also thank Lita Lewis for typing the manuscript on her personal time. The study was funded in part by Federal Aid in Wildlife Restoration Project W-17-R with additional support provided from the Alaska Power Authority.

REFERENCES

Baker, F. M., and F. X. Leuth. 1966. Mandibular cavity tissue as a possible indicator of condition in deer. Proc. Am. Conf. S. E. Game and Fish Comm. 20:69-74

Ballard, W. B. 1981. Gray wolf-brown bear relationships in the Nelchina Basin of southcentral Alaska. F. H. Harrington and P. C. Paquet, Co. Eds. Proc. Portland Wolf Symp. Portland, Oregon: In Press.

Bishop, R. H., and R. A. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Nat. Can., 101:559-593.

Cheatum, E. L. 1949. Bone marrow as an index of malnutrition in deer. N. Y. State Conser. 3:19-22.

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

Greer, K. R. 1968. A compression method indicates fat content of elk (wapiti) femur marrows. J. Wildl. Manage. 32(4):747-751.

Neiland, K. A. 1970. Weight of dried marrow as indicator of fat in caribou femurs. J. Wildl. Manage. 34(4):904-907.

Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. Natl. Park Serv. Sci. Monogr. Ser. 11. 210pp.

_____. In Press. Aspects of bone marrow fat determination in moose. J. Wildl. Manage.

Purol, D. A., J. N. Stuht, and G. E. Burgoyne, Jr. 1977. Mandibular cavity tissue fat as an indicator of spring physical condition for female white-tailed deer in Michigan. Michigan Dept. of Nat. Resources, Wildl. Div., Rept. No. 2792.

Rausch, R. A. 1969. A summary of wolf studies in southcentral Alaska, 1957-1968. Trans. N. Am. Wildl. and Nat. Resour. Conf., 34:117-131.

Sergeant, D. E., and D. H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Manage. 23(3):315-321.

Skoog, R. O. 1968. Ecology of caribou (*Rangifer tarandus granti*) in Alaska. PhD. Thesis, Univ. of California, Berkeley, California.

Snedecor, G. W., and W. G. Cochran. 1973. Statistical methods. The Iowa St. Univ. Press. Ames, Iowa. Sixth Ed. 593pp.

Snider, J. B. 1980. An evaluation of mandibular fat as an indicator of condition in moose. Proc. N. Am. Moose Conf. Workshop 16:37-50.

APPENDIX D.

ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

STATE OF ALASKA
Jay S. Hammond, Governor

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

DIVISION ON GAME
Ronald J. Somerville, Director
Donald McKnight, Research Chief

NELCHINA YEARLING MOOSE MORTALITY STUDY

by
Warren B. Ballard
Craig L. Gardner
and
Sterling D. Miller

Volume II
Final Report
Federal Aid in Wildlife Restoration
Projects W-17-11 and W-21-1, Job 1.27R

with Additional Support from the Alaska
Power Authority.

JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Warren B. Ballard, Craig L. Gardner, Sterling Miller, John Westlund, and Dennis McAllister.

Project No: W-21-11 & W-21-1 Project Title: Big Game Investigations

Job No.: 1.27R Job Title: Nelchina Yearling Moose Mortality Study

Period Covered: March 1, 1980 to June 30, 1981.

SUMMARY

Causes and rates of calf (0 to 6 months old), short yearling (7 to 12 months old), and yearling (13 to 24 months old) moose mortality were studied in Game Management Unit 13 from late March 1979 through June 1981. The status as of 1 July 1981 of 64 moose captured as short yearlings in 1979 was as follows: 22 had lost their radio-collars due to inadequate collar design; 8 had unknown status probably due to either dispersal or radio failure; 17 had died, primarily from winter-kill (59%) brown bear predation (18%); and 17 were still alive. Annual mortality rates for the 1978 cohort were 76-80% the first year and 5% the second year.

An additional 34 calf moose were captured and radio-collared in November 1979 to aid in assessing first year survival of moose calves following a removal of 48 brown bears (*Ursus arctos*) (see Ballard et al. 1980). From capture to 1 June 1980 6.1% of the moose died due to winter kill. No other mortality of radio-collared calves was observed. Second year mortality was 4%, which was attributable to unknown causes. The low rate of mortality prior to 1981 was attributed to mild winter conditions and low predator densities.

During fall 1980 both a standard moose sex-age composition survey and an intensive quadrat sampling technique were used in the bear transplant area to both compare sex-age data acquired from the two survey methods and to obtain estimates of moose density. Results of the comparisons are briefly described.

Census and composition data collected in 1980 were used to adjust sex-age composition data collected in fall 1979. Based upon this readjustment it was calculated that the fall 1979 calf: cow ratio following the transplant of brown bear was 73. Corrected 1979 composition data were used to calculate mortality from birth to 1 November 1979 following the bear transplant. The total number of calves that died from all mortality factors in 1979 was estimated at 9%. In comparison, studies conducted in 1977 and 1978 revealed that mortality during the same time period was 55%; 80% of which was attributable to predation by brown bears. Approximate rates of first year moose mortality under varying rates of wolf and bear predation and winter kill are presented and discussed. This analysis suggested that the largest increases in first year survival occurred when brown bear densities were temporarily reduced. It was tentatively concluded that the moose population was not being limited by deteriorating range conditions and that predation, primarily by brown bear, was preventing the moose population from increasing.

BACKGROUND

Studies of wolf (*Canis lupus*) food habits in the Nelchina and Susitna River Basins of southcentral Alaska (Game Management Unit 13) from 1975 through 1980 suggested that wolves were preying upon calf and yearling moose disproportionately to their presence in the moose population from January through July of each year (Ballard et al. 1981). Consequently this study was initiated to determine the importance of wolf predation to yearling moose survival. First year results of this study were reported by Ballard and Gardner (1980).

During the second year of study additional calf moose were captured and radio-collared to assess the causes and extent of yearling moose mortality in an area of reduced brown bear (*Ursus arctos*) density. Background for this portion of the study was provided by Ballard et al. (1980,1981).

OBJECTIVES

To determine the extent and causes of yearling moose mortality in the Nelchina and Susitna River Basins of Southcentral Alaska.

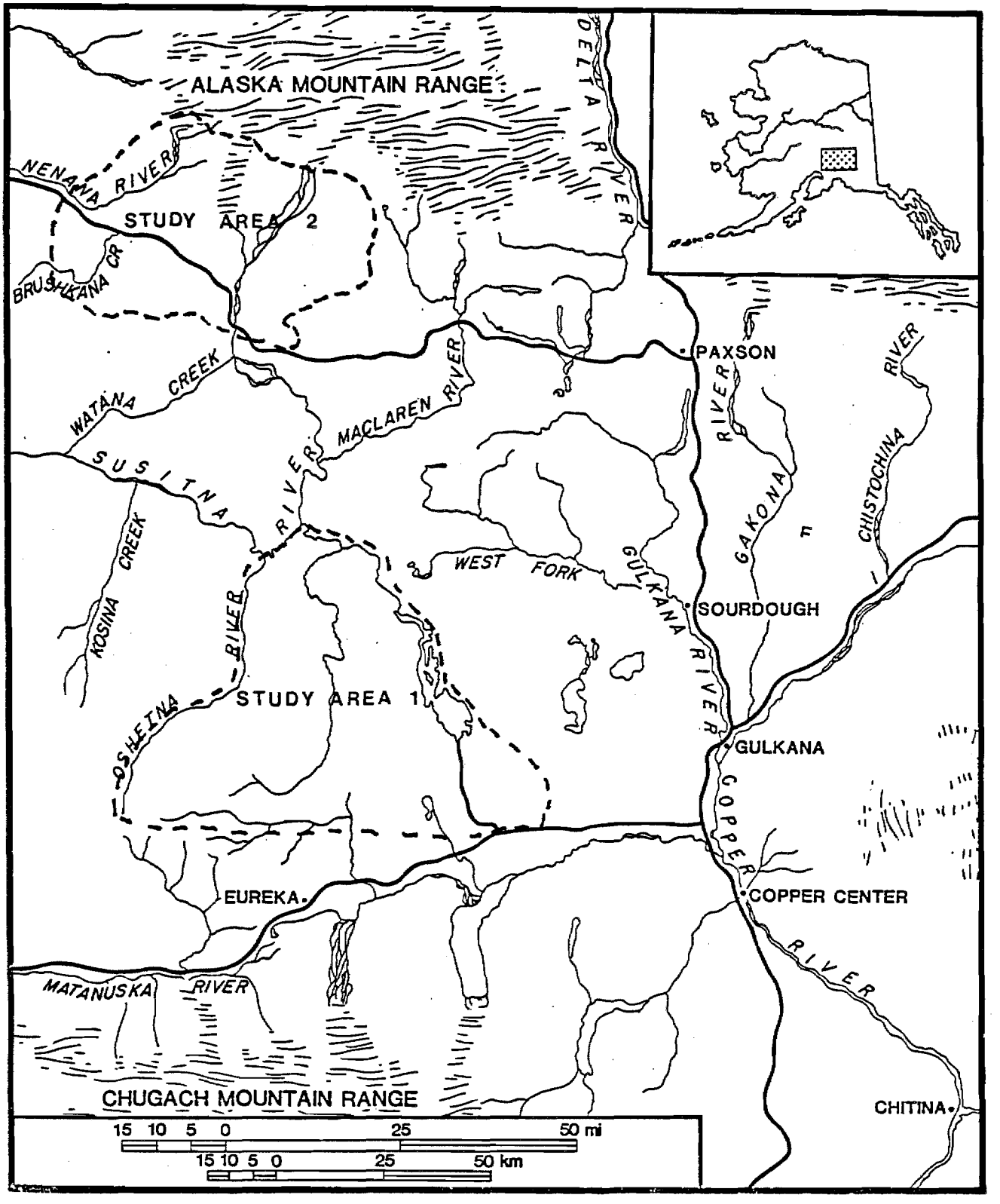
PROCEDURES

Yearling moose mortality was studied in two areas of GMU-13 (Fig. 1). Short yearling moose (7 to 12 months of age) were captured in Area 1 during March and April 1979, while calf moose (0 to 6 months of age) were captured in Area 2 during late November 1979. An additional 17 short yearling moose were captured in March 1981 as part of Susitna Dam Studies but this group will be discussed in the final study report. Topography, weather, geology and vegetation of this area has been presented elsewhere (Skoog 1968, Ballard and Taylor 1980, Ballard 1981).

Capture, processing, and radio-monitoring methods were described by Ballard and Gardner (1980) and Ballard et al. (1979). Procedures used on moose captured in the bear removal area in November 1979 were identical to those used earlier with the following exceptions: (1) 5 cc (1 mg/ml) of M-99 was used to immobilize calves, (2) radio-collars were constructed of butyl rubber with 2-3 inches of foam rubber lining the inner circumference to permit growth, (3) no blood samples were taken.

Annual mortality rates were calculated by multiplying percent survival estimates from different sampling periods within a year by one another and then subtracting from 100%.

Fig. 1. Location of study area in southcentral Alaska where causes of short yearling moose mortality were studied from March 1979 through June 1981.



RESULTS AND DISCUSSION

Capture related statistics including morphometric and blood parameters for short yearling moose captured in March-April 1979 were presented in Ballard and Gardner (1980) and will not be repeated here. Table 1 summarizes these statistics for Area 2 calves captured in November 1979.

During this reporting period a paper comparing tooth eruption patterns between moose populations from Isle Royale, Michigan, Kenai Peninsula, Alaska and the Nelchina Basin, Alaska was prepared and authored by Rolf Peterson, Charles Schwartz and Warren Ballard. A draft copy of the manuscript is presented in Appendix I. Also, a paper comparing bone marrow fat between longbones and mandibles for moose and caribou (*Rangifer tarandus*) was presented at the 17th North American Moose Conference and Workshop and is presented in Appendix II.

1978 Cohort

The status on June 1, 1981 of 64 short yearling moose captured in Area 1 during 1979 is given in Table 2. As reported earlier, a large number (n=22, 34%) of the radio-collars feel off due to problems with collar design (Ballard and Gardner 1980). Of the remaining radio-collared short yearlings, 17 were alive June 1, 1981, and the status of 8 was unknown because of either dispersal or radio failure. Of the 34 moose of known status, 17 (50%) had died. Causes of death for these were: 10 winter-killed (59%), 3 brown bear predation (18%), 2 hunter kills (12%), 1 unidentified predation (6%), and 1 tagging mortality (6%).

Table 3 summarizes the rates and causes of annual calf and yearling moose mortality for Area 1 from March 1979 through June 1981. Moose which either had lost their collars or whose status

Table 1. Location, ages, physical measurements, incisor status and other statistics associated with capturing and collaring of 34 calf moose in Game Management Unit 13 from November 27, 1979 through November 30, 1979.

Accession #	Date	Collaring Location	Sex	Age (Months)	Measurements (cm) Total Length	Hind Foot	Neck Circum.	Chest Girth	Drug Dosage (cc)	Induction Time
120375	11/29/79	Between Windy and Valdez Creek	M	5	215	67	69	156	5	--
120376	11/29/79	Windy Creek	M	5	210	67	65	148	5	--
120377	11/29/79	Windy Creek	F	5	207	65	65	136	5	--
120378	11/29/79	Windy Creek	F	5	212	66	67	162	5	--
120379	11/29/79	Between Windy and Valdez Creek	M	5	---	--	--	---	5	7
120380	11/29/81	Valdez Creek	F	5	206	69	60	142	5	--
120381	11/29/81	Middle Fork of Susitna River	M	5	---	--	--	---	5	--
120382	11/29/81	Middle Fork Susitna River	M	5	---	--	--	---	5	9
120383	11/29/79	Valdez Creek	F	5	213	72	67	173	5	9
120384	11/29/79	Valdez Creek	F	5	218	70	62	152	5	--
120385	11/29/79	Valdez Creek	M	5	212	73	64	157	5	--
120386	11/29/79	Gracious House	F	5	202	67	66	152	5	--
120387	11/29/79	Susitna Lodge	F	5	222	68	65	157	5	9
120388	11/27/79	Windy Creek	M	5	205	72	70	163	5	9

Table 1. (cont'd)

Accession #	Date	Collaring Location	Sex	Age (Months)	Measurements (cm) Total Length	Hind Foot	Neck Circum.	Chest Girth	Drug Dosage (cc)	Induction Time
120389	11/27/79	Between Windy and Valdez Creek	F	5	205	70	67	150	5	7
120390	11/27/79	Between Windy and Valdez Creek	F	5	202	--	68	---	5	--
120391	11/27/79	Between Windy and Valdez Creek	M	5	214	72	70	163	5	15
120392	11/27/79	Between Valdez and Windy Creek	M	5	190	--	67	155	5	--
120393	11/27/79	Between Windy and Valdez Creek	M	5	210	--	--	---	5	--
120394	11/27/79	Between Windy and Valdez Creek	F	5	205	--	--	---	5	--
120395	11/27/79	Between Windy and Valdez Creek	M	5	200	--	79	---	5	--
120396	11/30/79	West Fork Susitna River	M	5	197	63	66	144	5	3
120397	11/30/79	West Fork Susitna River	F	5	199	67	61	140	5	11
120398	11/30/79	Mdl Fork Susitna River	M	5	200	68	68	162	5	12
120399	11/30/79	Mdl Fork Susitna River	M	5	202	65	70	158	5	12
120400	11/30/79	West Fork Susitna River	M	5	211	67	62	148	5 1/	24

Table 1. (cont'd)

Accession #	Date	Collaring Location	Sex	Age (Months)	Measurements (cm) Total Length	Hind Foot	Neck Circum.	Chest Girth	Drug Dosage (cc)	Induction Time
120401	11/30/79	West Fork Susitna River	M	5	214	66	68	142	5	10
120402	11/30/79	Mdl Fork Susitna River	M	5	201	--	66	134	5	8
120403	11/30/79	Mdl Fork Susitna River	F	5	207	65	67	150	5	9
120404	11/30/79	Mdl Fork Susitna River	F	5	213	65	61	142	5 1/	19
120405	11/30/79	Mdl Fork Susitna River	F	5	192	66	62	139	5	11
120406	11/30/79	West Fork Susitna River	F	5	211	69	61	154	5	6
120407	11/30/79	West Fork Susitna River	F	5	198	67	67	148	5	9
120408	11/30/79	West Fork Susitna River	M	5	204	67	64	148	6	12

1/ Was darted twice.

Table 2. Summary of the status by date of 64 radio-collared short yearling moose from March 1979 to 1 June 1981 in the Nelchina Basin of Southcentral Alaska.

I.D. #	Sex	Radio #	Surviving to 6/1/81	Slipped Collar	Lost Radio Contact	Bear Predation	Winter Kill	Hunting Mortality	Tagging Mortality	Unk. I.D. Pred.
120255	F	3600		6/7/79						
120227	M	3617		4/5/79						
120229	M	3586			7/2/79					
120231	M	3602				5/29/79				
120233	F	3589		7/9/79						
120235	M	3603		5/31/79						
120236	F	3606		4/8/79						
120237	F	3619		4/30/79						
120239	F	3611					4/11/79			
120241	M	3582						9/79		
120244	F	3581		4/5/79						
120249	M	3594	X							
120250	M	3616		4/30/79						
120252	F	3610		5/22/79						
120253	F	3583		5/79						
120254	M	3604		4/5/79						
120255	F	3592		4/8/79						
120256	F	3620		4/5/79						
120257	M	3607			6/23/79					
120258	F	3599					4/5/79			
120259	F	3585			4/5/79					
120260	F	3561		4/5/79						
120261	M	3629			10/7/80					
120262	F	3621		10/7/80						
120263	F	3584		4/14/79						
120264	F	3588	X							
120265	M	3601			1/80					
120266	M	3597		4/5/79						
120267	F	3618		4/8/79						
120268	M	3596			3/08/80					
120269	M	3590	X							
120270	M	3593					4/6/79			

Table 2. (cont'd)

I.D. #	Sex	Radio #	Surviving to 6/1/81	Slipped Collar	Lost Radio Contact	Bear Predation	Winter Kill	Hunting Mortality	Tagging Mortality	Unk. I.D. Pred.
120271	M	3613			8/7/80					
120273	F	3612					4/14/79			
120275	F	3615		4/10/79						
120276	F	3622		4/12/79						
120277	M	3623				5/2/79				
120278	M	3598					4/20/79			
120279	F	3614		4/6/79						
120280	M	3608		4/30/79						
120281	M	3605					4/27/79			
120284	M	3587					4/27/79			
120285	M	3595					4/27/79			
120287	M	3582					5/2/79			
120288	F	3620							4/20/79	
120290	F	3599	X							
120291	F	3618	X							
120292	M	3507					5/18/79			
120293	F	3604	X							
120294	M	3615	X							
120295	M	3591				8/4/79				
120296	F	3587								5/18/79
120297	F	3595	X							
120298	F	3612	X							
120299	F	3592	X							
120300	F	3598	X							
120301	M	3622	X							
120302	F	3611	X							
120303	F	3605	X							
120304	M	3617						9/12/79		
120305	F	3606			3/18/81					
120306	F	3620	X							
120307	F	3593	X							
120308	F	3581	X							

Table 3. Rates and causes of annual mortality (March, 1979 to June, 1981) of moose captured as short yearlings in late winter 1979 in GMU-13 of Southcentral Alaska.

	Dates					
	3/79 - 6/1/79 [1]		6/2/79 - 6/1/80		6/2/80 - 6/1/81	
	No.	%	No.	%	No.	%
Sample Size	43	100	24	100	17	100
Causes of mortality						
Natural						
Winter Kill	10	23	0	0	0	0
Bear Predation	2	5	1	4	0	0
Unknown Predation	1	2	0	0	0	0
Subtotal	13	30	1	4	0	0
Hunting	0	0	2	8	0	0
Total	13	30	3	13	0	0
No. Surviving	30	70	21	87	17	100

1/ Does not include period from birth up to March 1979.

as of June 1 was unknown were excluded from calculations for the preceding year. Natural causes, primarily winter kill (77% of mortality), accounted for 30% mortality of the short yearling moose from late March to 1 June 1979. Results of calf mortality studies during 1977 and 1978 indicated that 45% of the moose calves survived to November 1 (Ballard et al. 1981). Based upon this survival rate and that of short yearlings (70%) for every 100 calves produced in 1978, a minimum of 69 died. However, this figure is conservative because it excludes the period between November 1 to late March during which time some moose doubtless died during winter 1978-79, the second most severe winter in terms of total snowfall and due to wolf predation. During winter 1978-79, 7 of 17 (41%) short yearlings of radio-collared cows perished (Ballard and Taylor 1980). Thus, a more accurate estimate of first year mortality during a severe winter was 73%; however, even this estimate may be low--because 16 of 33 of the radio-collared adults occupied an area of low wolf density (Ballard and Taylor 1978). Correspondingly, many of the short yearling losses were probably attributable to winter-kill. During winters 1978-79 and 1979-80 it was estimated that two wolf packs had preyed upon 9 to 24% of the short yearlings during late winter (Ballard et al. 1981). During this study no losses of radio-collared yearlings were attributable to wolf predation even though wolf studies indicated short yearlings were being killed. We do not know if the lack of wolf predation on the radio-collared yearlings during March through June was representative or if sample size or other unknown factors precluded its identification. Thus including losses due to winter wolf predation we estimate that first-year mortality of moose during this year with a severe winter ranged from 79 to 84% based upon the following assumptions: 55% newborn moose calf mortality attributable primarily to bear predation; 30 to 41% winter and spring mortality of surviving members of this cohort primarily from starvation and bear predation; and a maximum of 24% mortality due to wolf predation (total mortality estimated by multiplying individual survival rates, and subtracting from 100%, therefore, summing the individual rates will exceed 100%).

Yearling mortality of the 1978 cohort was 14%, however, hunting losses accounted for 66% of this mortality. Therefore, second-year natural mortality was estimated at 5% which was highly comparable to the 6% adult mortality estimated by Ballard and Taylor (1980) for adult moose. No mortality was observed for 2-year-old moose.

Rates and causes of mortality for the 1978 bull cohort from late March through May 1979 are summarized in Table 4. Mortality during this time period was estimated at 43%, while yearling (2nd year of life) losses including hunting mortality was 38%. Excluding hunting, natural mortality from June 2, 1979 to June 1, 1980 was 17%. No mortality was observed among 2-year olds, which suggests that new hunting regulations based upon antler restriction (legal bull must have antler spread of 36 inches or more) are protecting this cohort from hunting mortality. Winter kill (n = 7) and bear predation (n = 3) were the causes of natural mortality. Rate of natural mortality for males of the 1978 cohort during the first and second year of life was significantly (chi-square, $P<0.05$) greater than that for females. Based upon blood parameters used by Franzmann and LeResche (1978) to assess the physical condition of adult moose, male short yearling moose were in poorer physical condition at the time of capture than were females (Ballard and Gardner 1980).

1979 Cohort

The status of 34 calf moose studied in Area 2 from November 1979 through June 1981 is summarized in Table 5. Twenty-seven moose were known to be alive as of June 1, 1981. Two died from winter-kill in March 1980 while two others died of unknown causes and one slipped its collar during winter 1980-81. Radio contact with four moose (3 in 1980 and 1 in 1981) was lost due to either radio failure or dispersal.

Table 4. Rates and causes of annual mortality of bull moose captured as short yearlings in late winter 1979 in GMU-13 of Southcentral Alaska.

	Dates					
	3/79 - 6/1/79 1/		6/2/79 - 6/1/80		6/2/80 - 6/1/81	
	No.	%	No.	%	No.	%
Sample Size	21	100	8	100	3	100
Causes of mortality						
Natural						
Winter Kill	7	33	0	0	0	0
Bear Predation	2	10	1	13	0	0
Subtotal	9	43	1	13	0	0
Hunting	0	0	2	25	0	0
Total	9	43	3	38	0	0
No. Surviving	12	57	5	62	3	100

1/ Does not include period from birth up to March 1979.

Table 5. Summary of the status by date of 64 radio-collared short yearling moose from March 1979 to 1 June 1981 in the Nelchina Basin by Southcentral Alaska.

I.D. #	Sex	Radio #	Surviving to 6/1/81	Slipped Collar	Lost Radio Contact	Bear Predation	Winter Kill	Hunting Mortality	Tagging Mortality	Unk. I.D. Pred.
120375	M	5712	X							
120376	M	5517			12/2/80					
120377	F	5199			3/19/81 1/					
120378	F	5190	X							
120379	M	5185	X							
120380	F	5181	X							
120381	M	5197	X							
120382	M	5182	X							
120383	F	5186			7/18/80					
120384	F	5175	X							
120385	M	5196			3/27/80					
120386	F	5171	X							
120387	F	5195	X							
120388	M	5180	X							
120389	F	5176	X							
120390	F	5192	X							
120391	M	5193	X							
120392	M	5174	X							
120393	M	5191	X							
120394	F	5194	X							
120395	M	5200	X							
120396	M	5184	X							
120397	F	5179	X							
120398	M	3992	X							
120399	M	3597								12/6/80
120400	M	5183	X							
120401	M	5178					3/6/80			
120402	M	5198	X							
120403	F	3623	X							
120404	F	3602	X							
120405	F	3614					3/6/80			
120406	F	5187		3/19/81						
120407	F	5173	X							
120408	M	5188	X							

1/ Radio-failure confirmed-Present with radio-collared twin.

Table 6 summarizes rates and causes of annual mortality to 1 June 1981 for moose captured as calves in November 1979. Excluding early neonatal losses (pre-November), first-year (11/79-6/1/80) mortality due to winter kill was 6.1%, which was significantly less (P 0.05) than that suffered by the 1978 cohort during the severe winter of 1978-79. This significantly lower mortality rate can be attributed to milder snow conditions during winter 1979-80 and perhaps to reduced bear predation. High survival was also confirmed during a spring composition survey flown on May 23, 1980 (Table 7). Because bull moose cannot be accurately identified from aircraft during spring, we assumed the spring sex ratio of adults was identical to the fall 1979 bull:cow ratio (18M=100F). Subtracting adult bulls (N=14) from the total numbers of adults counted (n=93) yielded an estimate of 58 short yearlings:100 cows (includes cows ≤2 yr. olds). This estimate was comparable with the fall ratio of 58 calves: 100 cows (≥2 yr. old) which indicates that survival was quite high.

Second year survival of the 1979 cohort during winter 1980-81 was similar to that experienced by the 1978 cohort during 1979-80; 96% survival in 1980-81 for the 1979 cohort versus 95% (excluding hunting) survival in 1979-80 for the 1978 cohort.

Evaluation of Brown Bear Transplant

Routine moose sex and age composition counts were conducted in Moose Count Area 3 during early November 1980. Immediately following the composition count, the area was censused using quadrat sampling techniques developed by Gasaway (1978), Gasaway et al. (1979), and Gasaway and Dubois (unpub. report). Comparison of the resulting sex and age composition data in addition to the fall population estimate is summarized in Table 8. Similar to comparisons made elsewhere in Alaska calf:100 cow ratios provided by quadrat sampling methods were considerably higher than those provided from standard composition counts (Gasaway pers. comm.).

Table 6. Rates and causes of annual mortality of moose captured as calves in November, 1979 in GMU-13 of Southcentral Alaska.

	Dates			
	11/2/79 - 6/1/80 1/		6/2/80 - 6/1/81	
	No.	%	No.	%
Causes of mortality	33	100	28	100
Natural Mortality				
Winter Kill	2	6	0	0
Bear Predation	0	0	0	0
Unknown predation	0	0	0	0
Unknown causes	0	0	1	4
Subtotal	2	6	1	4
Hunting	0	0	0	0
Total	2	6	1	4
No. Surviving	31	94	27	96

1/ Does not include period from birth up to November 1979.

Table 7. Summary of spring moose composition survey conducted in Moose Count Area 3 on 23 May 1980 in the upper Susitna River Basin of Southcentral Alaska.

# Adults without short yearlings	# Females with 1 short yearling	# Females with 2 short yearlings	Lone yearlings	Total # short yearlings
58	30	5	6	46

Adults = 93
Short Yearlings = 46
% Short Yearlings = 36%
Count time: 250 minutes

Table 8. Comparison of moose sex-age composition data collected from standard moose surveys to that obtained from quadrat sampling techniques used in Moose Count Area 3 during November 1980 in the upper Susitna River Basin.

	Date	Tot. bulls per 100 cows	Sm. Bulls per 100 cows	Sm. bulls per 100 lg. bulls	Sm. bulls % in Herd	Calves per 100 cows $\geq$ 2 yrs.	Calves per 100 cows	Incidence of twins per 100 cows w/calf	Calf % in herd	Animals per hour	Total sample	Count time (hr.)	Area Sampled (mi^2)	Minutes/ (mi^2)
Composition count	11/1-2	36.7	21.8	146.4	11.9	40.1	31.4	16.3	17.2	37.0	344	9.3	273.5	2.0
Census	11/2-4	29.9	20.1	203.9	11.6	55.0	43.9	13.9	25.3	27.8	459	16.5	247.5	4.0
Stratification	11/1	--	--	--	--	--	--	--	--	89.9	187	2.15	273.5	.5

	x moose/group	% of observed moose comprised of singles	% of observed moose comprised of pairs	% of observed moose comprised of groups of 3	% of observed moose comprised of groups of 4 or more
Composition count	2.7	9.6	29.9	8.3	52.2
Census	2.6	7.6	34.4	20.9	37.0
Stratification	2.7	7.5	32.1	17.6	42.8

Population Estimate = 473 = $\pm$ 38 (90% CI = 435 - 510).
(uncorrected for observability)

This discrepancy is related to survey intensity and a higher probability of observing large groups of moose which proportionately contain fewer calves.

We used the relationship between the 1980 moose composition counts and the quadrat sampling to recompute ratios obtained in 1979 following the removal of 48 brown bears by transplant (Ballard et al. 1980; Miller and Ballard in press). Based upon the 1979 calf: cow ratio of 52.2 estimated from a composition count, the estimated ratio, had the area been censused, would have been 72.9 calves/100 cows, while the bull: cow ratio would have been 14.6. Similarly, the calf percentage of the herd would have been 45.2%. We estimated calf survival in moose count area 3 following the bear transplant by applying these ratios to a hypothetical moose population of 1,000. According to our projections, this hypothetical population in early November would have been comprised of 450 calves, 83 bulls, 60 yearlings cows (assumed to be sexually immature) and 407 cows. Assuming a pregnancy rate of 90% (Ballard and Taylor 1980) 366 cows should have produced calves in 1979. Twinning rates were calculated based upon 89 newborn moose calves captured in count area 3 from 1977 through 1979, yielding a twinning rate of 35% or a gross production of 135 calves/100 cows (Ballard et al. 1980). Therefore, 494 calves should have been produced. Since 450 calves theoretically were alive by 1 November, after the period when most neonatal losses occur (Ballard et al. 1981), an estimated 44 calves died following a reduction in bear density of approximately 60% (Ballard et al. 1980). This provides an estimate of 9% calf mortality from birth to November 1 in 1979. Similarly to the above analysis we applied the relationship between the 1980 composition count and census data to the 1977 and 1978 composition counts which were conducted prior to the reduction in bear density. The resulting estimated mortality rates were 60 and 55% for 1977 and 1978, respectively. These latter estimates were quite similar to those observed on radio-collared moose calves.

Calf mortality studies conducted in GMU-13 during 1977 and 1978 prior to bear removal suggested that 55% of the newborn moose calves died between birth and 1 November of each year (Ballard et al. 1981). During 1979 after bears had been removed the radio-collared calf data continued to indicate that about half of the calves were being killed by bears. We discounted these data for this analysis because of the following: 1) relatively small sample size (27 in 1979 versus 120 in 1977 and 78); 2) the smaller sample of calves was concentrated in a relatively small area which made calves vulnerable to a relatively small number of bears (Ballard et al. 1980); and 3) comparisons of fall calf:cow ratios with other unmanipulated moose count areas suggested that there had been a significant improvement in calf survival (op. cit.). Based upon the estimated mortality rate derived from the 1979 composition count the temporary reduction in brown bear density may have reduced calf mortality from 55% to 9%, an 84% decrease in total mortality.

Mortality of calves and short yearlings in count area 3 during winter 1979-80 was estimated at 6%. Therefore, during the year of the bear reduction program, first year mortality of the 1979 cohort due to early neonatal losses and winter kill totaled an estimated 14%. No losses were attributable to wolf predation; however, if wolves had preyed upon 24% of the calves (the maximum estimate of wolf predation) and short yearlings from 1 November through early spring 1979, the first year mortality rate would have been 36%.

Table 9 summarizes approximate rates by cause of first year moose mortality for the Nelchina and upper Susitna River Basins as determined from several studies conducted from 1975 through 1981. Based upon these estimates, first year moose mortality varied from 23 to 84% depending upon the magnitude of bear predation, wolf predation, and winter severity. These figures do not consider winter-kill and wolf predation as compensatory mortality factors, nor do they consider variations in moose density.

Table 9. Estimates of first year moose mortality by cause and time period for the Nelchina and Susitna River Basins of Southcentral Alaska.

% Mortality birth - 1 Nov. (level of bear predation)	% Mortality from winter kill- 1 Nov. - 1 June (winter severity)	% Mortality from wolf predation- 1 Nov. - 1 June (predation level)	Total calculated first year mortality 7/
		High 5/ .24	.84
	Severe 3/ .41		
		Low 6/ .09	.77
High 1/ .55			
		High 5/ .24	.68
	Mild 4/ .06		
		Low 6/ .09	.62
		High 5/ .24	.68
	Severe 3/ .41		
		Low 6/ .09	.54
Low 2/ .09			
		High 5/ .24	.36
	Mild 4/ .06		
		Low 6/ .09	.23

1/ Mortality rate estimated from calf mortality studies (Ballard et al. 1981) and includes 20% of total mortality which was not attributable to brown bear predation.

2/ Based upon estimated calf production and survival following a 58% reduction (transplant) in brown bear density (see text, this report).

3/ Determined from observations of short yearling losses of radio-collared adult moose during 1978-79 (Ballard and Taylor 1980).

4/ Determined from observations of radio-collared calf moose during 1979-80.

5/ Extrapolated from predation rates for two wolf packs numbering 7-8 wolves studies during winter 1979-80 (Ballard et al. 1981). Percent of calves preyed upon was determined by estimating the total pack area moose population by estimating % of moose observed according to survey intensity (from Gasaway and Dubois, unpub. rept.).

6/ Extrapolated from predation rate for one wolf pack numbering 2 wolves studied during winter 1978-79 (Ballard et al. 1981). Percent calves preyed upon estimated same as that described for #5.

7/ Assumes no compensatory mortality. Annual mortality was estimated by determining percent survival from birth to 1 November and from 1 November to 1 June. The estimates were then multiplied and the sum subtracted from 100 percent.

Nevertheless, they provide a general estimate of the extent of mortality from the three major mortality factors. This analysis suggests that the largest increases in survival occurred when brown bear densities were temporarily reduced to the level attained during the bear transplant.

According to this simple model with high bear predation and severe winters, a reduction in wolf pack size from 7-8 to 2 wolves only resulted in a 7% decrease in mortality. A similar difference also occurred with the same conditions, but during mild winters. However, the difference between high and low wolf predation with high bear predation levels during severe versus mild winters was 22%.

During years of low bear predation such as that following the bear transplant (Ballard et al. 1980) a difference in high and low wolf predation during severe winters would result in an estimated difference of 14% mortality, while during mild winters the projected difference was 13% (Table 9). With low predation by both bears and wolves during a mild winter, first-year mortality was at its lowest level (23%).

The high survival of calf and yearling moose in Study Area 2 could be attributed to reduced brown bear predation as a result of the brown bear transplant (Ballard et al. 1980) and the mild winter of 1979-80. The high survival rates documented in this study suggest that at least on a short term basis, the study area's moose population was not being limited by deteriorating range conditions and that predation, primarily by brown bears, was preventing the moose population from increasing.

RECOMMENDATION

1. Continue to monitor survival of moose captured in 1979 and 1981.

2. Initiate a long term study to develop a satisfactory brown bear harvest strategy which would reduce bear predation and allow the moose population to increase while maintaining a viable bear population.

ACKNOWLEDGMENTS

Sterling Eide, Albert Franzmann, Dennis McAllister, Christian Smith, Robert Tobey, John Westlund, (all Alaska Department of Fish and Game) and William Martin (U. S. Fish and Wildlife Service) participated in the tagging operations.

Special appreciation is extended to Mr. Alfred Lee, Lee's Air Taxi Service, not only for donating flying time, but also for helping pick up the radio collars which slipped off moose. Many of the projects successes could be attributed to the interest and effort given by Mr. Lee.

Appreciation is also extended to Vern Lofstedt, Kenai Air Service, for piloting the helicopter, and to Ken Bunch, Sportsman's Flying Service, for assistance with monitoring radio-collared moose.

Karl Schneider and G. Bos reviewed this report and made a number of suggestions for improvement. SuzAnne Miller advised us on statistical procedure.

LITERATURE CITED

Ballard, W. B., and K. P. Taylor. 1978. Upper Susitna River Moose Population Study. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. Prog. Rept. W-17-10, Jub 1.20R. Juneau. 62pp.

_____, A. W. Franzmann, K. P. Taylor, T. Spraker, C. C. Schwartz, and R. O. Peterson. 1979. Comparison of techniques utilized to determine moose calf mortality in Alaska. 15th N. Am. Moose Conf. Workshop, Kenai, Alaska.

_____, and K. P. Taylor. 1980. Upper Susitna Valley moose population study. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. Final Rept. W-17-9 and W-17-11, Job 1.20R. Juneau. 102pp.

_____, S. D. Miller, and T. H. Spraker. 1980. Moose calf mortality study, Game Management Unit 13. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. Final Rept. W-17-9. 123pp.

_____, and C. L. Gardner. 1980. Nelchina Yearling Moose Mortality study. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. Rept. W-17-11 and W-21-1. 22pp.

_____. 1981. Grey wolf-brown bear relationships in the Nelchina Basin of southcentral Alaska. F. H. Harrington and P. C. Paquet, Co. eds. Portland Wolf Symposium. Portland, Oregon: in press.

_____, R. O. Stephenson and T. H. Spraker. 1981. Nelchina Basin Wolf Studies. Alaska Dept. of Fish and Game. P-R Proj. Rept., W-17-9 aND W-17-10. 201pp.

Franzmann, A. W., and R. E. LeResche. 1978. Alaskan moose blood studies with emphasis on condition evaluation. J. Wildl. Manage. 42:344-351.

Gasaway, W. 1978. Moose survey procedures development. Alaska Dept. Fish and Game. P-R Proj. Rept. 47pp.

_____, S. J. Harbo, and S. D. DuBois. 1979. Moose survey procedures development. Alaska Dept. Fish and Game. P-R Proj. Rept. 87pp.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Thesis. Univ. California, Berkeley. 689pp.

PREPARED BY:

Warren B. Ballard
Game Biologist III

APPROVED BY:

_____
Director, Division of Game

SUBMITTED BY:

Karl B. Schneider
Regional Research Coordinator

_____
Research Chief, Division of Game

APPENDIX E

Appendix E. Daily activity, movements and association of eight members of the Watana wolf pack as determined from aerial observations from 6 May through 1 July 1981 in the Susitna River Basin of southcentral Alaska.

Wolf - 308 - Adult gray female

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/6-5/8/81 am 1600 (11)	0	-	den	1(324)	0	-	-
5/9/81 pm (11)	0	-	den	1(324)	0	-	-
5/10/81 1335 (11)	0	-	den	0	0	-	-
5/11/81 1005 (11)	0	-	den	0	0	-	-
5/12/81 1853 (11)	0	-	den	2(323) (325)	0	-	323 returned
5/13/81 1625 (11)	0	-	den	3(323) (324) (346)	0	-	346 returned
5/14/81 0820 (11)	0	-	den	1(324)	0	-	-
5/15/81 1530 (11)	0	-	den	2(323) (346)	0	-	-
5/16/81 1020 (11)	0	-	den	2(324) (325)	-	-	-
5/17/81 1800 (11)	0	-	den	1(323)	-	-	-

Wolf - 308 - Adult gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/18/81 - 1410 (11)	0	-	den	2(323)	-	-	
5/21/81 0905 (11)	0	0	den	3(324) (325) (346)	0	-	-
5/22/81 1730 (11)	0	0	den	2(323) (346)	0	-	-
5/23/81 0937 (11)	0	0	den	0	0	-	-
5/24/81 1855 (11)	0	0	den	2(323) (346)	0	-	-
5/25/81 0955 (11)	0	0	den	3(323) (325) (346)	0	-	-
5/26/81 - (11)	0	0	den	3(324) (346)	0	-	-
5/27/81 0900 (11)	0	0	den	2(325) (346)	0	-	-
5/30/81 1610 (11)	0	0	den	3(323) (325)	0	-	-
5/31/81 1634 (11)	0	-	den	3(323) (324) (325)	-	-	
6/1/81 0920 (11)	0	-	den	1(346)	-	-	

Wolf - 308 - Adult gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/2/81 1930 (11)	0	-	den	3(323) (324) (346)	-	-	
6/3/81 1255 (11)	0	-	den	3(323) (324) (346)	-	-	
6/4/81 1945 (11)	0	-	den	5(323) (324) (325) (345) (346)	-	-	
6/5/81 1930	4.0	SSE	2 mi. E. standing bear	4(323) (324) (346) (1)	4.0	SSE	Suspected traveling from caribou kill made by bl. bear several days earlier.
6/6/81 0940 (11)	4.0	NNE	den	4(323) (324) (325) (346)	0	-	-
6/7/81 2050 (11)	0	-	den	4(323) (324) (325) (345)	0	-	-
6/8/81 0830 (11)	0	-	den	?	0	-	-
6/9/81 1721 (11)	0	-	den	4(323) (324) (345) (346)	0	-	-

Wolf - 308 - Adult gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/10/81 1145 (11)	0	-	den	3(323) (345) (346)	0	-	-
6/11/81 2028 (11)	0	-	den	5	(11)	0	-
6/13/81 1245 (11)	0	-	den	3(323) (324) (325)	0	-	-
6/14/81 1024 (11)	0	-	den	3(325) (345) (346)	0	-	-
6/15/81 1557 (11)	0	-	den	4(323) (324) (325) (345)	0	-	-
6/16/81 1139 (11)	0	-	den	2(323) (346)	0	-	-
6/18/81 1600 (11)	0	-	den	2(323) (346)	0	-	-
6/19/81 1200 (124)	10.3	SW	Fog Lake	3(323) (345) (346)	10.3	SW	on calf moose kill.
6/21/81 1645 (11)	10.3	NE	den	2(323) (345)	0	-	-
6/22/81 1230 (11)	0	-	den	5(323) (324) (325) (345) (346)	0	-	-

Wolf - 308 - Adult gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/23/81 1100 (11)	0	-	den	5(11)	0	-	-
7/1/81 1353 (24)	.8	N	N of den	4(323) (324) (345) (346)	.8	N	Rendez-vous site

Wolf - 323 - Yearling gray female

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/11/81 1225 (59)	2.0	SW	W.F. Gulkana	0	39.5	ESE	-
5/12/81 1853 (11)	39.2	ENE	den	2(308) (325)	0	-	-
5/13/81 1625 (11)	0	-	den	3(308) (324) (346)	0	-	-
5/14/81 0810 (65)	1.0	NE	near den	0	1.0	NE	-
5/15/81 1530	1.0	SW	den	2(308) (346)	0	-	-
5/17/81 1800 (11)	0	0	den	1(308)	0	-	-

Wolf - 323 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/18/81 1410 (11)	0	0	den	2(308) (324)	0	-	-
5/21/81 1020 (76)	7.5	NE	East of Big Lake	0	7.5	NE	-
5/22/81 1730 (11)	7.5	SW	den	2(308) (346)	0	-	-
5/23/81 0950 (81)	4.5	S	E. of St. bear Lake	1(325)	4.5	S	-
5/24/81 1855 (11)	4.5	N	den	2(308) (346)	0	-	-
5/24/81 1945 (85)	5.5	S	Isl. on Sue	1(325)	5.5	S	Ravens in area. 2 bear closeby.
5/25/81 0955 (11)	5.5	N	den	3(308) (324) (346)	0	-	-
5/26/81 1840 (90)	6.3	S	S. of River	0	6.3	S	
5/30/81 1610 (11)	6.3	N	den	2(308)	0	-	
5/31/81 1634 (11)	0	-	den	3(308) (324) (325)	0	-	

Wolf - 323 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/1/81 0925 (109)	2.3	E	E. of den	1(325)	2.3	E	On 50% consumed calf moose.
6/2/81 1930 (11)	2.3	W	den	3(308) (345) (346)	0	-	
6/3/81 1255 (11)	0	-	den	3(308) (324) (346)	0	-	
6/4/81 1945 (11)	0	-	den	5(308) (324) (345) (346)	0	-	
6/5/81 1930 (100)	4.0	SSE	2 mi. E. Std. bear Lk	4(308) (324) (346) (1)	4.0	SSE	Suspect traveling from caribou killed by bl. bear.
6/6/81 0940 (11)	4.0	NNE	den	4(308) (324) (346) (25)	0	-	
6/7/81 2050 (11)	0	-	den	4(308) (324) (325) (346)	0	-	
6/8/81	NO DATA						
6/9/81 1721 (11)	0	-	den	4(308) (324) (345) (346)	0	-	

Wolf - 323 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/10/81 1145 (11)	0	-	den	3(308) (345) (346)	0	-	
6/11/81 1031 (11)	0	-	den	5(308) (324) (325) (345) (346)	0	-	
6/12/81 2028 (11)	0	-	den	5(308) (324) (325) (345) (346)	0	-	
6/13/81 1245 (11)	0	-	den	3(308) (324) (325)	0	-	
6/15/81 1557 (11)	0	-	den	4(308) (324) (325) (345)	0	-	-
6/16/81 1139 (11)	0	-	den	2(308) (346)	0	-	-
6/18/81 1600 (11)	0	-	den	2(308) (346)	0	-	-
6/19/81 1200 (124)	10.3	SW	Fog Lake	3(308) (345) (346)	10.3	SW	on calf moose kill.
6/21/81 1645 (11)	10.3	NE	den	2(308) (346)	0	-	-

Wolf - 323 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/22/81 1230 (11)	0	-	den	5(308) (324) (325) (345) (346)	0	-	-
6/23/81 100 (11)	0	-	den	5(11)	0	-	-
7/1/81 1353 (24)	.8	N	N. of den	4(308) (325) (345) (340)	.8	N	Rendez-vous site.

Wolf - 324 - Yearling gray female

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/6-5/8/81 am 1615 (11)	3.7	N	den	1(308)	0	-	
5/9/81 pm (11)	0	0	den	1(308)	0	-	
5/10/81 1600 (51)	5.0	SW	Mouth Watana	0	5.0	SW	
5/11/81 1000 (55)	2.5	NE	Delusion	?	2.8	SW	

Wolf - 324 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/12/81 1850 (62)	2.0	W	Watana	?	1.2	SSW	
5/13/81 1625 (11)	1.2	NNE	den	3(308) (323) (346)	0	-	
5/14/81 0820 (11)	0	0	den	1(30)	0	-	
5/16/81 1020 (11)	0	0	den	2(308) (325)	0	-	
5/17/81	7.7	NW	Deadman	0	7.7	New	
5/18/81 1410 (11)	7.7	SE	den	2(308) (323)	0	-	
5/21/81 0905 (11)	0	0	den	3(308) (325) (346)	0	-	-
5/22/81 1730 (80)	3.3	S	St. Bear Lake	0	3.3	S	-
5/23/81 - (82)	1.8	SSW	N. of Sue. River	0	5.0	S	-
5/25/81 0955 (11)	5.0	N	den	3(308) (323) (346)	-	-	-
5/26/81 - (11)	0	0	den	3(308) (346)	-	-	-

Wolf - 324 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
/27/81 0910 92)	3.0	E	E. of den	0	3.0	E	-
/31/81 1634 11)	3.0	W	den	3(308) (323) (325)	0	-	
6/1/81 959 110)	9.3	SW	E. mouth Deadman Ck.	0	9.3	SW	
6/2/81 945	10.5	NE	N. of den	0	2.8	N	on adult caribou kill, 50% consumed.
6/3/81 255 11)	2.8	S	den	3(308) (323) (346)	0	-	
6/4/81 945 11)	0	-	den	5(308) (323) (325) (345) (346)	0	-	
6/5/81 930 100)	4.0	SSE	2 mi. E. Std. Bear Lk.	4(308) (323	4.0	SSE	Suspected traveling from caribou kill made by bl. bear.
6/6/81 940 (11)	4.0	NNE	den	4(308) (323) (325) (346)	0	-	-

Wolf - 324 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/7/81 2050 (11)	0	-	den	4(308) (323) (325) (345)	0	-	
6/8/81	NO DATA						
6/9/81 1721 (11)	0	-	den	4(308) (323) (345) (346)	0	-	
6/10	NO DATA - Absent from den.						
6/11/81 1031 (11)	?	?	den	5(308) (323) (324) (345) (346)	0	-	
6/12/81 1245 (11)	0	-	den	3(308) (323) (325)	0	-	
6/14/81 1043 (114)	5.5	S	Isl. on Sue.	?	5.5	S	Suspect feeding on on kill of 5/24-6/14.
6/15/81 1557 (11)	5.5	N	den	4(308) (323) (325) (345)	0	-	-
6/18/81 1705 (121)	6.8	NW	2.5 mi. W. Big Lake	0	6.8	NW	-
6/19/81 1110 ?	Not at den						

Wolf - 324 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/21/81 1720 (126)	16.3	SSW	Fog Lakes	0	13.8	SW	On old adult moose kill.

Wolf - 325 - Yearling gray male

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/22/81 1230 (11)	13.8	NE	den	5(308) (323) (325) (345) (346)	0	-	-
5/23/81 1100 (11)	0	-	den	5(11)	0	-	-
7/1/81 1353 (24)	.8	N	N. of den	4(308) (345) (325) (346)	.8	N	Rendez-vous site
5/6/-5/8/81 am 1610 (50)	4.0	NW	St. Bear Lk	0	4.3	S	
5/10/81 1400 (52)	7.5	NE	Watana Bend	0	4.7	ENE	
5/11/81 1011 (54)	2.3	SW	Watana Ck.	0	2.7	E	

Wolf - 325 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/12/81 1853 (11)	2.7	ESE	den	2(308) (323)	0	-	
5/13/81 1635 (52)	4.7	ENE	Watana Ck.	0	4.7	ENE	
5/14/81 0815 (66)	3.5	WSW	Near den	0	1.2	NE	
5/15/81 1020 (11)	0	0	den	2(308) (324)	0	-	
5/17/81 1810 (70)	2.5	SW	Delusion Ck.	0	2.5	SW	
5/18/81	7.5	NE	Upper	-	5.2	NE	
5/21/81 0905 (11)	4.8	SW	den	3(308) (324) (346)	0	-	-
5/22/81 1725 (79)	5.8	SSE	Susitna River	0	5.8	SSE	-
5/23/81 0950 (81)	1.0	NNW	E. St. bear	1(323)	4.5	S	-
5/24/81 1945 (85)	1.0	S	Isl. on Sue	1(323)	5.5	S	Ravens in area, 2 bears closeby.

Wolf - 325 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/25/81 0950 (86)	5.8	NNW	ESE den	0	1.0	W	Possible small mammal kill.
5/26/81 18:55 (91)	7.3	SSE	S. of	0	7.0	SSE	with bears 280 & 341
5/27/81 0900 (11)	7.0	NNW	den	2(308) (346)	0	-	-
5/30/81 1610 (11)	0	0	den	2(308) (323)	0	-	-
						adult ____	80-90% con.
5/31/81 1634 (11)	0	0	den	3(308) (323) (324)	0	-	-
6/1/81 0925 (109)	2.3	E	E. of den	1(323)	2.3	E.	on 50% consumed calf moose.
6/2/81 1930 (97)	3.3	SW	2 mi. ENE St. Bear Lk.	0	3.8	SSE	
6/3/81 1250 (98)	6.3	NNW	N. of den	1(345)	2.8	N	Same kill that 324 pres on 6/2
6/4/81 1945 (11)	2.8	S	den	5(308) (323) (324) (345) (346)	0	-	

Wolf - 325 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/5/81 1925 (11)	0	-	den	1(345)	0	-	308 traveling on 1st occasion.
6/6/81 0940 (11)	0	-	den	4(308) (323) (324) (346)	0	-	
6/7/81 2050 (11)	0	1	den	4(308) (323 (324) (346)			
6/8/81	NO DATA						
6/9 & 10	NO DATA (absent from den)						
6/11/81 1031 (11)	?	?	den	5(308) (323) (324) (345) (346)	0	-	
6/12/81 2028 (11)	0	-	den	5(308) (323) (324) (345) (346)	0	-	
6/13/81 1245 (11)	0	-	den	3(308) (323) (324)	0	-	
6/15/81 1557 (11)	0	-	den	4(308) (323) (324) (345)	0	-	

Wolf - 325 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/10/81 1148 (117)	3.3	S	1 mi. N.	0	S	-	308 traveling on 1st occasion.
5/17/81 1255 (114)	2.5	SSE	Isl. on	0	5.5	S	Same location as wolves on 5/24, 6/14.
5/18/81 1300 (122)	1.0	S	South of	0	6.5	S	-
5/19/81 1030 (114)	1.0	S	Isle of River	0	5.5	S	same loc. as 5/24, 6/14, 6/17.
6/21/81 1630 (125)	.5	N	N. of Island	0	5.0	S	-
6/22/81 1245 (11)	5.8	N	den	5(308) (323) (324) (345) (346)	0	-	
6/23/81 1024 (11)	0	-	den	3(308) (323) (324) (345) (346)	0	-	
7/1/81 1353 (24)	.8	N	N. of den	4(308) (323) (345) (346)	.8	N	Rendezvous site

Wolf - 346 - Yearling gray female

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/11/81 - 1250 (60)	2.5	W	Little Gap Lake	0	38.2	ESE	
5/12/81	NO SIGNAL						
5/13/81 1645 (11)	38.2	WNW	den	3(308) (323) (324)	0	-	
5/14/81 0815 (67)	1.7	NE	close to den	-	1.7	NE	
5/15/81 1530 (11)	1.7	SW	den	2(308) 323	0	0	-
5/16/81 1015 (68)	8.2	SE	opp. Kosina Ck.	-	8.2	SE	Rendezvous
5/17/81 1813 (69)	8.7	NW	close to den	-	1.2	SW	-
5/18/81 1400 (73)	8.7	SE	opp. Kosina Creek	-	8.2	SE	suspect kill-same loc. as 5/16
5/21/81 0905 (11)	8.3	NE	den	3(308) (324) (325)	0	-	-
5/22/81 1730 (11)	0	-	den	2(308) (323)	0	-	-
5/23/81 1000 (83)	8.5	SE	On Sus. opp. Kosina	0	8.5	SE	same loc. as #346 on 5/18.

Wolf - 346 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/24/81 - 1855 (11)	8.5	NW	den	2(308) (323)	0	-	
5/25/81 0955 (11)	0	-	den	3(308) (323) (324)	0	-	-
5/26/81 - (11)	0	-	den	3(308) (324)	0	-	-
5/27/81 0900 (11)	0	-	den	3(308) (325)	0	-	-
5/30/81 1600 (107)	10.5	SE	near den	0	0.5	SE	-
6/1/81 920 (11)	0.5	NW	den	1(308)	0	-	Rendezvous
6/2/81 1930 (11)	0	-	den	3(308) (323) (345)	0	-	-
6/3/81 1730 (11)	0	-	den	3(308) (323) (324)	0	-	-
6/4/81 1945 (11)	0	-	den	5(308) (323) (324) (325) (345)	0	-	
6/5/81 1930	4.0	SSE	2 mi. E	4(308) (323) (324) (1)	4.0	SSE	Suspect travelling from caribou kill made by bl. bear.

Wolf - 346 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/6/81 0940 (11)	4.0	NNE	den	4+(308) (323) (324) (325) (346)	0	-	
6/7/81 0900 (111)	2-5	N	N. of den	0	2.5	N.	On old moose kill.
6/7/81 2050 (11)	2.5	S	den	4(308) (323) (324) (325)	0	-	-
6/8/81	NO DATA						
6/9/81 1721 (11)	0	-	den	4(308) (323) (324) (345)	0	-	
6/10/81 1145 (11)	0	-	den	3(308) (323) (345)	0	-	
6/11/81 1071 (11)	0	-	den	5(308) (323) (324) (325) (345)	0	-	
6/12/81 2028 (11)	0	-	den	5(308) (323) (324) (325) (345)	0	-	
6/13/81 1259 (114)	5.5	S	Isl. on River	1(345)	5.5	S	Suspect feeding on kill same loc. as 5/24.

Wolf - 346 - Yearling gray female (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/14/81	5.5	N	den	3(308) (325) (345)	0	-	
6/16/81 1139 (11)	0	-	den	(308) (323)	0		-
6/18/81 1600 (11)	0	-	den	(323) (308)	0		-
6/19/81 1200 (124)	10.3	SW	Fog L.	(308) (323)	10.3	SW	On calf moose kill.
6/21/81 1645 (11)	10.3	NW	den	(323) (308)	0	-	-
6/22/81 1645 (41)	0	-	den	(324) (325) (346) (323)	0	-	-
6/23/81 1645 (41)	0	-	den	(324) (325) (346) (323)	0	-	-
7/1/81 1353 (24)	0.8	N. of den	Rendezvous	(308) (323) (325) (345)	0.8	N	Rendezvous

Wolf - 310 - Adult gray male

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/10/81 1830 (53)	44.5	ESE	Upper W. Fork	7(323) (331) (344) (345) (346) (2)	40.5	ESE	-
5/11/81	1.7	SSE	0	0	41.5	ESE	-
5/12/81 1800 (61)	12.2	SW	Tyone Ck	3(344) (345) 1	41.2	SE	-
5/13/81 1715 (63)	7.2	N	Tyone	2(344) (345)	365.	SE	-
5/14/81 0855 (64)	5.7	NW	Susitna Bend	2(344) (345)	31.0	SE	On 50% consumed adult moose carcass.
5/17/81 1915 (72)	9.5	E	upper W. Fork	2(344) (345	39.5	ESE	Attacking cow w/2 yrls.
5/18/81 1330 (75)	2.5	W	Little Gap Lake	2(344) (345)	37.0	ESE	-
5/21/81 1045 (77)	21.0	SE	2 mi. S Susitna	1(344)	54.8	SE	-
5/22/81 1530 (78)	16.8	N	2 mi. W. Vermillion Lk.	2(344) (345)	47.3	ESE	-
5/23/81 - (88)	4.5	N	Long Lake	2(344) (345)	45.3	Traveling from kill newborn moose calf	

Wolf - 310 - Adult gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/24/81 1820 (84)	11.3	WSE	3.5 E. Tyone River	2(344) (345)	ESE	On adult moose kill 75% consumed.	
5/25/81 1120 (87)	2.0	S	4 mi. ESE mouth Tyone River	2(344) (345)	36.5	ESE	
5/26/81 - (89)	12.8	SW	4.5 mi. NW Lone Butte	3(344) (345) (1 gray)	33.5	SE	
5/27/81 - (93)	12.5	SE	8 mi. W. Moore Lk.	2(344) (345)	46.0	SE	On short yrl. moose kill.
5/28/81 1832 (96)	15.0	NE	Near Susitna den	3(344) (345) (1)	49.5	SE	-
5/29/81	NO SIGNAL						
5/30/81 1025 (105)	2.8	NE	At Susitna den	0	53.8	SE	-
5/31/81 1515 (105)	0	0	At Susitna den	0	53.8	SE	-
6/1/81 1738 (105)	0	0	At Susitna	1(295)	53.8	SE	Wolf 295 of Susitna Pack present.
6/2/81 1817 (96)	4.8	NNW Tyone Lake	NNW	0	49.5	SE	-
6/6/81 1155 (102)	2.8	NE	At Susitna Rendezvous Site	0	53.8	SE	-

Wolf - 310 - Adult gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/7/81 1900 (103)	16.0	NW	1 mi. N. of mouth Tyone Ck.	0	39.3	SE	-
6/8/81	NO DATA						
6/9/81 1606 (105)	16.3	SE	Susitna den	2(2 unc.)	54.0	SE	-
6/10/81 0928 (105)	0	-	Susitna den	0	54.0	SE	-
6/12/81 2202 (113)	12.5	NW	W. Tyone River	1(1 unc.)	43	SE	-

Wolf - 344 - Yearling gray male

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/11/81 1208 (57)	3.2	SSW	Tyone River	0	40.5	ESE	-
5/12/81 1800 (61)	10.2	SW	Tyone Ck.	3(310) (345) (1 unc.)	41.2	SE	-
5/13/81 1715 (63)	7.2	N	Tyone Ck.	2(310) (345)	36.5	SE	-
5/14/81 0855 (64)	5.7	NW	Susitna Bend	2(310) (345)	31.0	SE	On old adult moose kill.

Wolf - 344 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/17/81 1915 (72)	9.5	E	Upper West	2(310) (345)	39.5	ESE	Attacking cow w/2 yrls.
5/18/81 1330 (75)	2.5	W	Little Gap	2(310) (345)	37.0	ESE	
5/21/81 1045 (77)	21.0	SE	2 mi. S. Susitna den	1(310)	54.8	SE	-
5/22/81 1530 (78)	16.8	N	2 mi. W. Vermillion	2(310) (345)	47.3	ESE	-
5/23/81 - (88)	4.5	N	Long Lake	2(310) (345)	45.3	E	Traveling from newborn calf moose kill.
5/24/81 1820 (84)	11.3	WSW	3-5 E Tyone River	2(310) (345)	35.5	ESE	On adult moose kill 75% consumed.
5/25/81 1120 (87)	2.0	S	4 mi. ESE mouth Tyone River	2(310) (345)	36.5	ESE	-
5/26/81 - (89)	12.8	SW	4.5 mi. NW Lone Butte	3(344) (345) (1 unc.)	33.5	SE	-
5/27/81 - (93) k	12.5	SE	8 mi. W. Moore Lake	2(310) (34)	46.0	SE	On short yrl. moose kill.
5/28/81 1832 (96)	15.0	NE	Near Susitna den	3(310) (345) (1 unc.)	49.5	SE	-
5/29/81	No Signal						

Wolf - 344 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/30/81 1018 (104)	8.8	SSE	Susitna Lake	0	56.8	SE	-
5/31/81 1454 (108)	20.5	SSE	Susitna Lake	0	73.0	SE	
6/5/81 1735 (99)	22.0	NE	Daisy Ck.	0	53.0	SE	-
6/6/81 1130	Close to Susitna den (general location)						
6/8/81	NO DATA						
6/15/81 1421 (115)	37.0	SW	Oshetna River	0	50	SSE	-
6/16/81 1023 (116)	2.8	SSW	Oshetna River	0	50	SSE	-
6/17/81 1054 (119)	7.8	SE	Upper Little Nelchina	0	45	SSE	-
6/19/81 0901 (120)	3.3	E	Little Nelchina	0	45	SSE	Suspect kill present from magpies.
6/22/81 1040 (400)	13.3	N	Little Oshetna	1(1 unc.)	45	SSE	-

Wolf - 345 - Yearling gray male

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/11/81 1205 (56)	4.0	SW	Tyone River	0	38.2	SE	-
5/12/81 1800 (61)	10.0	S	Tyone Ck.	3(310) (344) (1 unc.)	41.2	SE	-
5/13/81 1715 (63)	7.2	N	Tyone Ck.	2(310) (344)	36.5	SE	-
5/14/81 0855 (64)	5.7	NW	Susitna Bend	2(310) (344)	31.0	SE	On old adult moose kill.
5/17/81 1915 (72)	9.5	E	Upper West	2(310) (344)	39.5	ESE	Attacking cow w/2 yrl.
5/18/81	2.5	W	Little Gap Lake	2(310) (344)	37.0	ESE	
5/22/81 1530 (78)	10.8	E	2 mi. W. Vermillion Lk.	2(310) (344)	47.3	ESE	
5/23/81 - (88)	4.5	N	Long Lake	2(310) (344)	45.3	E	Traveling from new-born calf moose kill.
5/24/81 1820 (84)	11.3	WSW	3-5 mi. E Tyone River	2(310) (344)	35.5	ESE	On adult moose kill 75% con-sumed.
5/25/81 1120 (87)	2.0	S	4 mi. ESE mouth Tyone River	2(310) (344)	36.5	ESE	-

Wolf - 345 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
5/26/81 - (89)	12.8	SW	4.5 mi. W. Lone Butte	3(310) (344) (1 unc.)	33.5	SE	-
5/27/81 - kill. (93)	12.5	SE	8 mi. W. Moore	2(310) (344)	46.0	SE	On short yrl. moose kill.
5/28/81 1832 (96)	15.0	NE	Near Susitna	3(310) (344) (1 unc.)	49.5	SE	-
5/29/81 - (94)	5.8	W	6.5 mi. W. of Tyone Lake outlet	0	44.8	SE	-
5/30/81 1436 (106)	19.3	NNW	Near B-S Lakes	0	30.0	E	-
5/30/81 1545 (95)	1.5	S	3 mi. SW Susitna den	0	30.3	SE	-
6/2/81 1930 (11)	30.3	NW	Watana den	3(308) (323) (346)	0	-	-
6/3/81 1250 (98)	2.8	N	N. of den	1(325)	2.8	N	On caribou kill which 324 was obs. 6/2.
6/4/81 1945 (11)	2.8	S	den	5(308) (323) (324) (325) (340)	0	-	
6/5/81 1925 (11)	0	-	den	1(325)	0	-	308 traveling.

Wolf - 345 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/6/81 0850 (101)	3.8	SSE	2 mi. NE St. Bear Lake	0	3.8	SSE	At old caribou kill made by cin. bl. bear.
6/8/81	NO DATA						
6/9/81 1727 (11)	3.8	NNW	den	4(308) (323) (324) (346)	0	-	
6/10/81 1145 (11)	0	-	den	3(308) (323) (345)	0	-	
6/11/81 1031 (11)	0	-	den	5(308) (323) (324) (325) (346)	0	-	
6/12/81 2028 (11)	0	-	den	5(308) (323) (324) (325) (346)	0	-	
6/13/81 1259 (114)	5.5	S	Isl. on River	1(346)	5.5	S	Suspect feeling on kill same location as 5/24.
6/14/81 1024 (11)	5.5	N	den	3(308) (325) (340)	0	-	
6/15/81 1557 (11)	0	-	den	4(308) (323) (324) (325)	0	-	

Wolf - 345 - Yearling gray male (cont'd)

Date-Time Obs. #	Distance traveled (mi)	Direction of travel	Location	# Assoc. (ID)	Distance from den (mi)	Direction from den	Misc.
6/15/81 1209 (118)	5.3	SE	E. St. Bear Lk.	0	5.3	SE	
6/19/81 1200 approx. (124)	10.3	SW	Fog L.	3(308) (346)	10.3	SW	On calf moose kill.
6/22/81 1230 (401)	10.3	NW	den	4(324) (325) (346) (323)	0	-	
6/23/81 1110 (11)	0	-	den	4(323) (324) (325) (346)	0	-	
7/1/81 1353 (24)	0.8	N	N. of den	4(308) (323) (325) (346)	0.8	N	Rendezvous site.