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FEEDING BEHAVIOR OF INTERIOR BROWN BEARS

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Volume I
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-10 and W-17-11, Job 4.13R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Ted Spraker and Warren Ballard

Project Nos: W-17-10 and W-17-11 Project Title: Big Game Investigations

Job No: 4.13R Job Title: Feeding Behavior of Interior Brown Bears

Period Covered: January 1, 1978 to June 30, 1979

SUMMARY

Thirty-eight brown bears were captured and marked by the Alaska Department of Fish and Game in Game Management Unit 13 from April 9 to June 23, 1978. Twenty-three of these bears were radio-collared. Phencyclidine hydrochloride was used to immobilize bears from a Bell 206 Jet Ranger B helicopter. Eighty-one percent of the bears were immobolized with a single drug injection. Drug dosages were: 1.4 mg/lbs for yearlings, 1.0 mg/lbs for females and young males and 0.75 mg/lbs for adult males. Cubs of-the-year were captured by hand. Induction time averaged 8.8 minutes and ranged from 4 to 16 minutes.

The sex ratio and average age of bears reported in the sport harvest from GMU 13 are compared to those of captured bears. Captured bears had a 50:50 sex ratio while bears harvested from 1961 to 1977 were comprised of 57 percent males to 43 percent females. The comparison suggests current hunting regulations protecting females with cubs and hunter's preference for large bears have resulted in a disproportionate percentage of males in the sport harvest. The weighted mean age of harvested males (239 over 2 years of age) from 1969 to 1977 was 6.4 years compared to 6.9 for captured males (over 2 years of age). Females in the sport harvest averaged 6.3 years of age compared to 8.1 years for captured females. Fifty-two percent of the captured bears were less than 5 years old for both sexes.

Morphological measurements were collected and are briefly discussed. Body weights of adult males averaged 254 kg (550 lbs), while adult females averaged 125 kg (275 lbs), 51 percent smaller than males. The largest skull measured (male) was 69.2 cm (27 2/8 inches) long.

Hair and blood samples were collected and processed, and the raw data are tabulated. Discussion of these data pertaining to the establishment of baseline hair and blood values for free roaming brown bears will be presented in future reports as will data pertaining to movements and predation.

CONTENTS

BACKGROUND

Alaskan brown bear (*Ursus arctos*) ecology has been investigated on the Alaska Peninsula (Glenn 1971, 1972, 1973, 1975 and 76), the Brooks Range (Reynolds 1974 and 1975), and in Southeastern Alaska (Wood 1973, 1974 and 1976). All of these bear studies have focused on coastal or arctic populations. Studies have not been conducted on Interior Alaska brown bear populations which in recent years have been subjected to increasing levels of sport harvest (ADF&G files). Basic knowledge of brown bear biology is currently insufficient to accurately manage these populations on a sound scientific basis. One such area where little is known is Game Management Unit (GMU) 13, commonly referred to as the Nelchina Basin.

Within recent years both the number of reported brown bear sightings and sport harvest have increased (Eide 1978). Scant information indicates that the bear population in the Nelchina Basin may be increasing. From 1948 to 1953 intensive poisoning by the Federal government reduced predator population to low levels (Rausch 1967). Although wolves (*Canus lupus*) were the target species some bears undoubtedly died. Since the early 1950's wolf populations in this area have increased and presumably bear populations also. Rausch (1969), Bishop and Rausch (1974) and McIlroy (1974) have speculated about the apparent inverse relationships between numbers of predators and moose (*Alces alces*).

In light of its depressed moose population and the obvious importance of GMU-13 to the statewide moose harvest, a series of studies were initiated to investigate predator-prey relationships. Initially these studies focused only on moose and wolves, the partial results of which were reported by Stephenson 1978, Ballard and Taylor 1978a and b and Ballard and Spraker, in prep). First year results of a moose calf mortality study identified brown bear predation as a major neonatal moose calf mortality factor (Ballard and Taylor 1978b). The results of that study and subsequent requests by the public for liberal bear hunting seasons in order to increase moose calf survival prompted initiation of the present study.

OBJECTIVES

To determine distribution, seasonal movements and home ranges of brown bears in Game Management Unit 13.

To determine spring and summer food habits of brown bears in Game Management Unit 13.

To determine sex and age composition, productivity, mortality and physiologic status of brown bear populations in Game Management Unit 13.

STUDY AREA

Brown bears were studied in that portion of Game Management Unit 13 lying within the following boundaries; the Richardson Highway on the east, the Glenn Highway to the south, the center of the Talkeetna Mountain Range on the west, and the Alaskan Mountain Range to the north (Fig. 1). This area corresponds closely to the study area where other radio-telemetry research is in progress (Ballard and Taylor 1978a and b, Ballard and Spraker, in press).

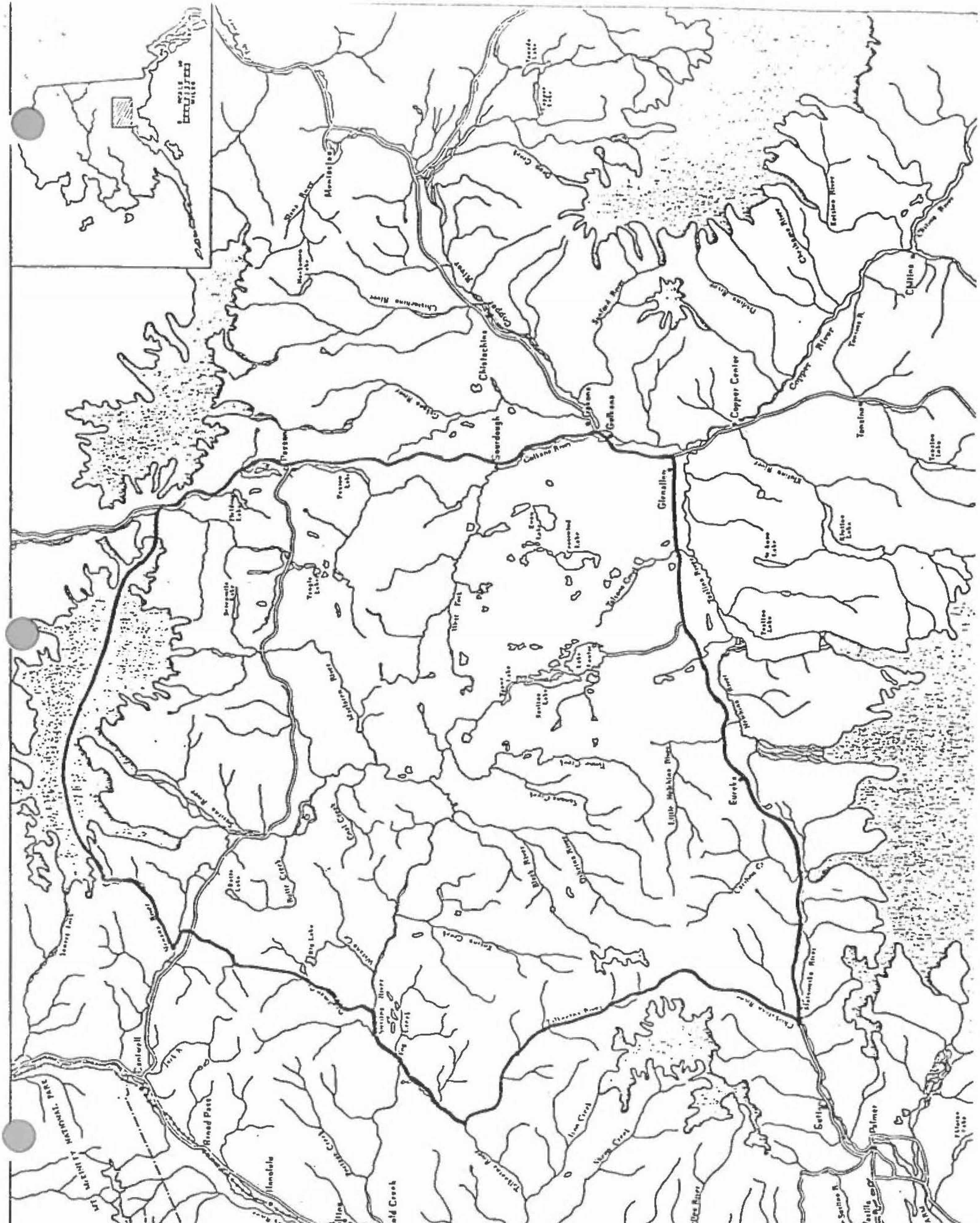
Topography, climate, vegetation and geology of the study area have been extensively described elsewhere (Skoog 1968; Rausch 1967, 1969; VanBallenberghe 1977; Ballard and Taylor 1978b and others).

PROCEDURES

Initially, bears were located by searching from fixed-wing aircraft (Piper Super Cub PA-18-150) in both early morning and late evening hours. After several bears were captured and radio-collared, flights to locate bears were discontinued, since bears were located incidental to monitoring radio-collared bears and moose calves.

When a bear was found, its location was relayed by radio to a helicopter (Bell 106B) which was located close by. Immediately upon locating the bear from the helicopter, the helicopter was lowered to within approximately 25 meters of the bear in order to estimate weight for calculating proper drug dosage. Etrophine hydrochloride (M-99, D-M Pharmaceuticals, Inc., Rockfield, MD) and its antidote M-50-50 (diprenorphine) were used on one bear while the remainder were immobilized with phencyclidine hydrochloride (Sernylan, BioCeutic Laboratories, St. Joseph, Missouri). Drug dosages of phencyclidine hydrochloride recommended by Glenn (1971) were 1.0 mg per pound for females and young adult males and 0.75 mg per pound for adult males. When bears were found in heavy timber, the helicopter was used to haze the bear towards an open area for easier darting. Drugs were administered with a dart fired from a Cap-Chur Gun (Palmer Chemical and Equipment Co., Douglasville, Georgia). Experience proved that even older, more wary, bears could be moved into open areas if herded slowly.

Once a bear was darted, the helicopter was moved away from it, but the bear was always kept in sight, especially in dense vegetation. If there was no risk of losing a darted bear, the helicopter was landed and the bear's progress was monitored from fixed-wing aircraft. Once immobilized, the helicopter transported the 2-man tagging crew to the site. Upon reaching the immobilized bear, the dart was removed and checked for percent injection.



Copper River
Chistochina
Gulkana
Copper Center
Glennallen
Chitina
Tonsina
Paxson
Sourdough
Gulkana River
Tazlina River
Matanuska River
Eureka
Susitna River
Talkeetna River
Cantwell
MT. McKINLEY NATIONAL PARK
Sutton
Palmer
Wasilla
KNIK ARM

Adult bears were fitted with a radio-collar (Model MK-IV, Telonics Company, 1048 East Norwood, Mesa, Arizona 85203) which emitted a pulsed signal on frequencies ranging from 150.000 through 151.000 Mhz. Transmitters were hermetically sealed and had a theoretical life span of 44 months. Each transmitter contained an inverse "mortality sensor" which lowered the pulse rate of the radio when the unit remained motionless for a 4-hour period. This theoretically extended the life of the radio by utilizing less battery power when bears were denning.

Each bear was ear-tagged with a numbered roto-tag (Oberach Patent, Ltd., London, England). Additionally, each ear-tag was accompanied by colored polyvinyl plastic measuring 7 cm by 10 cm to aid in identifying bears from fixed-wing aircraft. Flags were color coded according to sex of bear; international orange for males and fluorescent green for females. Flags on subadult bears were temporarily marked with a red or green grease pencil to alleviate recapture.

Captured bears were also marked by a three-digit tattoo number being placed in the upper and lower lip. Standard tattoo pliers with 3/8 inch digits and green paste tattoo ink were purchased from Stone Manufacturing and Supply Co., 1212 Kansas Avenue, Kansas City, Kansas 66105.

Both lower first premolars were extracted when practical for age determination according to methods described by Johnson and Lucier (1975). A micrometer was used to measure length of the upper and lower left canines from anterior to posterior and width from labial to lingual sides.

Blood samples were taken from the femoral artery using both 10 ml evacuated vials and 150 ml evacuated bottles. One additional 10 ml vial containing heparin was filled to provide whole blood for determination of percent hemoglobin (Hb) with a Hb-meter (American Optical Corporation, Buffalo, New York) and packed cell volume (PVC) with a microhematocrit centrifuge (Readocrit-Clay-Adams Company, Parsippany, NJ). Upon returning from the field, the blood was centrifuged and serum separated and placed into 5 ml plastic vials and immediately frozen. One-ml samples of serum were later sent to Pathologists Central Laboratory, 1100 East Union, Seattle, Washington 98122, for blood chemistry analysis and protein electrophoresis (Franzmann and Arneson 1973). Remaining sera are being stored frozen for possible future analysis.

Hair samples were plucked from the center of the bear's back, between the shoulders, to aid in assessing the animal's condition using techniques presented by Franzmann, et. al. (1975). All hair samples (35) were later sent to Dr. Arthur Flynn, Case Western Reserve University, Cleveland, Ohio for analysis.

Morphological measurements were taken and recorded on a field data sheet (Fig. 2) provided by Glenn (1972). Measurements included; total length, shoulder height, length of hind foot, neck circumference, heart girth, body length and head width and length. Bears were weighed with either a hand-held spring scale (Hanson Model 8920, Northbrook, Ill.),

Fig. 2 (cont'd)

Nelchina Basin Brown Bear Tagging Data Sheet

Time Bear First Observed_____

Specific Location_____

Grid No._____ Map Coordinates_____

DRUG DATA: Est'd. Wt._____ Circle Each Used: 1. Sernalyn 2. Sparine

3. M-99 4. M. 50-50 5. Other

	Dosage	Time Darted	Time Down	Dart Location
1st Hit				
2nd Hit				
3rd Hit				
Total				

Cont. Comments:

RESIGHTINGS:

Fig. 2 Reverse Side of Brown Bear Tagging Data Sheet1/

Bear No._____ Date_____ Sex_____ Est'd. Age_____ Cem. Age_____

Collector_____ Recorder_____ Recapture_____ New_____

	Temp.	Pulse Rate	Resp. Rate	Convulsion	Tremor	Other
Time						
Time						

Were all darts checked for complete drug injection? Yes_____ No_____

MEASUREMENTS: Measured Wt._____ T.L._____ Ht. Sh._____ H.F._____ Neck_____

Girth_____ B.L._____ Head: Width_____ Length_____

Length of Upper Left Canine_____ Lower Left Canine_____

PHOTOGRAPHS: Dentition ( ), Collar ( ), Mammae ( ), Whole Bear ( ), Vulva ( )

SPECIMENS COLLECTED: Tooth (Be specific)_____ Blood: Vol._____

Blood Smear: Yes____ No____ Vag Smear: Yes____ No____ Feces: Yes_____ No_____

Urine: Yes____ No____ Milk: (no less than 10 ml prefer 100-200 ml) Vol._____

PRODUCTIVITY: Female: No. of .5 yr. olds_____ 1.5 yr._____ 2.5 yr._____

Mammae: Length_____ Color_____ Vulva:_____ Male: Testes Descended: Yes____ No____

Other Bears Present (Describe)_____

RECAPTURE DATA: Tattoo: No._____ Condition_____ Ear Tags (Number, Type, Condition):

Left_____ Right_____

Collar (Number, Type, Condition)_____

NEW TAG DATA: Left Ear: Large Roto No._____ Color_____ Small Roto No._____

Color_____ Right Ear: Large Roto No._____ Color_____ Small Roto No._____

Color_____ Collar: Type_____ Collar Color Code:_____

_____ Collar Plate Ident.: Figure_____

Temporary Markings:_____

Time Departed_____ Completeness of Recovery_____

Comments:_____

Punch Tattoo No. Here

1/ Form provided by Glenn (1972).

capacity 200 pounds, or a Senator Scale (Martin-Decker Corp., Santa Anna, Calif.) with a capacity of 1500 pounds. When bears were weighed with the Senator Scale, it was first attached to the cargo hook under the helicopter and a cargo net containing the bear was then fastened to the scale. Weight was recorded by a biologist from the ground and corrected to indicate the bear's live weight by subtracting the weight of the cargo net (40 pounds) from the total weight.

Rectal swabs were taken when practical to culture for pathogenic bacteria. Culterette (Scientific Products, McGaw Park, Ill.) swabs were used and refrigerated until transferred to Dr. Roger Grischkowsky, Alaska Department of Fish and Game Laboratory, Anchorage, Alaska. All samples taken to Grischkowsky were cultured on the following laboratory media; blood agar, EMB, SS, BG and Mac. Enterbacteria were identified by the Enterotube method (R. Grischkowsky, Pers. Comm.).

Immobilized bears were observed until they had regained good head movement before the tagging crew departed. Radio-collared bears were monitored from fixed-wing aircraft (Piper Super Cub or Cessna 180) generally twice per day for the first two weeks of the study. Thereafter until the end of June, monitoring was reduced to once per day.

Radio-collared bears were located using twin 3-element antennae mounted on each of the aircraft's wing struts using methods similar to those described by Mech (1974). Bears were visually observed when possible, and location and activity were recorded on standard forms and topography maps (scale 1:63,360).

RESULTS AND DISCUSSION

Thirty-eight brown bears were captured, marked and released in Game Management Unit 13 from April 9 to June 23, 1978 (Table 1). The sex ratio of captured bears was 50 percent males (N = 19) and 50 percent females (N = 19). In comparison, Eide (1977) reported a sex ratio of 57 percent males to 43 percent females for 742 bears harvested in Game Management Unit 13 from 1961 to 1977. These data suggest that current Game Management Unit 13 hunting regulations protecting females with cubs, in addition to hunter preference for large bears, may have resulted in a disproportionate number of males in the sport harvest.

The weighted average age of males in the sport harvest (239) from 1969 to 1977 was 6.4 years compared to 6.9 years for captured males that were harvestable (over two years of age in 1977). The female segment of the sport harvest during the same period averaged 6.3 years old compared to 8.1 years old for captured females that were harvestable. Fifty-two percent of the captured bears were less than 5 years old in comparison to 55 percent in the sport harvest for both sexes.

Adult males (5.5 years and older) averaged 254 kg (550 lbs) (SD = 11 kg) and ranged in weight from 226 kg (497 lbs) to 289 kg (635 lbs).

able 1. Tagging statistics of brown bear captured in Game Management Unit 13 from April 9 to June 23, 1978.

ear ID Number Tattoo)	Ear Tag No. L	R	Capture Date	Sex	Age (Yrs)	Weight Kg(lbs)	Capture Location
200	990	992	4/09/78	M	7	289(635)	Upper West Fork-Gulkana R.
201	801	802	5/24/78	M	10	227(500)	Oldman Lake
202	803	804	5/24/78	F	8	105(230)	Oldman Lake
203	805	806	5/24/78	F	2	52(115)	Upper Tyone Creek
204	807	808	5/25/78	F	7	159(350)	Curtis Lake
205	809	810	5/27/78	M	4	205(450)	Victory Creek
206	811	812	5/27/78	F	13	170(375)	Victory Creek
207	813	814	5/27/78	F	11	98(215)	Fish Lake
None	815		5/27/78	M	.5	5(12)	Fish Lake
None	816		5/27/78	F	.5	5(12)	Fish Lake
208	819	820	5/27/78	F	12	91(200)	Second Hill Lake
209	817	818	5/28/78	F	5	101(222)	1 West Fork-Susitna River
210	821	822	5/28/78	M	2	61(134)	2 West Fork-Susitna River
211	823	824	5/29/78	M	4	136(300)	3 West Fork-Susitna River
212	825	826	5/29/78	F	10	105(230)	4 West Fork-Susitna River
213	827	828	5/29/78	F	10	102(225)	5 Boulder Creek
214	829	830	5/29/78	M	3	102(225)	6 Valdez Creek
215	831	832	5/29/78	F	3	75(164)	7 East Fork-Susitna River
216	833	834	5/29/78	M	11	255(560)	8 East Fork-Susitna River
217	835	836	5/30/78	M	3	139(305)	9 Middle Fork-Susitna River
	837	838	5/30/78	M	3	100(220)	10 Middle Fork-Susitna River
219	839	840	5/30/78	F	4	95(210)	11 West Fork-Susitna River
220	841	842	5/31/78	F	5	125(275)	Y Lake
221	843	844	5/31/78	F	8	136(300)	Trappers Den
222	851	852	6/05/78	M	11	289(635)	Twin Lakes
223	845	846	6/03/78	M	2	92(202)	Trappers Den
224	847	848	6/03/78	M	2	85(186)	Trappers Den
225	849	850	6/04/78	M	4	159(350)	Nelchina River
226*	853	854	6/06/78	M	5	236(520)	Loon Lake
227	855	856	6/07/78	M	9	268(590)	Twin Lake
228	857	858	6/10/78	M	7	226(497)	Upper Tyone Creek
229	859	860	6/10/78	F	2	91(200)	Upper Tyone Creek
230	861	862	6/10/78	M	9	250(550)	12 Monahan Flats
231	863	864	6/11/78	F	12	154(338)	Marie Lake
232	865	866	6/23/78	F	1	45(100)	Mile 175-Richardson Hwy.
233*	No Tags		6/11/78	M	14+	250(550)	Tyone Creek
234	869	870	6/23/78	F	5	148(325)	Mile 175-Richardson Hwy.
235	867	868	6/23/78	F	1	45(100)	Mile 175-Richardson Hwy.

* Tagging mortality.

Adult females (5.5 years and older) averaged 125 kg (275 lbs) (S.D. = 12 kg) and ranged in weight from 91 kg (200 lbs) to 170 kg (374 lbs), 51 percent smaller than average adult males. Further analysis and comparison of weights of bears to results of other studies will be made after additional bears have been captured during spring 1979. All results will be reported in the final report.

Two tagging mortalities occurred during this period of study. Bear number 226 was captured on an exceptionally warm day in a dry area and never recovered from the effects of the drug, death may have been due to physiological problems caused by body temperature escalation. Bear number 233, the second mortality, took refuge in a shallow pond during the last few minutes of drug induction and subsequently drowned. Repeated unsuccessful attempts were made to haze or lure the bear from the pond with the helicopter. It is worthy to note that number 233 would have been the oldest male (14+ years) captured. Number 206, the oldest female (13 years), also displayed a similar behaviorial trait of taking refuge in a pond during the final minutes of drug induction. However, she was successfully roped, pulled from the pond using the helicopter and held until completely immobilized. We suspected that this type of behavior was triggered by two factors: 1) older bears with presumably slower metabolic rates over-heated faster stimulating the desire to go to water, and 2) older bears when stressed by aircraft attempt to hide rather than run as do younger bears.

Eighty-one percent of the study animals were immobilized with a single injection of phencyclidine hydrochloride (Table 2). Seventeen percent required a second drug injection and three percent required a third, due to either under-estimation of the bear's weight resulting in a low drug dosage or failure of the dart to fully inject the drug dosage. Mean induction time for bears immobilized with a single injection was 9 minutes (S.D. = 3.3) and ranged from 4 to 16 minutes.

Morphological measurements in relation to age of male and female captured bears are tabulated in Tables 3 and 4, respectively. Analysis of these data and data collected from additional bears captured during spring 1979 will be reported in the final report.

Breeding status and productivity of captured females over 2 years of age are shown in Table 5. Age compared with breeding status revealed some females successfully bred at 3.5 years of age. These findings compare favorably with those of Glenn et. al. (1972) on the Alaska Peninsula and Hensel et. al. (1969) on Kodiak Island where females successfully bred at 3.5 years of age. However, they differ from those of Reynolds (1976) for Northern Alaska, Pearson (1972) for the Yukon Territory and Craighead et. al. (1969) for Wyoming where minimum breeding ages were determined to be 6.5, 6.5 and 4.5 years old, respectively.

Females with cubs averged 1.8 young which was the same rate calculated by Reynolds (1976) for the Brooks Range. In comparison the rates in other studies were: 2.1 on the Alaska Peninsula (Glenn et. al. 1976), 2.2 on Kodiak Island (Hensel et. al. 1969), 2.2 in Yellowstone National Park (Craighead and Craighead 1967), 2.0 in Glacier National Park, British Columbia (Mundy and Flook 1973) and 1.6 in Southwestern Yukon

Table 2. Dosages of phencyclidine hydrochloride (conc. 100 mg/ml) utilized to immobilize brown bears in Game Management Unit 13 from April 9 to June 23, 1978.

Bear ID Number (Tattoo)	Sex	Age (Yrs)	Weight (kg)	Drug Dosage (ml)	Induction Time (min)	Hit Location	Comments
200	M	7	289	7.0	No Reaction	Ctr. Back	1st dosage - no effect
				7.0	8	Rt. Shoulder	
201	M	10	227	5.0	-	Ctr. Back	2nd dosage - 2 ml
202	F	8*	105	4.0	8	L. Side Behind Shld.	Complete injection (M-99)
203	F	2	52	2.0	7	L. Shoulder	Complete injection
204	F	7	159.	4.5	10	Ctr. Back	Up & running @ 11 min. 2nd dosag required
				3.0	4	Left Rump	
205	M	4	205	4.0	7	Ctr. Back	Complete injection
206	F	13	170	4.0	-	Ctr. Back	2nd & 3rd dosages required-would
				2.0	-	Ctr. Back	not stay down
				4.0	53	Ctr. Back	
207	F	11	98	4.0	8	Ctr. Back	Complete injection, down hard
208	F	12	91	3.5	16	Ctr. Back	Up & running - required 2nd dosa
				3.0	4	Back of Front Leg	
209	F	5	101	3.0	11	Ctr. Back	Complete injection
210	M	2	61	3.0	8	Ctr. Ribs/Left Side	Complete injection
211	M	4	136	4.0	13	Mid-Back	Complete injection
212	F	10	105	3.0	10	Top Left Rump	Complete injection
213	F	10	102	3.5	4	Left Ribs	Down hard, may have hit vein, co vulsed one time only for approxi mately 30 seconds
214	M	3	102	2.5	10	(?)	Complete injection
215	F	3	75	2.5	6.5	Head Above Left Ear	Complete injection
216	M	11	255	5.0	10	Ctr. Back	Could not handle, 2nd dosage I.V
				1.0	4	Femoral Artery	6 Convulsions @ 30 seconds each
217	M	3	139	3.5	-	Ctr. Back	2nd dosage necessary as 1st dart
				3.0	4.5	Ribs - Left Side	bounced out
218	M	3	100	3.0	-	Left Rump	No reaction to 1st dart after 16
				3.0	5	Right Rump	minutes
219	F	4	95	3.0	12	Rump	Complete injection
220	F	5	125	3.0	9	Base of Neck	Complete injection

* Bear immobilized with M-99.

Table 2 (cont'd). Dosages of phencyclidine hydrochloride (conc. 100 mg/ml) utilized to immobilize brown bear in Game Management Unit 13 from April 9 to June 23, 1978.

Bear ID Number (Tattoo)	Sex	Age (Yrs)	Weight (kg)	Drug Dosage (ml)	Induction Time (min)	Hit Location	Comments
221	F	8	136	1.8	16	Top of Head	Given additional 1 ml inter-musc
				1.0	10	Inner-Muscular	(after 1st 16 min. head still up required 2nd dosage) animal work able @ 10 minutes.
222	M	11	289	6.0	9	Ctr. Back	Complete injection
223	M	2	92	3.5	4.5	Ctr. Back	Complete injection
224	M	2	85	3.0	-	Ctr. Back	Incomplete injection rec. 2.2 ml
225	M	4	159	0.5		Left Ribs	1st dart did not inject total of 3.5 ml
					2.5	Ctr. Back	2nd dart required
226	M	5	236	6.0	-	Ctr. Back	Could not handle, 2nd dosage
				1.0	10	Inner-Muscular	required
227	M	9	268	5.0	9	Ctr. Back	Complete injection
228	M	7	226	4.0	-	-	Could not handle, 2nd dosage
				1.0	-	Inner-Muscular	required
229	F	2	97	2.0	-	-	0.5 ml sparine, 3rd dosage, 1 ml sernylan
230	M	9	250	5.0	9	-	2nd dosage required (I.M.)
				1.0	-		
231	F	12	154	3.0	9	Left Rump	Complete injection
232	F	1	45	1.2	9	Left Flank	Given additional 0.6 ml sparine
233	M	14+	250	5.0	-	Ctr. Back	Complete injection, drowned
234	F	5	148	3.0	7	Ribs (lower left)	Complete injection
235	F	1	45	1.2	4	Low Right Rump	Given additional 0.6 ml sparine

Table 3. Morphological measurements in relation to age of male brown bears captured in Game Management Unit 13 from April 9 through June 23, 1978.

Age (Yrs)	Bear I.D. Number	Weight (kg)	Total Length (cm)	Shoulder Height (cm)	Length of Hind Foot (cm)	Neck Circum-frence (cm)	Girth (cm)	Body Length (cm)	Head Width (cm)	Head Length (cm)	Head Width and Length (cm)	Length Upper Left Canine (mm)	Width Upper Left Canine (mm)	Length Lower Left Canine (mm)	Widt Lowe Left Canir (mm)
.5	815*	5													
2	210	61	152.4	95.3	29.8	45.4	83.8	84.5	16.8	28.9	45.7	17.0	13.7	16.3	12.4
2	223	92	179.7	89.9	31.4	51.1	101.9	96.2	17.8	31.4	49.2	17.6	14.8	20.0	15.8
2	224	85	170.1	96.5	30.5	48.3	94.6	99.4	16.8	30.5	47.3	15.1	13.6	18.0	15.0
3	214	102		101.6	31.1	57.2	97.2	100.3	18.4	31.4	49.8	19.0	15.0	20.8	15.1
3	217	139	183.5	104.8	32.1	60.3	110.2	110.8							
3	218	100	165.1	97.2	28.9	53.7	96.2	95.3	18.1	31.1	49.2	18.6	14.7	20.8	14.6
4	205	205	229.2	128.6	36.8	77.2	124.1	111.8	21.6	38.7	60.3	22.0	16.0	23.0	16.0
4	211	136	182.9	111.4	31.8	73.0	118.7	114.3	21.6	36.8	58.4	22.0	16.3	22.1	16.3
4	225	259	188.3	109.5	34.3	60.6	102.2	102.9	19.4	32.4	51.8	22.0	15.3	22.3	15.2
5	226	236	197.5	120.0	35.6	79.4	136.8	104.1	22.9	37.5	60.4	22.8	16.8	22.9	12.8
7	200	289	223.5	132.4	26.0	87.6	148.0		25.4	42.5	67.9				
7	228	226	200.0	122.6	36.6	76.8	135.9	126.4	23.3	36.7	60.0	20.0	15.0	20.0	15.5
9	227	268	219.7	121.9	35.2	91.4	144.1	128.6	25.1	38.7	63.8	22.3	15.8	21.0	14.8
9	230	250	199.7	123.2	34.9	84.5	147.3	130.8				25.0	19.0	21.8	15.6
10	201	227	192.7	121.0	38.9	91.0	151.0	130.0	25.5	38.4	63.9	20.0		21.5	
11	216	255	216.5	125.7	34.6	85.1	138.4	130.8	25.1	38.7	63.8	24.3	17.4	22.2	16.0
11	222	289	224.2	144.8	40.0	93.3	144.8	137.2	27.3	41.9	69.2	24.2	19.3	27.3	18.0
14	233	250	230.5	131.8	34.9	97.2	140.3	124.5	26.0	39.4	65.4	23.2	22.0	21.5	15.7

* Ear tag number.

Table 4. Morphological measurements in relation to age of female brown bears captured in Game Management Unit 13 from April 9 through June 23, 1978.

Age (Yrs)	Bear I.D. Number	Weight (kg)	Total Length (cm)	Shoulder Height (cm)	Length of Hind Foot (cm)	Neck Circum-frence (cm)	Girth (cm)	Body Length (cm)	Head Width (cm)	Head Length (cm)	Head Width and Length (mm)	Length Upper Left Canine (mm)	Width Upper Left Canine (mm)	Length Lower Left Canine (mm)	Width Lower Left Canine (mm)
.5	816*	5													
1	232	45	142.2	78.7	28.6	44.1	84.5	86.7	15.9	27.3	43.2				
1	235	45	144.8	81.6	25.7	48.3	89.5	81.6	15.9	26.7	42.6	11.1	9.8	9.7	9.4
2	203	52	157.4	93.5	31.0	48.0	86.8	88.5	16.5	29.6	46.1				
2	229	95	148.9	91.1	30.5	51.4	86.7	91.1	17.0	27.3	44.3	17.0	11.0	18.2	14.0
3	215	75	157.5	89.9	27.0	48.3	89.2	81.3	16.8	28.3	45.1	16.1	13.1	17.0	12.1
4	219	95		103.2	30.2	53.7		102.6	17.8	31.8	49.6	17.3	13.1	18.5	13.6
5	209	101	184.2	97.2	29.8	57.5	104.8	97.2	18.7	32.4	51.1	17.7	13.6	17.6	13.7
5	220	125	193.7	101.6	31.1	59.1	106.7	109.2	20.3	34.0	54.3	17.1	13.1	18.7	12.8
5	234	148	180.3	102.6	31.8	66.0	119.1	114.3	21.3	33.0	54.3	19.4	15.0	20.2	14.0
7	204	159	189.9	101.0	29.5	63.5	111.8	101.7	20.5	35.2	55.7		14.0		15.2
8	202	105	182.0	104.0	32.5	61.0	98.8	104.0	21.1	35.2	56.3				
8	221	136	188.6	104.1	30.8	56.5	101.6	106.7	20.0	33.3	53.3	17.9	12.9	18.0	13.0
10	212	105	184.1	96.2	29.2	57.8	96.2	97.2	19.1	31.4	50.5	17.8	12.2	16.4	11.8
10	213	102	185.4	107.6	32.1	53.0	104.8	83.8	22.2	33.0	55.2	18.2	14.2	19.0	13.8
11	207	98	181.0	108.3	32.1	59.1	102.2	93.3	21.6	34.0	55.6	18.2	12.5	18.0	12.5
12	208	91	180.3	107.6	30.8	59.1	106.0	104.1	22.2	35.2	57.4	21.0	15.2	20.8	14.0
12	231	154	205.7	97.8	29.2	66.0	117.5	119.4	21.0	37.1	58.1				
13	206	170	198.1		34.6	72.4	135.3	108.0	22.5	36.8	59.3	22.6	15.0	20.6	14.7

* Ear tag number.

Table 5. Breeding status and known productivity of female brown bears over 3 years of age, captured in Game Management Unit 13 from April 9 through June 23, 1978.

Bear I.D. Number	Age (Yrs)	Age First Bred (Yrs)	Offspring No.-Age (Yrs)	Remarks
202	8	Unk.	None	Lactating and in estrus, with 10 year old male #201 when captured.
204	7	4	2 - 2.5	Abandoned yound (#229, other unmarked) and was observed with 7 year old male #228 on 6/10/78.
206	13	Unk.	None	Lactating and in estrus, with 4 year old male #205 when captured.
207	11	Unk.	3 - 0.5	Two cubs captured-ear tagged only. Male-#815, female #816.
208	12	Unk.	None	Lactating and in estrus, not with a male when captured.
209	5	Unk.	None	Not lactating, in estrus and with 2 year old male #210 when captured.
212	10	Unk.	None	Lactating and in estrus, with 4 year old male #211 when captured.
213	10	Unk.	1 - 1.5	Lactating - yearling never observed with sow after capture date.
215	3	Unk.	None	Not lactating - mammae small (0.8 cm) and pink colored.
219	4	Unk.	None	Not lactating, in estrus, mammae small (1.0 cm) and pink in color.
220	5	3	1 - 1.5	Lactating
221	8	Unk.	2 - 1.5	Lactating
231	12	Unk.	None	Lactating and in estrus, with 10 year old male #201.
234	5	3	2 - 1.5	Lactating, yearlings not with sow during late July.

Table 6. Brown bear hair element values by sex and age for bears captured in Nelchina Basin from April 9 through June 23, 1978 (ppm).

Bear ID Number	Sex	Age (Years)	Zinc	Copper	Calcium	Magnesium	Potassium	Sodium	Cobalt	Iron	Manganese	Chromium
200	M	7	267	26	825	85	1830	5350	1.3	73	0.8	0.2
201	M	10	193	35	650	90	1690	5720	1.9	118	0.6	0.4
202	F	8	204	17	930	115	2730	5890	2.0	62	0.7	0.1
203	F	2	216	36	1120	95	800	5450	1.3	87	1.0	0.3
204	F	7	137	22	1350	130	1350	6030	1.6	65	1.3	0.5
205	M	4	293	25	890	65	2380	5580	2.1	108	1.1	0.3
206	F	13	304	20	765	95	1770	5820	1.5	104	0.7	0.3
207	F	11	185	28	1040	65	1820	6140	1.6	85	1.2	0.4
208	F	12	217	19	990	85	3000	5730	1.3	99	0.9	0.4
209	F	5	302	17	1080	75	1780	5840	1.5	83	0.6	0.3
210	M	2	170	16	1315	70	1160	5370	1.8	86	1.3	0.1
211	M	4	206	26	870	80	1930	5410	1.3	111	1.3	0.3
212	F	10	261	22	930	115	2160	5590	2.8	93	1.3	0.3
213	F	10	255	28	1530	100	2380	6140	1.9	78	1.0	0.3
214	M	3	287	30	845	90	2310	5720	1.5	80	1.1	0.4
215	F	3	242	27	965	70	4280	6680	1.7	74	1.2	0.4
216	M	11	209	31	1005	80	3870	5270	1.3	108	1.6	0.1
217	M	3	263	22	1710	130	3120	5630	0.9	82	1.3	0.3
218	M	3	184	19	885	110	3210	4550	1.4	105	0.5	0.2
219	F	4	348	23	960	100	900	5700	2.4	78	0.9	0.3
220	F	5	197	13	930	120	1490	5390	1.2	119	1.0	0.4
221	F	8	268	26	1160	90	1090	5110	1.8	97	2.0	0.3
222	M	11	317	29	465	85	1150	6030	1.6	83	1.2	0.2
223	M	2	261	37	820	100	2670	5010	2.0	122	1.2	0.3
224	M	2	373	20	655	115	2120	5680	1.3	101	0.6	0.4
225	M	4	217	17	985	85	2070	6430	0.9	83	0.8	0.4
226	M	5	226	47	1250	70	1490	3270	1.7	78	1.2	0.4
227	M	9	281	19	685	85	4210	6780	1.0	120	1.3	0.3
228	M	7	172	38	930	95	1580	5140	1.6	80	1.0	0.2
229	F	2	193	27	1630	125	2760	5630	1.6	112	1.1	0.5
230	M	9	148	21	565	90	1340	5730	1.6	126	1.3	0.6
231	F	12	304	30	935	70	2510	5220	1.5	99	1.4	0.4
232	F	1	261	19	1265	80	1270	5660	1.2	107	0.7	0.3
233 - No Data												
234	F	5	257	26	1340	110	820	5250	1.8	105	0.9	0.3
235	F	1	149	28	1290	100	2030	4890	1.6	85	0.8	0.4

Territory (Pearson 1972). Aspects of productivity will be discussed in the final paper when additional information is available.

Table 6 lists the values (ppm) for 35 bear hair samples analyzed for 10 elements by atomic absorption spectroscopy; Zinc ($\bar{x}$ = 239, SD = 57.5, range 137 to 373), Copper ($\bar{x}$ = 25, SD = 7.3, range 13 to 47), Calcium ($\bar{x}$ = 1016, SD = 287.1, range 465 to 1710), Magnesium ($\bar{x}$ = 93, SD = 18.5, range 65 to 130), Potassium ($\bar{x}$ = 2088, SD = 906.3, range 800 to 4280), Sodium ($\bar{x}$ = 5567, SD = 615.1, range 3270 to 6780), Cobalt ($\bar{x}$ = 1.6, SD = 0.4, range 0.9 to 2.8), Iron ($\bar{x}$ = 94, SD = 171., range 62 to 126), Manganese ($\bar{x}$ = 1.1, SD = 0.3, range 0.5 to 2.0), and Chromium ($\bar{x}$ = 0.3, SD - 0.1, range 0.1 to 0.6). Table 7 lists the serial physiologic values of blood samples collected during this report period. Both sets of data will be placed on computer and analyzed in future reports.

Data pertaining to seasonal movements, home ranges and predation were insufficient for presentation at this time and will be presented in subsequent reports.

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Table 7. Blood values by sex and age for brown bear captured in Nelchina Basin from April 9 through June 23, 1978.

Bear ID Number	Sex	Age (Years)	Total Protein GM/100ml	% of Total	Albumin GM/100ml	% of Total	Alpha 1 Globulin GM/100ml	% of Total	Alpha 2 Globulin GM/100ml	% of Total	Beta Globulin GM/100ml	% of Total	Gamma Globulin GM/100ml	% of Total	Albumin/ Globulin	Hemoglobin	Packed Cell Volumn
200 - No Data																	
201	M	10	6.5	100	3.8	58	0.3	5	0.9	13	0.8	13	0.7	11	1.4		35
202	F	8	6.1	100	3.5	58	0.4	6	0.7	11	0.9	14	0.7	11	1.4		52
203	F	2	3.8	100	2.2	57	0.4	10	0.5	12	0.5	13	0.3	8	1.3		
204	F	7	4.8	100	3.0	62	0.4	8	0.4	8	0.6	13	0.4	8	1.6		45
205	M	4	5.9	100	3.7	62	0.3	5	0.7	12	0.6	9	0.7	11	1.7		
206	F	13	5.6	100	3.4	61	0.3	6	0.6	11	0.6	10	0.7	12	1.6		
207	F	11	5.6	100	3.3	61	0.4	7	0.5	8	0.4	7	0.9	16	1.4		
208	F	12	5.5	100	2.7	49	0.4	7	0.9	17	0.7	12	0.8	15	1.0		
209	F	5	7.3	100	4.7	64	0.4	5	0.8	11	1.2	16	0.3	4	1.8		49
210	M	2	7.7	100	4.6	60	0.6	8	0.6	7	1.3	17	0.6	8	1.5		51
211																	50
212	F	10	7.4	100	4.6	61	1.0	13	0.3	4	1.1	15	0.5	6	1.6	20+	46
213	F	10	7.0	100	4.7	68	0.4	6	0.6	9	0.7	9	0.6	9	2.1	20+	48
214	M	3	6.7	100	3.8	57	0.5	7	0.9	14	0.7	10	0.9	13	1.3		48
215	F	3	6.5	100	4.7	73	0.4	6	0.6	9	0.5	8	0.3	4	2.7		47
216	M	11	8.0	100	5.0	62	0.6	7	0.9	12	0.8	10	0.8	10	1.6		46
217	M	3	7.8	100	4.9	62	0.6	8	0.8	10	0.9	11	0.7	9	1.7		
218																	
219																	
220	F	5	7.0	100	4.3	61	0.5	7	1.1	15	0.7	10	0.5	7	1.6		
221	F	8	7.0	100	5.1	73	0.3	4	0.5	5	0.7	10	0.5	7	2.7		
222	M	11	8.2	100	5.3	65	0.5	6	1.1	13	0.9	11	0.5	6	1.8	18	53
223	M	2	6.6	100	4.1	61	0.5	7	0.7	10	1.1	16	0.3	5	1.6	17.6	47
224	M	2	6.6	100	4.3	65	0.5	8	0.7	11	0.8	12	0.3	5	1.8	18.9	48
225	M	4	7.2	100	4.8	67	0.5	7	0.6	8	0.7	10	0.7	10	2.0	19	50
226	M	5	8.1	100	4.9	60	0.3	4	1.3	16	1.0	12	0.7	8	1.5	17	31
227	M	9	8.0	100	5.1	63	0.4	5	0.7	9	1.2	15	0.6	8	1.7	19	48
228	M	7	7.8	100	4.7	60	0.4	5	1.0	13	0.9	11	0.9	11	1.5		41
229	F	2	7.2	100	4.7	66	0.6	8	0.7	9	0.9	12	0.4	5	1.9		49
230	M	9	7.1	100	4.8	67	0.4	6	0.6	8	0.7	9	0.7	9	2.0		49
231	F	12	8.3	100	5.0	60	0.6	8	0.8	10	0.9	10	1.0	12	1.5		40
232	F	1	6.7	100	3.6	54	0.5	7	0.9	14	0.6	9	1.0	15	1.5		43
233 - No Data																	50
234	F	5	7.0	100	4.6	65	0.4	6	0.7	9	0.7	9	0.7	10	1.9		48
235	F	1	5.6	100	3.6	64	0.5	9	0.5	10	0.5	9	0.5	9	1.8		48

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

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

INTRODUCTION

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

Rausch (1969), Bishop and Rausch (1975), and McIlroy (1974) described the history of the Nelchina Basin moose population. The moose population began declining after the severe winter of 1961-62. The decline continued with severe winters occurring in 1965-66 and 1971-72. Although wolf predation was not suggested as the main reason for the population decline, it was thought to have at least accentuated the decline, and perhaps more importantly, prevented recovery during mild winters (Bishop and Rausch 1975). This trend of thought, coupled with the findings of Stephenson and Johnson (1972,1973), which revealed high percentages of calf moose in wolf scats, suggested that wolf predation on moose calves was preventing the moose population from recovering. Consequently, in 1975 a series of studies on wolf-moose relationships were initiated. These studies were later expanded to include brown bear-moose relationships. Information pertaining to these studies was reported by Stephenson (1978), Ballard and Taylor (1978a,b), Ballard and Spraker (1979), Spraker

and Ballard (1979) and Ballard et al. (in press). Considerable attention was focused on gathering wolf food habits information during the late spring and summer when most moose calf mortality occurred. The purpose of this paper is to report on observed encounters between bears and wolves during these studies, and to discuss the significance of such interactions.

MATERIALS AND METHODS

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

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

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

Observations of circumstances surrounding bear-wolf encounters were recorded, as they occurred, in a notebook and then elaborated upon after the flight ended. When it became apparent that more than two or three observations would be collected, notes were recorded on a Sony tape recorder (Model TC-55) and transcribed after the flight had terminated.

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

Study Areas and Wolf Pack History

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

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

Mendeltna Wolf Pack

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

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

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

Hogan Hill Wolf Pack

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

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

RESULTS AND DISCUSSION

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

On 11 June, at 2500 hr., adult gray-black female wolf 07 was observed being chased by a cow moose which was exhibiting aggressive behavior (mane ruffed-up and ears down). Wolf would veer off a straight line in what appeared to be an attempt to lose the pursuing cow. When wolf appear to lose cow by crouching in brush, the cow would search for the wolf and in three instances was able to find it. The cow gained ground on the wolf which appeared to tire. On one occasion the wolf stopped and crouched in the brush. The cow ran over to the area and appeared to trample the wolf. Wolf then continued running but at a much slower pace and with a limp. The chase lasted approximately 15 minutes, at which time the wolf appeared to head for den site, while the cow began traveling back the direction from which it had come. Cow continued to exhibit aggressive behavior. Cow began swimming a pond on the other side of which I observed a brown bear sow with three yearling cubs. The cubs

were huddling over and dragging around a calf moose carcass. Cow ran around the bears within a 40-50 m radius. Wolf 08, a yearling male, was present in dense spruce some 150-175 m away from the bears, but was not observable. I returned to the calf kill at 2230 hr. via helicopter and frightened the bears, which were huddled over the calf carcass, away from the site. Examination of kill revealed puncture marks on the neck and either puncture or claw marks on the anus. Only the head had been fed on. The skull was cleaned out so that all that remained was skin casing. Tongue, eyes and ears had been eaten which was characteristic of bear-killed calves (Ballard et al., in press). Imprints were noted in area and bear hair was noticeably evident on surrounding brush. Interpretation: Bears made the kill and wolves were attempting to scavenge, but were chased away by cow or bears or both.

On 12 June, at 0910 hr., wolf 83, an adult gray male, and a smaller, drabber gray adult of unknown sex were observed chasing and harassing same bears observed the previous evening. The wolves stayed fairly close to each other while chasing the fleeing bears. When the bears stopped running one wolf would crouch and approach the sow. The sow would charge the approaching wolf at which time the other wolf would would charge and chase the yearling cubs causing the sow to charge the second intruding wolf. On one occasion the wolves treed all three cubs. The wolves appeared to press their charge when the bear's direction of movement was towards den #2 which was less than 2 km away to the east. On one occasion the radio-collared wolf was observed sneaking around and crouching down in front of the bear's direction of movement. Apparently the sow detected this action because when she was approximately 10 m

away, she charged the crouched wolf and almost caught it by the hind quarters. It appeared that when the bears finally established a trend of movement away from the den, the wolves no longer pursued and began heading back towards the den. These activities lasted 15 minutes and covered 0.6 km from where we first observed the bears. Interpretation: Wolves discouraged bear movement towards wolf den.

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

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

On 16 June, at 1945 hr., wolves 83 (adult gray male), 08 (yearling gray male), a small gray adult of unknown sex, and one black yearling of unknown sex were observed attacking an adult brown bear which possessed an adult moose kill. Initially three wolves were observed equally

spaced surrounding the bear. One of the wolves was observed attempting to nip the bear in rump. Bear made several short charges at wolves which were approaching to within 3-5 m. Wolves easily out manuevered the bear and three of the wolves appeared to keep the bear away from the kill as a fourth wolf fed on it. The bear's direction of movement was toward the kill and after 15 minutes of encountering the wolves, the kill was reached. When the bear reached the kill the wolves stopped harassing the bear and began traveling in the direction of the main den. Kill was estimated to be 50 percent consumed. Interpretation: Either bear or wolves made kill and wolves were attempting to displace bear.

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

On 24 June, at 1655 hr., wolf 83 (adult gray male) was observed alone resting approximately 10 m from an adult moose kill with one adult brown bear on it. Head, rear quarters, guts and skin were all that remained. Interpretation: Kill was made by either wolves or bear. Wolf may have been attempting to scavenge and/or displace bear. On 29 June three wolves were observed feeding at kill site.

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

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

Aggressive behavior between the two predator species occasionally results in mortality to the participants. Joslin (1966) reported that an adult female wolf was killed close to a den by a black bear (*Ursus americanus*). In September 1976 a member of the Mendeltna pack was killed by a brown bear probably as a result of competition over an adult moose kill. Details of this particular observation were presented in Ballard (in press). Mech (1970) thought that occasionally wolves killed

bears, but that the victims were probably cubs, young bears, or older weakened bears. Murie (1944) suggested that bear-wolf encounters were more intense on the part of wolves when they occurred close to wolf dens. The Mendeltna wolves exhibited agonistic behavior towards bears both at kills and in areas close to den sites. Observations recorded during this study substantiate that wolves do occasionally kill bears. The result of brown bear-gray wolf encounters, therefore, may at times be an additional source of natural mortality not previously documented for either predator species. Whether it is a significant source of mortality for either species is unknown.

Reasons for Contested Kills

During summer 1977 the Mendeltna pack had six contested kills in addition to several bear encounters away from kill sites. In contrast, during a similar study period in 1978 when the Hogan Hill pack was studied, none of six kills were contested and no bear encounters away from kills were observed. Reasons for the larger number of contested kills for the Mendeltna pack may be related to a number of factors including: (1) observability, (2) predator density and (3) prey density.

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

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

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

I speculate that the bear-wolf encounters observed while studying the Mendeltna wolf pack were due primarily to lower moose densities in that area. This speculation was supported by predation data collected by monitoring radio-collared bears. These data indicate that bears took substantial numbers of moose in all of the areas studied (Ballard and Spraker, in prep.). Thus, for the Hogan Hill area, where moose were

more abundant, no kills were contested, because, I suspect, sufficient moose were available for each predator during the study period.

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

Significance of Contested Kills to Predator Ecology

During this study I was unable to quantify how much was eaten by each predator species at a particular kill site because the observation periods were too short and in some cases, my presence may have interferred.

In many cases, however, it it was apparent that both species were able to feed at many of the kills for varying lengths of time. The amount consumed by wolves at a particular kill site could alter kill rates and influence how kill data are interpreted.

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

The amount of prey biomass available per adult wolf was calculated for both study packs (Table 1). Two values were calculated for the Mendeltna Pack: the first value assumed that all of the prey biomass was available to wolves even though bears were present on some kills while for the second value I arbitrarily assumed that only 50 percent of the biomass on bear contested kills was available to wolves. Although I

could not determine how much was eaten by either predator at a kill site, I did observe that both usually fed on some quantity. Regardless, the range of 4.7 to 6.2 kg/wolf/day of available food for the Mendeltna Pack was greater than the rate of 4.4 kg/wolf/day calculated for the Hogan Hill Pack.

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

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

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

Only with recent years have both black and brown bears been identified as significant predators of cervids (Schlegel 1976, Franzmann and Schwartz 1978, Ballard and Taylor 1978, and Ballard et al., in press). The fact that both predator species have potential to not only prey upon ungulate species, but also to scavenge and interact with one another could greatly complicate our attempts to understand predator-prey relationships.

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

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

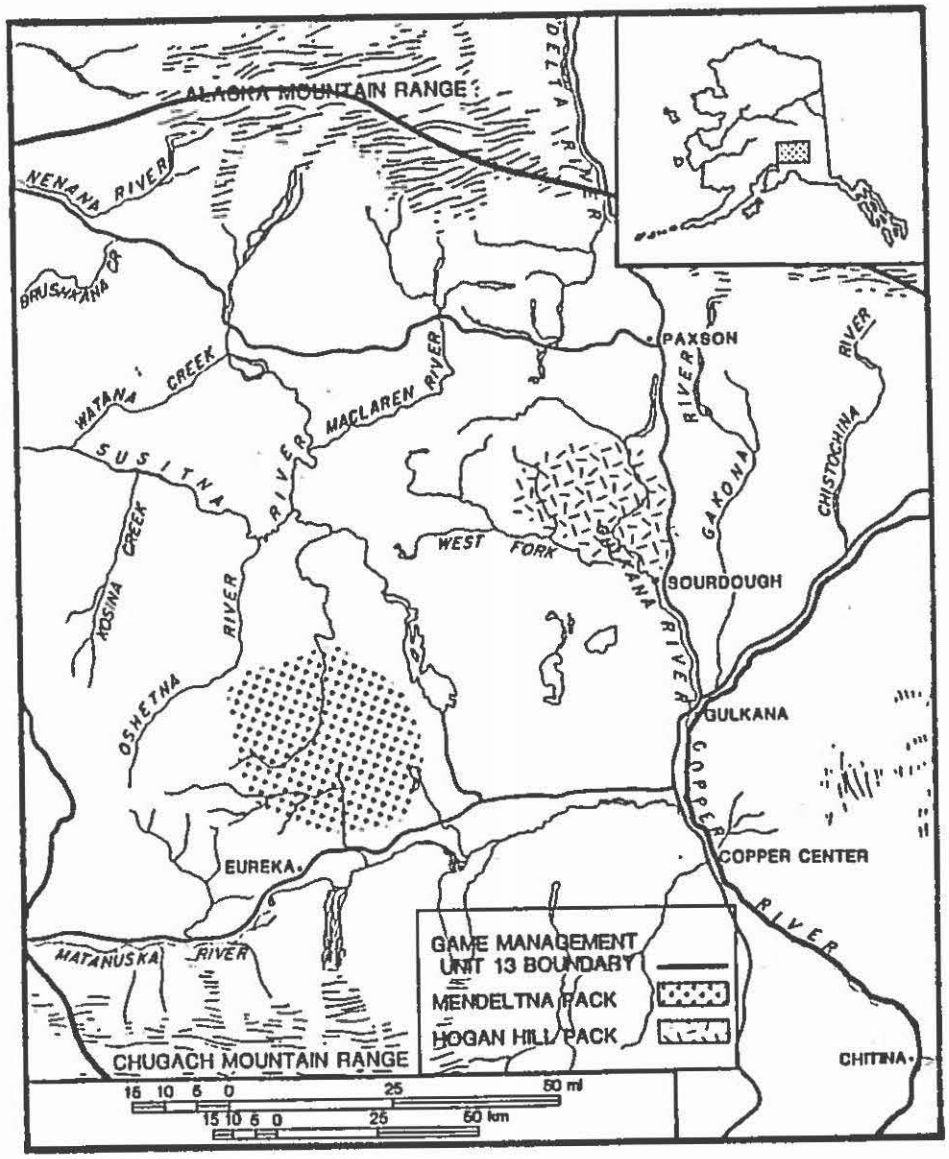
1/ Biomass of available food based upon following assumptions: Weight of adult moose = 427.5 kg (from Franzmann and Bailey 1977) and yearling moose = 197.5 kg. (from Franzmann and Arneson 1973, 1975) of which approximately 75% (from Peterson 1977) available as food yielding 321 kg. and 148 kg., respectively.

Newborn calf moose weights 29.4 kg. (from Ballard and Taylor 1978) and gains weight at rate of 1.9 kg/day (from Franzmann and Arneson 1973). Therefore, 15 day old calf weighs 72 lbs., of which 90% is consumable yielding 64 lbs.

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

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

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


ALASKA MOUNTAIN RANGE
DELTA RIVER
NENANA RIVER
BRUSHKANA CR
WATANA CREEK
SUSITNA RIVER
MACLAREN RIVER
PAXSON
GAKONA RIVER
CHISTOCHINA RIVER
WEST FORK
GAKONA RIVER
SOURDOUGH
KOSINA CREEK
OSHETNA RIVER
GULKANA
COPPER RIVER
COPPER CENTER
EUREKA
MATANUSKA RIVER
CHUGACH MOUNTAIN RANGE
GAME MANAGEMENT UNIT 13 BOUNDARY
MENDELTNA PACK
HOGAN HILL PACK
CHITINA
15 10 5 0 25 50 mi
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