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FINAL REPORT

State: Alaska Department of Fish and Game

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Project Title: NPR-A Mammal Studies

Job Title: Structure, Status, Reproductive Biology, Movement, Distribution and Habitat Utilization of a Grizzly Bear Population in NPR-A.

Period Covered: April 1, 1977 through September 30, 1978

SUMMARY

Population biology, movement, distribution and habitat utilization of grizzly bears were studied in 1977 and 1978 in the northern foothills of the western Brooks Range. A total of 83 of the estimated 121 bears in the 5,200 km^2 (2,000 mi^2) study area were captured. A density of 1 bear/43 km^2 (1/17 mi^2) was estimated in the area. The population estimate for NPR-A was 420 bears. The age structure of the population showed more animals in the 0.5- to 2.5-year age classes than in any others. The sex structure of the portion of the population over age 1.5 was 60.2 percent females and 39.8 percent males. Measures of reproductive biology which were calculated included a mean age of 8.6 at first production of a litter, a reproductive interval of 4.06 years, a mean litter size of 2.08 young and a reproductive rate of 0.512 cubs/female/year. Evidence indicates that these parameters are higher than those reported in other portions of the North Slope, probably due to the availability of carrion and prey from calving caribou of the Western Arctic Herd.

The mean distance traveled per day by grizzly bears was observed to be 4.5 km (2.8 mi), but one individual traveled 163 km (101 mi) to the coast of the Arctic Ocean and later returned. Home ranges were calculated for 23 individual grizzlies; mean home range size for males was 764 km^2 (295 mi^2) and 246 km^2 (95 mi^2) for females. Food habits and habitat use were discussed. Bears usually denned within their spring, summer and fall ranges, but four individuals moved from 16.1 to 43.8 km (10.0-27.2 mi) from their fall ranges to den. The mean range of denning dates in 1977 was from 12 to 18 October; in 1978, from 7 to 9 October. Dens were located throughout the study area in all types of terrain and at elevations from 270 to 1,280 m (900 to 4,200 ft). Disturbance of denning bears by seismic exploration was monitored; no abandonment of dens was observed, but the potential for adverse impact exists, especially by females with newborn young.

CONTENTS

BACKGROUND

The history of brown/grizzly bears (Ursus arctos L.) has been one of continuous reduction of numbers and range coinciding with human population growth and development. Only remnant populations remain in Europe (Cowan 1972, Curry-Lindahl 1972). In North America, where they once ranged throughout the western portion of the continent, populations are now much reduced or absent in most areas south of the Canadian border (Storer and Tevis 1955, Craighead and Craighead 1967, Cowan 1972, Herrero 1972). In the past much of the North American brown/grizzly bear range has been protected by its rugged physiography or inaccessibility, but these obstacles to resource development and access are no longer effective.

The potential for adverse impact of development on grizzly bear populations in Alaska is probably greatest from the Brooks Range north to the Arctic Ocean. Here the grizzly is at the northern extent of its range; the period of food availability during the summer season is short, reproductive potential is low, the area required for individual home ranges is large and the stunted vegetation of the region provides little cover (Reynolds 1976, Reynolds et al. 1976).

Brooks et al. (1971) pointed out the possible detrimental impact that development of oil and gas resources might have on North Slope grizzlies, including disruption of habitat, increased human habitation and increased access. Since then, construction of the Trans-Alaska Oil

Pipeline has been completed, a road linking Fairbanks with the Arctic Ocean coast has been finished, exploration for additional petrochemical reserves has increased and plans for networks of transportation corridors throughout the area have been made. The exploitation of tremendous potential gas and oil reserves in National Petroleum Reserve-Alaska (NPR-A) would take place in the largest undeveloped area remaining on the North Slope. This is an area where loss of habitat or development-caused disruption of population dynamics could have undesirable consequences for grizzly bear survival or population maintenance.

Before the impact of increased resource development on grizzly bears of NPR-A can be evaluated, it is necessary to determine basic biological information including sex and age structure, reproductive biology, movement patterns, home range size and population boundaries. Several studies have been conducted on the North Slope outside the borders of NPR-A. R. L. Rausch (1969 and pers. comm.) studied some aspects of the sex and age structure of grizzly bears killed near Anaktuvuk Pass. Tentative estimates of abundance and productivity, instances of movement and evaluation of survey techniques for grizzly bears were reported by Crook (1971, 1972) in the central North Slope. In 1973 studies were initiated to determine potential impact of development on the ecology of eastern North Slope grizzly bear populations (Quimby 1974, Quimby and Snarski 1974, Reynolds 1974, Reynolds 1976, Reynolds et al. 1976). In these studies the grizzly bear population density was found to be low (1 bear/140-260 km^2 or 1 bear/360-675 mi^2), home range size large and reproductive potential low. It is uncertain whether these population parameters are region-wide or indicative only of the area studied. Regardless of the applicability, populations in the Arctic are more susceptible to impact from outside sources, including resource development, and, if adverse impact is to be avoided, a knowledge of grizzly bear habitat requirements and population dynamics is imperative.

OBJECTIVES

1. To determine the structure, size, status and reproductive biology of the grizzly bear population in NPR-A, and to evaluate how potential impacts of energy resource development upon the grizzly bear population can be avoided or mimimized.

2. To determine home range selection, movement patterns, distribution, denning characteristics and habitat utilization of grizzly bear populations in NPR-A.

PROCEDURES

During May-October 1977 and 1978 intensive study was carried out in a 5,200 km^2 (2,000 mi^2) area in the southwestern corner of NPR-A. The southern and western boundaries of the study area approximately follow the boundaries of NPR-A; that is, roughly the Kokolik River on the west and the crest of the Brooks Range on the south. The northern boundary was Archimedes Ridge (69°10'N latitude), and to the east, a line running from Thunder Mountain to the Utukok River (160°15'W longitude).

Field work was carried out from a tent camp at Driftwood Creek airstrip on the Utukok River (68°55'N latitude, 152°05'W longitude) from 1 May to 2 November 1977 and from 12 May to 16 October 1978.

Bears were captured with the use of a Bell 206B helicopter from 22 May to 7 July, 8 to 10 August 1977 and from 7 June to 3 July 1978; approximately 135 hours of helicopter flight time were used during the study. During the period that bears were captured, a Piper PA-18-150 (Super Cub) aircraft was used to locate grizzlies and to direct the helicopter with the immobilization crew to the site. In addition, the Super Cub was used to conduct surveys or make observations and to locate bears fitted with radio transmitters.

Capture procedures followed standard helicopter immobilization techniques used on grizzly bears in the eastern Brooks Range (Reynolds 1974, 1976). Bears were immobilized with Sernylan (phencyclidine hydrochloride, Bio-Ceutic Laboratories, St. Joseph, MO) injected into the rump using Cap-Chur equipment (Palmer Chemical and Equipment Co., Douglasville, GA). All animals were measured, weighed (Appendix I) and tattooed for permanent identification, ear tagged and marked with individually-coded visual identification collars or ear flags as described by Reynolds (1974) (Appendix II). In addition, 29 bears were fitted with collars containing radio transmitters; collars of 5 bears instrumented in 1977 were replaced in 1978.

A first premolar tooth was extracted for determination of age based on cementum layering (Mundy and Fuller 1964, Stoneburg and Jonkel 1966, Craighead et al. 1970). The techniques used to section, stain and mount teeth for age determination were described by Glenn (1972).

Whole blood was collected from femoral arteries using donor tubes and 150-cc vacuum plasma collection units (Travenol Laboratories, Forest Grove, IL) or 10-cc Vacutainers (Bection-Dickinson, Rutherford, NJ). Blood was centrifuged at the field station and sera were frozen for determination of the presence of Brucella suis (Neiland, in prep.) and for blood chemistry studies being conducted by Dr. M. Philo, University of Alaska, Naval Arctic Research Laboratory.

Fecal samples were collected to aid in determining seasonal food habits and are being analyzed in detail as part of a Masters of Science thesis (Hechtel, in prep.).

Information on breeding biology was obtained by: 1) recording data on the size, coloration and lactating condition of the mammae, condition of the vulva, baculum size and position of the testes; 2) observing male-female pairing; and 3) recording the number of cubs and age structure of all family groups.

The direct count method (Pearson 1976, Reynolds 1976) was used to determine the grizzly bear population size on the intensive study area; densities found on the study area in conjunction with those found elsewhere on the North Slope (Crook 1971, Quimby 1974, Reynolds 1974, Curatolo

and Moore 1975, Reynolds 1976) and in northern Canada (Pearson 1976) were used to extrapolate densities in NPR-A and arrive at a population estimate. Several other methods were considered and rejected because of erratic or less accurate results. The differential efficiency method (Caughley and Goddard 1972) for determining population size was used for grizzly bear populations in the eastern Brooks Range with no success (Reynolds 1976). The Lincoln Index (Overton and Davis in Gils 1969) requires the use of marked animals and since it was not possible to mark bears outside the intensive study area due to funding and logistic constraints this method was not applicable. The feasibility of using random transect lines 2,250 km (1,400 mi) in length or intensively surveyed 2,296 km^2 (886 mi^2) quadrats was tested during survey flights conducted to determine caribou distribution, but the number of bears seen during these surveys was too low to be representative of the areas. Crook (1972) tested a survey technique along river valleys of the central North Slope and found that the results were too erratic to be statistically meaningful. Until a more accurate survey or census method is devised and tested, the extrapolation of bear densities found in areas and habitats of intensive study will give the best population estimate.

Movements and home range size were determined from resightings of marked grizzlies during aerial surveys and from frequently locating 29 animals fitted with radio transmitters (Telonics, Inc., Mesa, AZ). Radio-collared bears were located using a Super Cub aircraft equipped with a radio receiver-scanner and four-element, high-gain Yagi antennas mounted to the wing struts. Transmitter signals were received at distances up to 48 km (30 mi) under optimum conditions when the aircraft was at 1,500 m (5,000 ft) above ground level (AGL); more often, especially in mountainous terrain, flight level was 300 m (1,000 ft) AGL and signals were received from 5-13 km (8-20 mi) distance.

Locations were plotted on 1:250,000-scale topographic maps and relevant information was recorded. When possible, locations were determined visually every 4 or 5 days in 1977 and every 7 days in 1978; however, other commitments or long periods of inclement weather creating unsafe flying conditions delayed observations. When radio-collared bears were not visually located during flights because of adverse weather conditions, cover or terrain, "fixes" were determined by triangulation or by abrupt changes in radio signal strength.

Home ranges were determined using two methods: the modified "exclusive boundary strip" (Stickel 1954, Berns and Hensel 1972, Curatolo and Moore 1975, Reynolds 1976) and the "minimum home range polygon" (Craighead and Craighead 1972; Pearson 1975, 1976; Craighead 1976). Home ranges were calculated by the two methods for comparative purposes. In the modified exclusive boundary strip method, the mapped locations were overlain by grid squares 4.83 km (3 mi) on a side or 23.3 km^2 (9 mi^2) in area, dimensions based on daily movements by bears. All grids including actual distances were connected by the shortest distance to other grids containing actual location; this was done because no observations were made during travel by a bear between location sites. In the minimum home range polygon method, the outermost observations sites plotted on

maps for each individual bear were connected and the home range size was determined by measuring the enclosed area with a polar planimeter.

FINDINGS AND DISCUSSION

Because of the difficulties in capturing a large enough proportion of a grizzly bear population to accurately describe the dynamics and reproductive biology of that population, findings presented here should be viewed as preliminary and contingent upon collection of additional data. Also, parameters describing productivity, especially reproductive interval and survival of young, must be recorded more than 2 years in order to be accurate.

Population Size

A total of 83 bears was captured and marked in the area of intensive study; an additional 47 unmarked but identifiable individuals were observed in the study area. Also, to account for those bears which did not stay in the study area throughout the year, the proportion of the home range of each bear outside the study area was estimated; the sum of these fractional home ranges of bears was subtracted from the study area population. Also, at least 6 mortalities occurred during 1977 and 1978, leaving a minimum total of 115 grizzlies in the study area.

The unmarked identifiable bears included 13 offspring of marked females, 7 unmarked females with 15 young, 1 unmarked female with 2 marked young and 11 single individuals. All sightings of these unmarked bears were recorded throughout the summer; unmarked females with young could be individually identified with more precision than single bears since those bears were encountered in family groups of varying size, age and coloration of individuals within the group, and their home ranges were smaller than those of single bears. It was more difficult to differentiate between individual solitary bears because of growth and pelage changes during the summer. However, a good minimum estimate of the number of solitary bears was obtained from observations of bears of the same size and coloration which were found repeatedly in the same vicinity, and from separate sightings of bears with similar descriptions which were seen within short periods of time or in widely separated locations. The accuracy of these techniques was illustrated when almost all of the bears captured in 1978 had been previously observed and accounted for in the 1977 estimate. The animals captured in 1978 which were not seen in 1977 were primarily cubs born in 1978.

A density of 1 bear/45 km^2 (1 bear/17.4 mi^2) was calculated from the observed minimum population of 115 bears in the 5,200 km^2 (2,000 mi^2) area. Because of the lack of escape cover and extensive aerial surveys conducted for 2 years in the study area, it was felt that at least 95 percent of all bears in the study area were located. Therefore, an adjusted population estimate of 121 bears inhabited the area during 1977 and 1978, or a density of 1 bear/43 km^2 (1 bear/16.6 mi^2).

The best method for determining grizzly bear density or population size in arctic regions has been a direct count in conjunction with an

intensive individual marking program over a period of years (Reynolds 1974, 1976; Pearson 1975, 1976). Other means of estimating the grizzly bear population in areas not under intensive study have not been successful in the past because of grizzlies' low density, sparse distribution and solitary habits (see Procedures section). However, even though the direct count method was felt to give accurate results, its use is limited to areas of intensive study and requires at least 2 years of data. Since it is not practical over an area as large as NPR-A, the technique of assigning densities based on smaller areas of intensive study and extrapolating these figures over wide areas was used to provide more meaningful information. Using this technique an estimate of 420 grizzly bears in NPR-A was derived. This population size was calculated by estimating bear densities in: 1) the coastal plain (sea level to 1,000-ft. mean elevation); 2) the low foothills (1,000-2,000 ft.); 3) the high foothills (2,000-3,000 ft. mean elevation); and 4) the mountains (elevations over 3,000 ft.) and extrapolating the density estimates to total populations for the areas contained in each elevational category.

The estimated densities of bears in these areas are: coastal plain - 1 bear/780 km^2 (300 mi^2); low foothills - 1 bear/90 km^2 (35 mi^2), range - 1/50-130 km^2 (20-50 mi^2); high foothills - 1 bear/130 km^2 (50 mi^2); and mountains - 1 bear/260 km^2 (100 mi^2). These estimates are based on densities determined in the study area in southwestern NPR-A, those from the central Brooks Range (Crook 1971) and from the eastern Brooks Range (Curatolo and Moore 1975, Reynolds 1976). While future research may result in the determination of more accurate densities for these areas, the present estimates of numbers for 1978 will probably not be changed appreciably.

By comparison, a grizzly bear population studied in the mountains and foothills of the north slope of the Brooks Range 500 km (310 mi) to the east of the study area had a density of 1 bear/148 km^2 (57 mi^2) (Curatolo and Moore 1975, Reynolds 1976). Possible explanations for these differences are discussed below.

Sex and Age Composition

Thirty-six males (43.4%) and 47 females (56.6%) were captured during this study. If bears of yearling or cub age are not included in these figures, 30 (42.2%) were males and 41 (57.8%) were females. However, these figures probably do not reflect the true sex ratio of the population since 8 identifiable unmarked females with young, 3 adult males, 1 adult female and 7 single bears of unknown sex were not included in these data. If those unmarked bears of identifiable sex over the age of yearlings are included with marked bears, 33 (39.8%) were males and 50 (60.2%) were females. Of 32 known cubs and yearlings in the study area in 1978, only 12 were marked and their sex ratio was equal. This situation is similar to that found in Wyoming (Craighead et al. 1974) and may be explained by the fact that males, especially young individuals, range more widely than females and are more prone to various mortality factors. Hunting pressure in the area is very low; most mortality is due to natural factors.

The sex and age distribution of marked and unmarked bears in the study area is presented in Table 1. Ages were determined from cementum annuli of first lower premolars. To facilitate analysis, all bears were assigned the ages they would have reached in 1978, regardless of their year of capture. The age distribution indicates that there are more females than males in the adult cohorts and that these females appear to have a longer life expectancy.

Table 2 shows a comparison of age distribution in the study area with populations in the eastern Brooks Range (Reynolds 1976) and Yellowstone National Park (Craighead et al. 1974). The increasing population in Yellowstone has a high proportion of cubs and is increasing even though survival of young age cohorts is low; in the Brooks Range the proportion of cubs is low but survival of the next two successive cohorts appears to be higher.

Reproductive Biology

To determine the reproductive rates for bears, the following parameters of reproductive biology must be known: age at first production of young, length of productive life of females, length of the reproductive cycle or reproductive interval and average litter size (Craighead et al. 1974). In Alaska the age at sexual maturity for brown/grizzly bears on the Alaska Peninsula and Kodiak Island has ranged from 3.5 to 6.5 years (Hensel et al. 1969, Glenn et al. 1976) and in the eastern Brooks Range ranged from 6.5 to 12.5 years of age (Reynolds 1976). In the Yukon Territory, Pearson (1972) concluded that females are first capable of conception at 6.5 years in the southwestern portion of the province and at 7.5 years in the northern portion. In Yellowstone National Park, Craighead et al. (1969) reported that females bred at 4.5 to 8.5 years of age and had their first cubs the following spring. Moreover, they observed that some 3.5-year-old females copulated but none bore cubs the following spring.

Although the age at first pregnancy is probably the most accurate measure of age at sexual maturity, the occurrence of pregnancies is not easy to establish. In wild populations intrauterine mortality or mortality in the den prior to spring emergence is difficult to ascertain. Also, pregnancy does not necessarily follow breeding. Observations of females in estrous condition at least 2 years prior to their first successful production of young were recorded in three instances in the study area and have been recorded in Wyoming (Craighead et al. 1969) and Alaska (Glenn et al. 1976, Reynolds 1976).

For these reasons, the age at which a female produces her first litter that survives until after the emergence of the family group from the den is defined as the beginning point of a female's productive life or the minimum age at first production of young. The condition, size and coloration of mammae are good indicators of past production or non-production of young (Lentfer et al. 1969, Glenn 1972, Reynolds 1976). For example, the mammae of a female which has not produced young are typically 10 mm in length, grey in color, are unwrinkled and show no scarring on the areola. Producing females have mammae which are 14 mm long, black and flaccid, often showing scarring near the areola.

Table 1. Age and sex structure of the grizzly bear population in southwestern NPR-A, 1978.

Age	Males	Females	Unmarked, sex unknown	Total known in age class*
0.5	3	1	13	17
1.5	3	5	7	15
2.5	4	7	6	17
3.5	2	3	2	7
4.5	1	2		3
5.5	5	2		7
6.5	4	1		5
7.5	0	4		4
8.5	3	2		5
9.5	2	3		5
10.5	1	1		2
11.5	1	1		2
12.5	0	3		3
13.5	0	0		0
14.5	2	1		3
15.5	0	3		3
16.5	0	0		0
17.5	2	1		3
18.5	1	1		2
19.5	0	1		1
20.5	2	1		1
21.5	0	0		0
22.5	0	1		1
23.5	0	0		1
24.5	0	1		1
25.5	0	1		1
26.5	0	0		0
27.5	0	1		1

* In addition to those bears which were assigned ages from premolar tooth cementum layering, sex and ages of 19 unmarked bears were also estimated. Based on size, pairing during the breeding season or accompaniment by offspring, the sex and age of unmarked bears on this study area were as follows: 2 of unknown sex were 2.5-3.5 years of age, 5 from 4.5-6.5 years of age, and 9 females and 3 males were estimated older than 6.5 years of age.

Table 2. A comparison of age cohorts of grizzlies in three populations.

Location	Percent cubs	Percent yearlings	Percent 2-yr-olds	Percent 3 and 4 yr-olds	Percent 5-yr-olds and older	Status of population
Yellowstone Park (Craighead et al. 1974)	18.6	13.0	10.2	14.7	43.7	increasing
Eastern Brooks Range (Reynolds 1976)	7.9	10.9	10.9	5.0	65.3	declining*
Western Brooks Range (present study)	10.8	9.5	10.8	9.5	50.0	unknown

* Based on reproduction and age distribution data.

The minimum age at first production of young for females was established at 6.5 years of age in the study area, although at least one female had not produced young at 9.5 years of age. Besides the female mentioned above which bred and became pregnant at age 5.5, no other females of that age were observed or were determined to have bred. For this reason, the mean age at first production of young should be used in calculation of reproductive potential rather than the minimum age. During this study 16 females accompanied by young were captured (Table 3); 1 female had cubs at 6.5 years, 2 at 8.5 years and 14 between 10 and 25 years. Of the 12 which were not accompanied by young when captured, 5 had produced young in the past and 7 had not. If these 5 females had successfully reared young, weaned them as 2-year-olds and been captured during the same summer in which weaning occurred, their ages at production of young would have been: 7.0 years, 1; 8.0 years, 1; 12.0 years, 1; 16.0 years, 1; 18.0 years, 1; and 25.0 years, 1. Bears whose mammae did not display evidence of rearing young included females of the following ages: 5.5 years (1), 6.5 years (1), 7.5 years (3), 8.5 years (1), 9.5 years (1). The earliest possible age of production for these individual females would be 1 additional year of age.

Assuming that: 1) all females over age 7.5 years which showed no previous evidence of rearing young conceived during the year of calculation; 2) those females which showed previous evidence of having young were captured during the year in which their young were weaned as 2-year-olds; and 3) young accompanied by females of ages 8.5 or 9.5 were the product of their first successful birth, then an average minimum age of 8.6 years at first successful production of cubs can be calculated from 11 individuals. It should be noted this is a minimum figure since the assumptions 1) and 2) create a bias toward a younger age; data strongly indicate little bias exists in assumption 3).

Female grizzly bears in NPR-A are potentially long-lived. The ages of the oldest five females at the time of capture as established by examination of premolar tooth cementum annuli were 18.5, 19.5, 21.5, 24.5 and 26.6. All of these females were accompanied by young or were in estrous condition during the study. Their ages and reproductive status during the study were as follows: three produced cubs at 17.5, 21.5 or 22.5, and 25.5; one bred at 19.5 years but did not produce young at age 20.5. Thus, females may potentially be reproductively active from age 6.5 to 25.5, a period of 19 years. In comparison, observations of maximum reproductive age were recorded at age 25.5 in Yellowstone Park (Craighead et al. 1974), 21.5 years in the northern Yukon (Pearson 1976) and 22.5 years in the eastern Brooks Range (Reynolds 1976).

The term length of the reproductive cycle or reproductive interval as used in the study was the time between production of successive litters by adult females. Although intervals for individual bears were established in some instances, accurate determination of an average reproductive interval for a species with such a low reproductive rate as grizzly bears requires observation of a population over a longer period of time than was possible in this study. An example of the importance of gathering long-term data occurred during this study: in mid-summer

Table 3. Litter size and reproductive status for female grizzlies.*

Bear no.	Age in 1978	Offspring no.	1975	1976	1977	1978	Reproductive history
1085	20.5	--	--	--	B	B	previous offspring
1086	17.5	1087, 1 UM	B	2 cubs	2 ylg	2 2-yr	previous offspring
1089	5.5	none	--	--	NB	?B	no previous offspring
1090	19.5	3 UM	B	3 cubs	3 ylg	3 2-yr	
1092	9.5	1093	--	B	1 cub	1 ylg	
1095	7.5	none	--	--	?B	?B	no previous offspring
1097	9.5	none	--	--	B	B	no previous offspring
1100	7.5	none	--	--	NB	B	no previous offspring
1104	10.5	(1101, 1102 probable)	2 cubs?	2 ylg?	2 2-yr?/B	1 cub/B	offspring prior to 1978 mortality: 1 cub
1105	8.5	--	--	--	B	B	no previous offspring
1106	12.5	1107, 1108, 1109	--	B	2 cubs	2 ylg	mortality: 1 ylg
1110	25.5	1160, 1161	--	--	B	2 cubs	previous offspring
1111	15.5	1112, 1113	2 2-yr	2 3-yr	2 4-yr/B	B	
1118	18.5	2 UM	--	--	B	2 cubs	previous offspring
1119	7.5	--	--	--	B	B	no previous offspring
1121	12.5	1122, 1123	--	B	2 cubs	2 ylg	
1127	27.5	--	--	--	B	--	previous offspring
1128	8.5	1129, 3 UM cubs	B	1 cub	1 ylg/B	3 cubs	
1130	22.5	2 UM	--	B	2 cubs	1 ylg	mortality: 1 cub or ylg
1134	15.5	1135, 1136, 1137	B	3 cubs	3 ylg	2 2-yr	mortality: 1 2-yr-old
1138	24.5	1151, 1152, 1153	B?	2 ylg, 1 cub	2 2-yr, 1 ylg	2 3-yr, 1 2-yr	possible adoption of young
1139	11.5	1140, 1141	--	--	B	2 cubs	
1142	14.5	none	--	--	--	B	previous offspring
1143	9.5	1144, UM	--	B	2 cubs	2 ylg	
1146	14.5	1145	B	2 cubs?	2 ylg?	1 2-yr	probable mortality of ylg
1154	11.5	1155	--	B	1 cub	1 ylg	
1156	6.5	none	--	--	--	B	no previous offspring
1158	7.5	none	--	--	--	B	no previous offspring
UM	--	2 UM	--	B	2 cubs	2 ylg	
UM	--	3 UM	--	--	B	3 cubs	possible mortality
UM	--	2 UM	--	--	B	2 cubs	
UM	--	2 UM	--	--	B	2 cubs	
UM	--	2 UM	--	B	2 cubs	--	
UM	--	1162, 1163	B	2 cubs	2 ylg	?B	
UM	--	3 UM	B	3 cubs	3 ylg	--	
UM	--	2 UM	2 cubs	2 ylg	2 2-yr	--	

* Designations are as follows: UM, unmarked; --, no data; B, bred during that season; NB, did not breed; cub, ylg, 2-yr, 3-yr: female accompanied by cub, yearling, 2-year-old or 3-year-old young.

1977, of 20 marked or identifiable females with offspring, only one family group was composed of a sow and 2-year-olds, a fact indicative of a 3-year reproductive interval (weaning of offspring as 2-year-olds); however, during 1978, of six females with yearlings, five accompanied their 2-year-old offspring through the following summer, thus these five females will display a minimum reproductive interval of 4 years. For these reasons, the reproductive interval for adult females from one summer to the next was calculated by use of the following assumptions: 1) of those which had bred or were capable of breeding, 72 percent conceived and were accompanied by cubs the following summer; 3 percent conceived, produced cubs, lost them through mortality and bred the following summer; and 25 percent bred, were not accompanied by cubs the following summer and then bred; 2) of the females with cubs, 95 percent were accompanied by yearlings the following summer, and 5 percent weaned or lost their offspring and then bred; 3) 65 percent of those with yearlings were accompanied by 2-year-old offspring through the following summer, and 35 percent weaned them and bred; 4) 65 percent which kept their young as 2-year-olds weaned them during the following spring, then bred and 35 percent kept them as 3-year-olds; and 5) all of those females which did not wean their offspring as 3-year-olds did so the following spring.

Using these assumptions, it is possible to generate a mean length of reproductive interval for the population. Starting with a theoretical population of 100 adult females for each possible combination of reproductive situations which could result in a cycle of a given length, the proportion of those females with a cycle of that length can be calculated. For example, the number of cycles 4 years in length included the total of those females which would have: 1) bred but did not produce cubs and so bred again the first year; bred unsuccessfully again the second year; bred, then produced cubs and kept them through the third year; and weaned yearling offspring and bred the fourth year; 2) bred 2 years until cubs were produced and kept throughout the breeding season, accompanied through the year as yearlings and then weaned 2-year-old offspring and bred; and 3) bred and produced cubs the following season during the first year, kept the offspring through the summer during the second (yearling) and third (2-year-old) years and then weaned them and bred when the offspring were 3-year-olds. Using this method, 0.99 individuals would have a reproductive interval of 7 years; 5.77, 6 years; 24.63, 5 years; 35.60, 4 years; 25.31, 3 years; and 4.15, 2 years for a mean calculated reproductive interval of 4.06 years.

It must be emphasized that without data collected over a longer period of time, a more accurate expression of the reproductive intervals is not possible. However, in order to better compare the reproductive biology of grizzly bears in NPR-A with those in other regions and to assess their population status, extrapolation of the data collected is necessary.

A mean litter size of 2.08 was determined from 50 offspring of 17 marked females and 7 unmarked identifiable females. Litter size ranged from 1 to 3 per female; at the first observation of the family group, 15

females were accompanied by 30 cubs, 7 females were accompanied by 16 yearlings and 1 female each was accompanied by two 2-year-olds and two 4-year-olds, respectively. Initial litter size of females accompanied by yearlings, 2-year-olds and 3-year-olds may have been larger due to the increased possibility of mortality. However, since litter size of females accompanied by yearlings was greater than those with cubs, all litters were combined in litter size calculations.

The mean litter size of 2.08 found in the southwestern portion of NPR-A was larger than those found in other studies in northern and interior Alaska or Yukon Territory. In those areas, litter size ranged from 1.60 to 1.83 (Reynolds 1974, 1976; Curatolo and Moore 1975; Pearson 1975, 1976; Dean 1976). In coastal Alaska, litter sizes ranged from 2.36 to 2.50 (Troyer and Hensel 1964; Glenn et al. 1976). These variations are probably reflections of the availability and nutritional quality of food which grizzlies may secure in the different regions.

The reproductive rate of a population is a measure of the potential of a population for growth and is expressed as the number of cubs produced per adult female per year (Craighead et al. 1976). Reproductive rate may also be expressed as the potential production of cubs during the reproductive life of an adult female. Table 4 compares the reproductive rates and potential production of cubs for four populations of brown or grizzly bears. The grizzly bear population in NPR-A had a higher reproductive rate than the declining population in the eastern Brooks Range, but not as high as populations in Yellowstone Park or the Alaska Peninsula. Potential production of cubs during the lifetime of an adult female was similar in NPR-A and the Alaska Peninsula, primarily due to longer reproductive longevity of bears in northern Alaska; this difference may be due to a high level of hunting pressure on the Peninsula which results in lower chances of survival to maximum potential age.

Mortality

Mortality was determined by direct observation or by disappearance of offspring which had been previously been observed in a family group. Six known and two probable mortalities of young bears were recorded during 1977-1978. These included two cubs, one yearling and three 2-year-olds. The two other mortalities occurred between summer 1977 and summer 1978, so it was not known whether one was a cub or yearling at the time of death or if the other was a yearling or 2-year-old. A single adult male, No. 1099, killed two other bears: the unmarked cub of female No. 1104 and No. 1101, a 2-year-old male weaned during spring 1977. One yearling, No. 1107, was very small (3 kg or 6.5 lb.) when captured as a cub, but survived through the winter and died in late May 1978, possibly killed by its siblings. A wolf (*Canis lupus*) was seen harassing an unmarked female with three cubs near Iligluruk Creek (D. James, pers. comm.); a female of the same description with only two cubs was later seen in the same vicinity, and it was assumed that the initial encounter may have resulted in the death of one of the cubs. One 2-year-old offspring of female No. 1134 disappeared during summer 1978 and was presumed dead. Two-year-old male No. 1162 died approximately 10

Table 4. Reproductive rates of grizzly bear populations.

Area	Mean age at 1st breeding to maximum age of breeding	Potential reproductive life ÷ reproductive interval		Litter size		Potential production of cubs	$\bar{x}$ reproductive rate (#cubs/female/year)
Yellowstone Park (Craighead et al. 1976)	6.3 - 25.5	19.2 years / 3.40	x	2.24	=	12.65	0.658
Alaska Peninsula (Glenn et al. 1976)*	6.3 - 22.5**	16.2 years / 3.77	x	2.50	=	10.74	0.664
Eastern Brooks Range (Reynolds 1975)*	10.1 - 24.5	14.4 years / 4.24	x	1.78	=	6.42	0.420
Southwestern NPR-A (this study)	8.6 - 26.5	17.9 years / 4.06	x	2.08	=	9.17	0.512

* My analysis of data presented by others.

** Data presented by these researchers designated greatest longevity of females as age 18.5; since that time new records have been observed (J. Faro, pers. comm.).

days after he was captured; his death may have been study-related but evidence was not conclusive.

Indirect evidence of mortality is also indicated by numerical differences between cohorts in the age structure of the population (Table 1). The lowest apparent survival rate occurs during ages 3.5 and 4.5 years or after weaning occurs, but the sample size is too small to make a definitive judgment. This is a time when animals are beginning to seek home ranges of their own without the protective influence of their mothers. Adult males may account for a sizable proportion of mortality; besides the deaths of two young attributed to No. 1099, another large male, No. 1082, was observed confronting or stalking female No. 1038 accompanied by three offspring near the Kokolik River. This confrontation lasted more than 30 minutes, with the male actively pursuing the female which was snarling as she retreated. This kind of intraspecific mortality has been documented in the past in Alaska (Troyer and Hensel 1962; Reynolds 1974, 1976; Glenn et al. 1976) and in Canada (Mundy and Flook 1973; Pearson 1975, 1976).

Factors Influencing Population Density and Reproductive Biology

Comparison of the grizzly bear population in the eastern Brooks Range (Reynolds 1974, 1976; Curatolo and Moore 1975) with that in this study area indicates that both population density and productivity are much greater in the southwestern portion of NPR-A. This may be a localized phenomenon due to the proximity of the traditional caribou (Rangifer tarandus) calving grounds of the Western Arctic Caribou Herd to the grizzly bear intensive study area. This proximity in turn increases the availability of caribou as a source of carrion or prey which may allow an increase in the productivity and density of the grizzly bear population.

Although no observations of grizzlies killing adult caribou were recorded, they are undoubtedly capable of doing so, especially those caribou debilitated by disease or by stress related to calving. In 1978, of 102 sightings of bears from 6 June to 3 July, the period when caribou are most available, a total of nine observations was made of bears at caribou carcasses; in addition, one bear was sighted on a carcass on 14 July, two bears were seen during the period with fresh blood on their muzzles and one bear was captured which smelled strongly of carrion, possibly from caribou. Of these 13 bears, adult males and females accounted for three and six sightings, respectively, and young-age males and females comprised two sightings each. After this period of greatest availability of caribou, two adult males and three adult females were sighted at caribou carcasses from 14 July to 23 September, and a 2-year-old male was sighted at two different carcasses.

In 1977, four observations of bear-killed caribou calves were made. Nineteen bears were seen by one research crew on the calving grounds in 1978, including four family groups and three solitary bears; one of the family groups, comprised of a sow with three yearlings, was observed killing four caribou calves within an hour (J. Bryant, pers. comm.). Another crew on the calving grounds saw at least eight bears during 5

days; some of these chased caribou and in three instances bears caught newly born caribou calves or found dead ones (P. Valkenberg, pers. comm.). Other bears were seen on the calving grounds, but the extent of predation is an aspect of bear/caribou ecology that needs to be explored further.

Another measure of the availability of caribou to the bear population is the number of caribou calves which die during the 3 weeks following birth. In 1977, the mortality rate of calves in the Western Arctic Herd during that period was estimated to be 23 to 28 percent or from 6,000 to 7,500 calves. If calves weigh an average of 5.9 kg (13 lb) at birth and gain about 450 g (1 lb) per day (Skoog 1968), a total biomass of from 34,000 to 44,000 kg (75,000 to 97,500 lb) of biomass, including hide, bones and waste, is available to predators and/or scavengers in the area.

These caribou may provide a protein source unavailable in the same quantities to other grizzly bear populations whose range does not overlap caribou calving grounds. Caribou may be a particularly important segment of the grizzly bears' diet because they are available during a time in which those portions of vegetation upon which bears feed are of poor nutritive quality; overwintering roots, tubers and bulbs begin to mobilize their nutrient supply into flower and leaf production during early summer, and most above-ground vegetation favored by bears is just beginning to grow (J. Bryant, pers. comm.). Caribou are available to bears as an abundant source of protein at a time when energy demands by bears are also high because of activity and movement associated with breeding. Since grizzly bear population size and reproductive capacity are probably closely related to food availability, high density and reproductive capacity of bears in an area of high protein availability would be expected.

Movement and Home Range

During 1977 and 1978, movement and/or home range size was determined from 852 sightings of 76 of the 83 bears which had been immobilized and fitted with visual markers or radio collars; 7 bears were not seen after tagging. The majority of the resightings were of radio-collared bears but some extreme movements were determined by resighting marked bears. The maximum distance traveled by bears of different sex and age categories was as follows: adult males, 163 km (101 mi); sub-adult males, 77 km (48 mi); breeding females, 55 km (34 mi); females with young, 38 km (24 mi); and sub-adult females, 18 km (11 mi).

Although grizzlies may move long distances during short periods of time, the average daily movements observed were relatively small. The extent of average daily movement for bears, in order of decreasing distance, was: breeding males, breeding females, females with offspring and sub-adult males or females (Table 5). The sizes of sub-adult individual movements were probably underestimated because the individuals which were radio-collared did not travel widely; other data indicate some sub-adult individuals, especially males, travel extensively prior to establishing a center of activity.

Table 5. Daily and maximum movements recorded for 26 radio-collared grizzly bears* in NPR-A, 1977 and 1978.

Reproductive status	Range of $\bar{x}$ distance traveled/day		Range of individual observations of distance traveled		Range of maximum distances between sightings	
	km/day	(mi/day)	km/day	(mi/day)	km/day	(mi/day)
Adult males	1.3-5.1	(0.8-3.2)	0.2-38.6	(0.1-24.0)	22.5-81.3	(14.0-50.5)
Sub-adult males	0.3-1.8	(0.2-1.1)	0.2-2.6	(0.1-1.6)	10.1-17.9	(6.9-11.1)
Breeding females	1.0-3.5	(0.6-2.2)	0.2-20.1	(0.1-12.5)	13.7-47.6	(8.5-29.6)
Females/cubs	1.0-1.8	(0.6-1.1)	0.2-4.7	(0.1-2.9)	16.1-33.8	(10.0-21.0)
Females/yearlings	0.5-2.4	(0.3-1.5)	0 -9.7	(0-6.0)	7.2-20.4	(4.5-18.9)
Females/2&4-year-olds	0.6-2.1	(0.4-1.3)	0 -5.1	(0-3.2)	17.4-38.0	(10.8-23.6)
Sub-adult females	1.0-1.8	(0.6-1.1)	0.2-6.4	(0.1-4.0)	12.9-17.9	(8.0-11.1)

* Movements were recorded for 26 individuals; 19 of these were calculated in both years. In such cases, figures for each year are included in the calculation of mean figures.

Because bears often spend several days in one area, travel to another area of use and then return to the area previously used, the size of mean daily movement was were related to length of time between sightings. Often, the longer the period between sightings, the smaller was the mean distance traveled. Of 49 instances in which observations were separated by previous observations of the same individual bear by 2 days or less, the average distance traveled was 4.5 km (2.8 mi); males moved an average of 5.0 km (3.1 mi) (26 observations of 5 bears) and females moved an average of 4.0 km (2.5 mi) (23 observations of 9 bears).

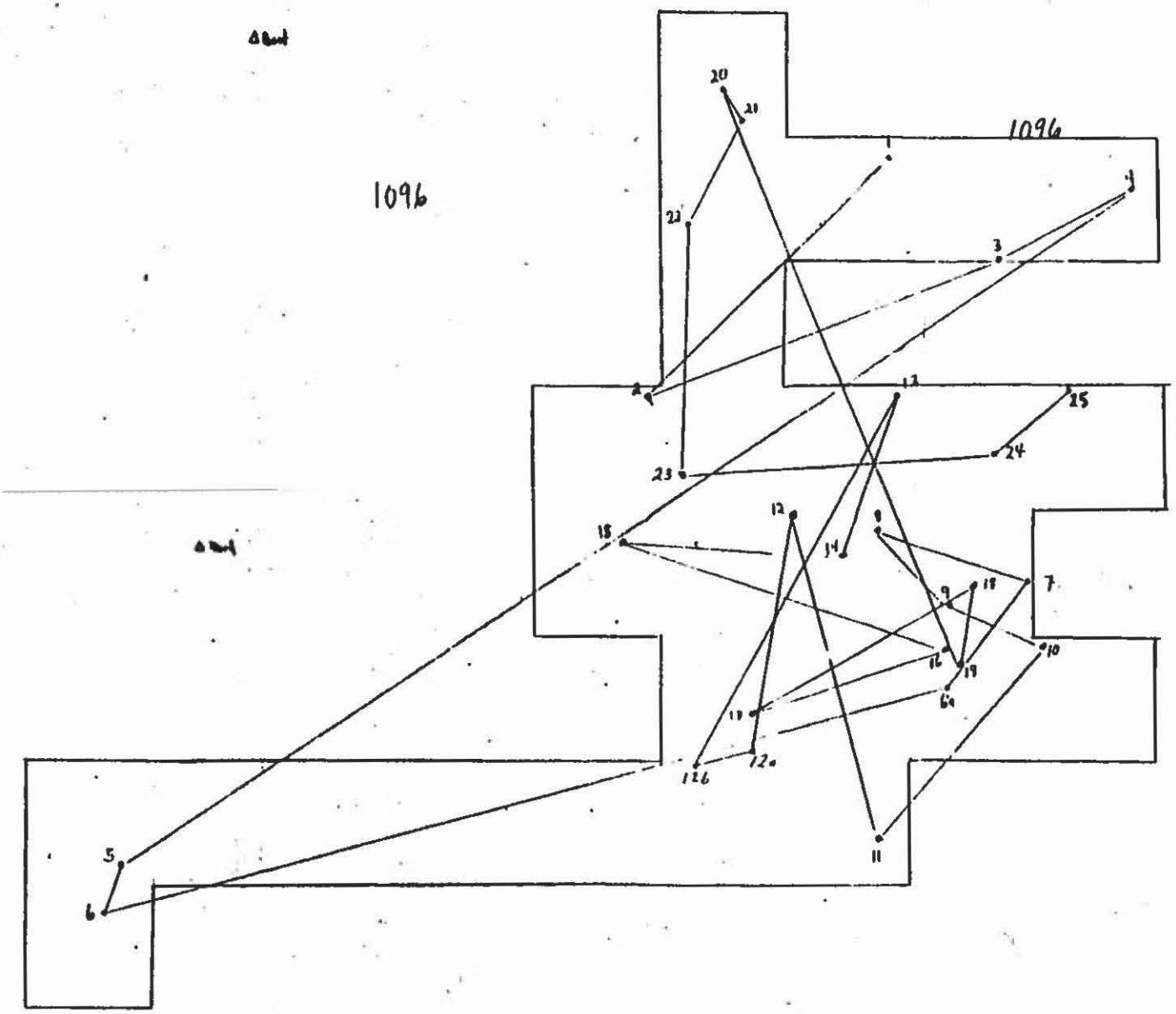
Movement outside the center of activity for individual bears did not usually occur; however, such movement during the breeding season or in search of food or denning sites was recorded. Although it is generally assumed that bears may move long distances to reach the core caribou calving area of the Western Arctic Herd, no data support the idea. It is more probable that bears whose home ranges overlap calving areas concentrate their feeding in these areas during the calving period. However, in 1978 two large adult males were observed following groups of migrating caribou cows and calves during post-calving migration 19.3 and 22.5 km (12 and 14 mi) west of their 1977 home ranges. The extent of the range increases for these males was not significant.

For comparative purposes, home ranges were calculated by two methods: the modified exclusive boundary strip (Berns and Hensel 1972, Curatolo and Moore 1975, Reynolds 1976) and the minimum area or minimum home range polygon (Craighead and Craighead 1972; Pearson 1975, 1976; Craighead 1976). The modified exclusive boundary strip method is based on the approximate size of daily movements and use of the method does not include large expanses of area in which no observations or assumed movements would have occurred (Fig. 1). This method was used in the eastern Brooks Range (Curatolo and Moore, 1975, Reynolds 1976) to delineate the home ranges of bears which traveled primarily along river valleys and did not utilize the expanses of mountainous country which separated adjacent river valleys. Home ranges were calculated by this method so that ranges of grizzlies in the present study in the western Brooks Range can be compared with those in the eastern Brooks Range (Table 6). Using this method, the home ranges of seven breeding male grizzlies in southwestern NPR-A had a mean area of 510 km^2 (197 mi^2) compared with a mean home range of 702 km^2 (271 mi^2) for five male grizzlies in the eastern Brooks Range. Sixteen females in southwestern NPR-A had home ranges with a mean area of 282 km^2 (109 mi^2) compared with the mean home range area of 230 km^2 (89 mi^2) for eight females in the eastern Brooks Range. The larger size of male home ranges in this study compared with those found in eastern Brooks Range animals may be due to differences in topography.

Minimum home range polygons (Craighead and Craighead 1972; Pearson 1975, 1976; Craighead 1976) were calculated for 23 individual grizzlies in 1975 and 1976; 17 of these were calculated during both years (Table 6). These home ranges were calculated by plotting observations made by radio tracking bears on mylar overlays of topographic maps, connecting the peripheral location sites and calculating the area enclosed for

Figure 1. Observed movement and home range size of grizzly bear No. 1096 in 1978, using the modified exclusive boundary strip method.

1096



1096
1478

Table 6. Home ranges of 23 grizzlies in southwestern NPR-A as determined by the modified exclusive and minimum area methods, 1977 and 1978.

Bear no.	Modified exclusive boundary in km (mi) 1977	1978	Minimum area in km (mi) 1977	1978	1977-1978
Adult males					
1082	443(171)	326(126)	603(233)	231(89)	717(277)
1083	466(180)	490(189)	583(225)	663(256)	1005(388)
1088	549(212)		1776(686)		
1091	389(150)	326(126)	637(246)	308(119)	746(288)
1096	464(179)	606(234)	723(279)	730(282)	1077(416)
1099	691(267)	862(333)	1399(540)	1597(607)[1]	3748(1447)[1]
				837(323)[2]	1756(678)[2]
1103	549(212)		961(371)		
Sub-adult females					
1100[3]	326(126)	373(144)	267(103)	316(122)[1]	660(255)[1]
				225(87)[2]	448(173)[2]
1102		210(81)		122(47)	
Adult females					
1085	376(145)	420(162)	546(211)	534(206)	873(337)
1086	290(112)	303(117)	223(86)	145(56)	280(108)
1090	186(72)	256(99)	88(34)	135(52)	158(61)
1092	210(81)	233(90)	104(40)	130(50)	194(75)
1097	350(135)	303(117)	360(139)	215(83)	386(149)
1104	316(122)	373(144)	363(140)	368(142)	539(208)
1105	186(72)	396(153)	109(42)	394(152)	389(150)
1106	430(166)	256(99)	479(185)	194(75)	477(184)
1110		210(81)		98(38)	
1111	363(140)	303(117)	396(153)	223(86)	461(178)
1121	223(86)	163(63)	192(74)	98(38)	236(91)
1134	130(50)	210(81)	39(15)	117(45)[1]	122(47)[1]
				49(19)[2]	80(31)[2]
1139		280(108)		225(87)	
1142		246(95)		194(75)	

[1] and [2] During a short period, three bears, Nos. 1099, 1100 and 1134, traveled from their summer range to a den site, a movement which greatly increased the size of the home range calculated by the minimum area method. Since this increase in home range did not reflect an increase in the potential habitat used, minimum area was calculated in two ways: one which includes the den site in calculation of home range(1) and one which excludes the den site(2).

[3] Sub-adult bears are usually defined as those younger than the minimum age at sexual maturity; although bear No. 1100 was at the age of sexual maturity or 6.5 years of age in 1977, she did not breed and so was a sub-adult in a practical sense. She did breed in 1978, but since this table shows differences in home range sizes for 2 years, she is listed in the sub-adult category.

each year and for both years. Figure 2 illustrates movement of adult male No. 1096 during 1977 from capture to denning and construction of his home range; Figure 3 illustrates movement during 1978 from emergence from the den in spring to denning the next fall; and Figure 4 shows the juxtaposition of the two home ranges and construction of a single home range for the 2-year period.

Because most other studies of grizzly bear movement and home range utilize the minimum area polygon method to determine home range size, that method was used in this study for most data analysis. Home ranges reported here are considerably larger than those calculated for bears in other areas (Table 7). Differences in home range size between bears on Alaska's North Slope and other areas of North America likely reflect the relatively low quality and short period of availability of forage on the north slope of the Brooks Range.

Home ranges for 18 individuals were calculated both in 1977 and 1978. Home ranges for all of these individuals were in the same general area during both years but peripheral areas used extensively in 1 year were not necessarily used the next. Those home ranges including all observation sites in both years were larger than those calculated for any 1 year. There was no pattern of general increase or decrease in home range size between the 2 years.

Table 8 compares the home ranges of bears of different reproductive status. In general, the reproductive status of bears in order of decreasing home range size was breeding males, breeding females, sub-adult females and females with offspring (no data were obtained for sub-adult males).

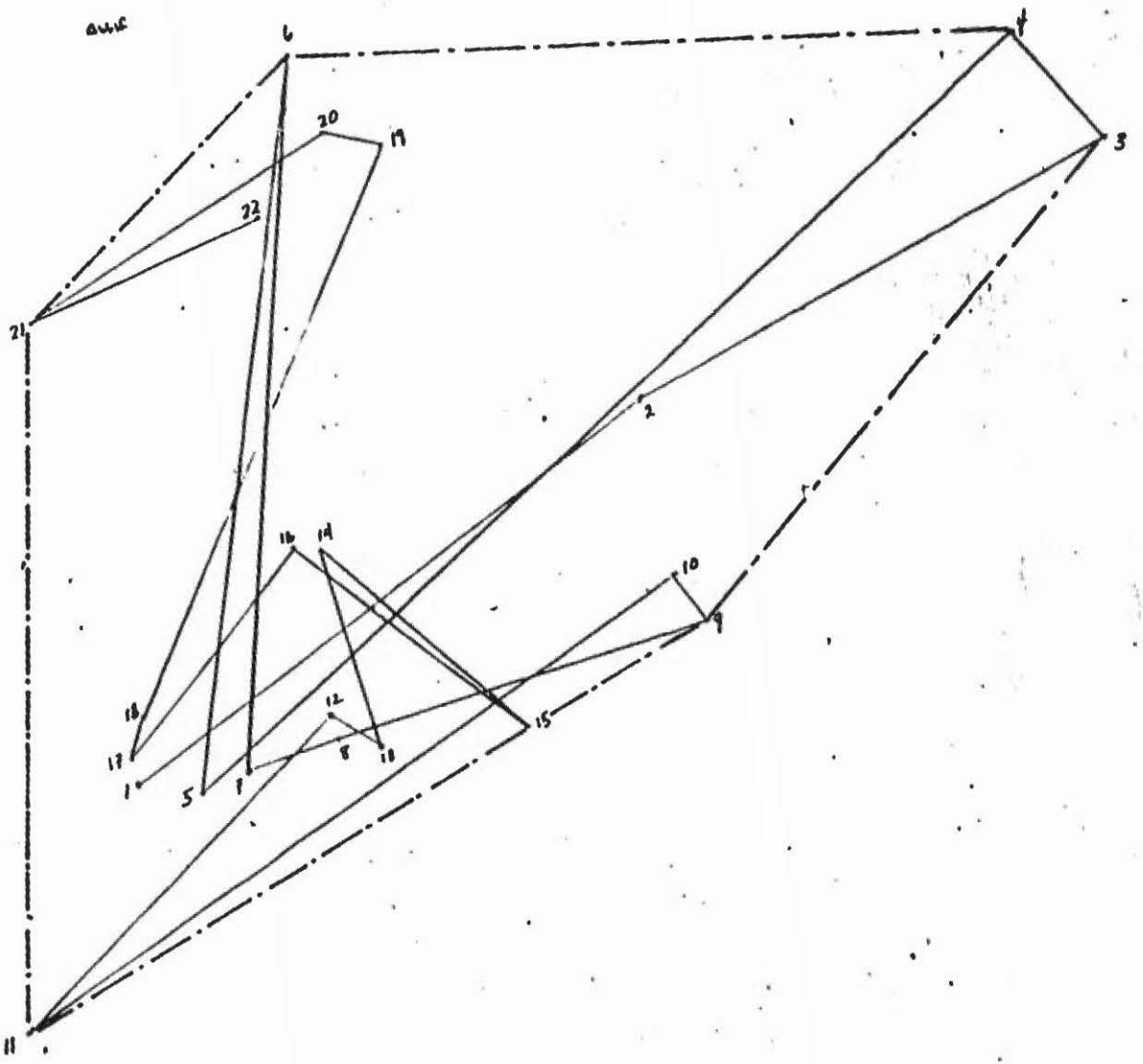
Although grizzly bears may be aggressive toward other bears of the same sex during the breeding season, they do not maintain defended territories, and home ranges of bears overlap broadly (Figs. 5, 6 and 7). Factors responsible for size and shape differences in home ranges are not known but the bears with the largest home ranges were males who traveled most widely during June and early July. This is a time when both grizzly bear breeding and caribou calving occur. Bears with the smallest home ranges were females which spent the season in relatively steep areas in the Brooks Range foothills.

Habitat Use and Food Habits

Although home ranges of radio-collared bears were located in different sections of the study area, portions of almost every home range contained all delineated habitat types. In order to analyze habitat use by bears, Hechtel (in prep.; see also Appendix III) made the following breakdown of habitat types, based on the relatively simple classification made by Spetzman (1959) and the comprehensive divisions of Alaskan arctic tundra by Murray and Batten (1977):

Figure 2. Observed movement and home range size of grizzly bear No. 1096 in 1977, using the minimum home range method.

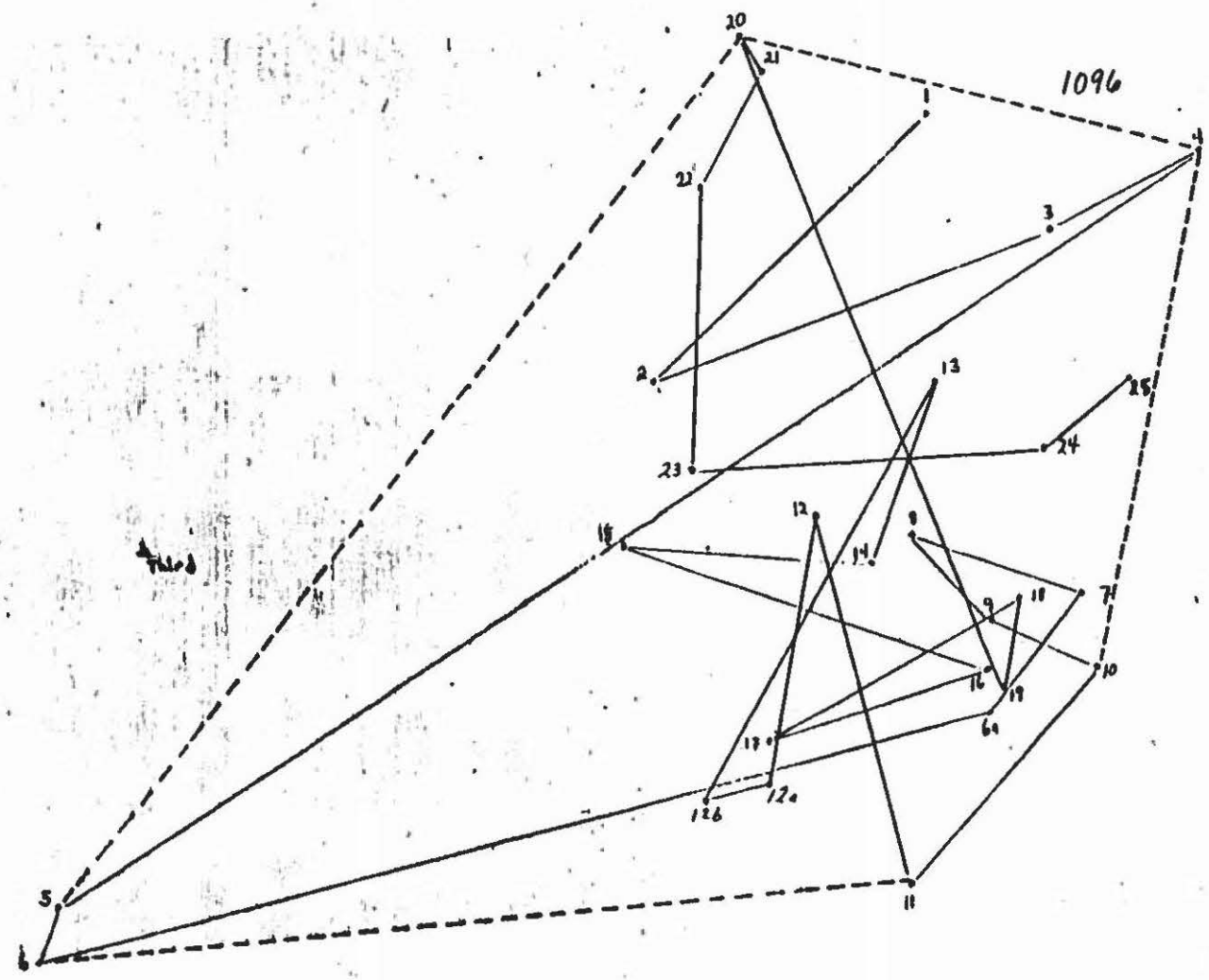
(broken spacing denotes boundary of minimum home range)



1096. Δblock
1977

Figure 3. Observed movement and home range size of grizzly bear No. 1096 in 1978, using the minimum home range polygon method.

(dashed lines denote boundary of home range)



1096
1978

Figure 4. Observed home range size of grizzly bear No. 1096 for 1977, 1978 and 1977/1978, using the minimum home range polygon method.

(solid lines denote total 1977 and 1978 home range boundary; broken spacing, 1977 home range boundary; dashed lines, 1978 home range boundary)

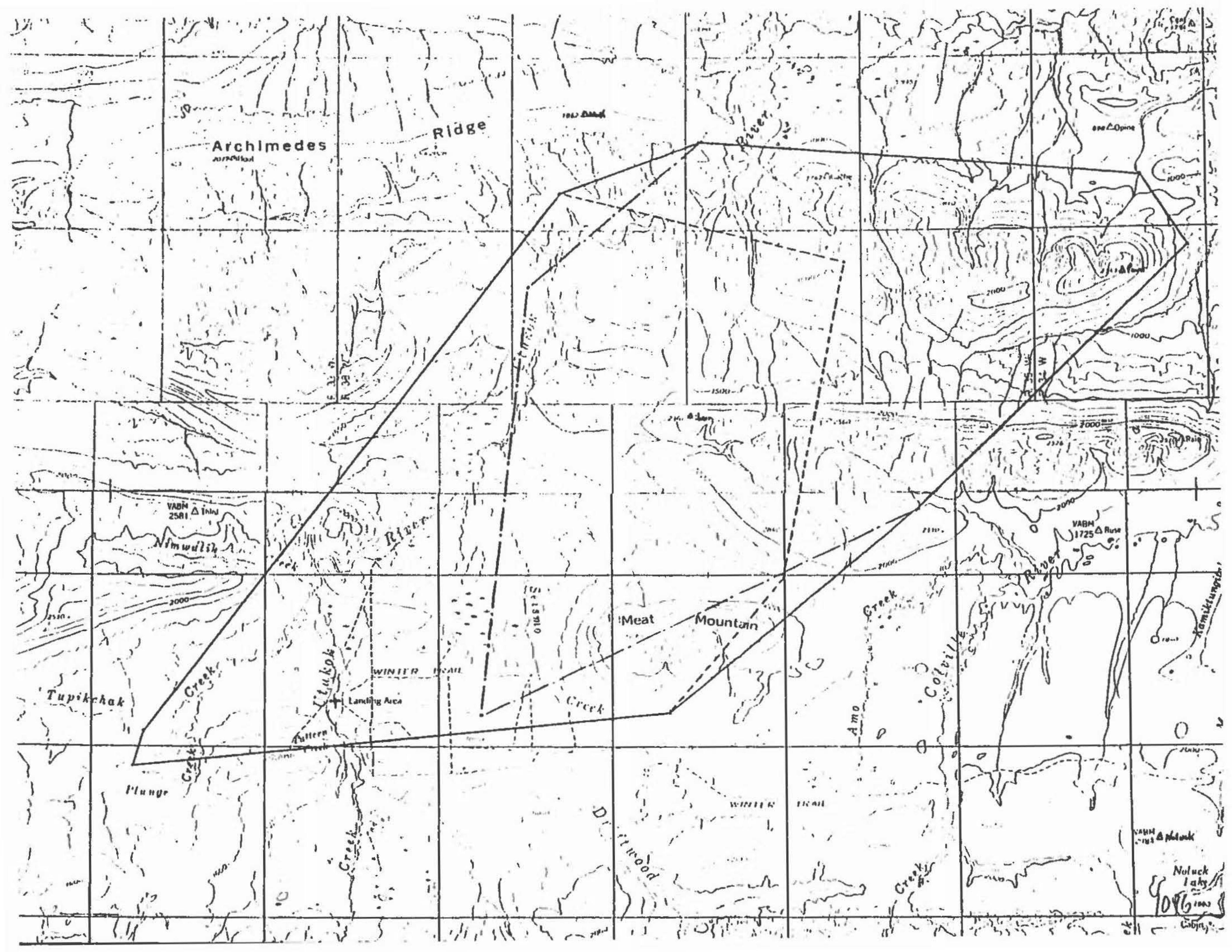

Archimedes
Ridge
River
VABM
2581 Δ Inlnl
Nimwulik
River
Creek
Tupikchak
Creek
Ulukok
Landing Area
WINTER TRAIL
Plunge
Creek
Seismo
Meat
Mountain
Creek
Driftwood
WINTER TRAIL
Amo
Creek
Colville
River
VABM
1725 Δ Ruse
Kamiktungitak
Creek
Noluck
Lake
Cabin
2000
1000
2100

Figure 5. The 1977 and 1978 home ranges of 10 females accompanied by offspring in the NPR-A study area.

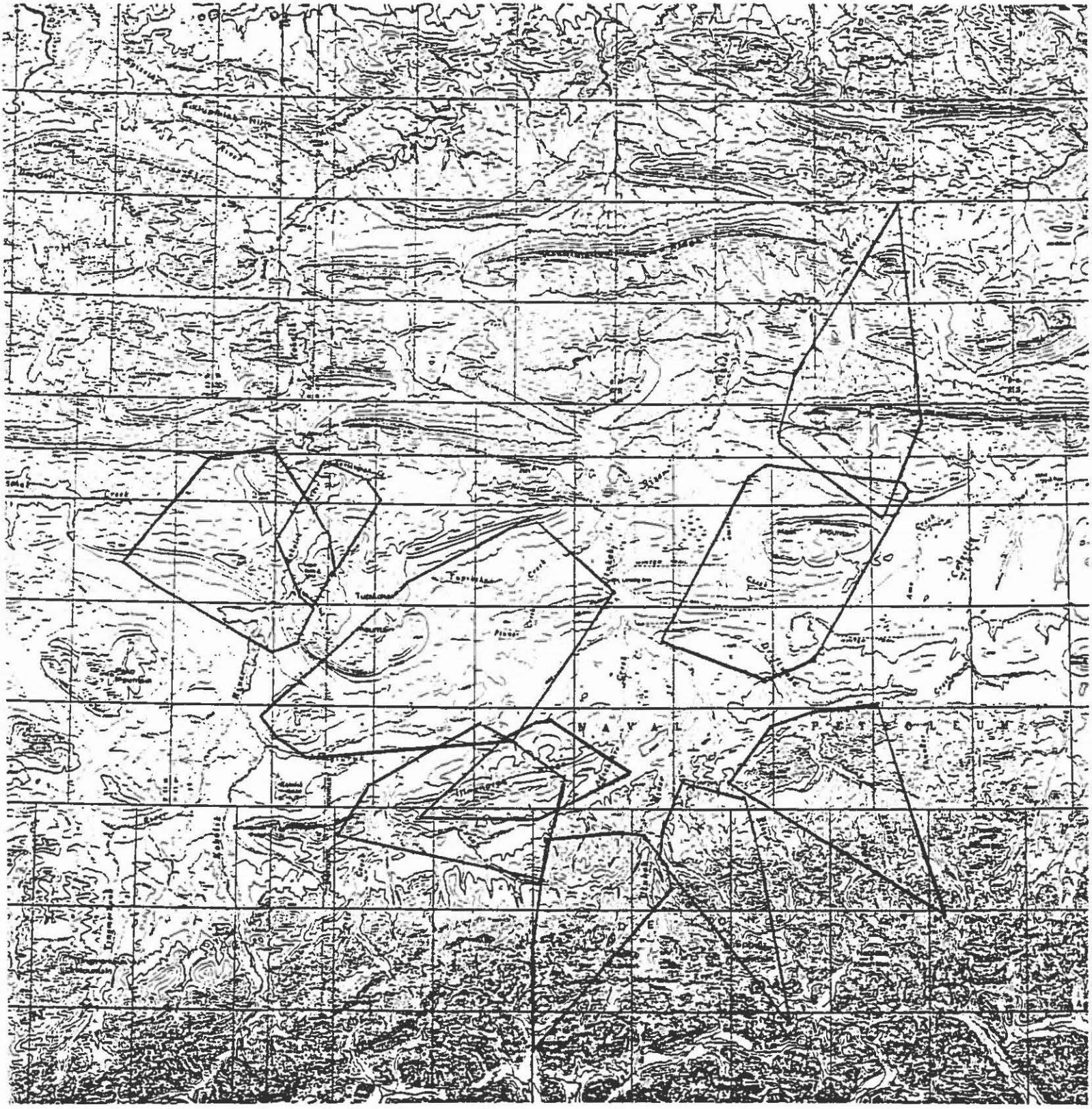

NAVAL PETROLEUM

Figure 6. The 1977 and 1978 home ranges of nine females without offspring in the NPR-A study area.

(Note: two ranges were calculated only in 1978; one female weaned her 4-year-old offspring, bred and then accepted the 4-year-olds again in 1977 but was unaccompanied by young in 1978.)

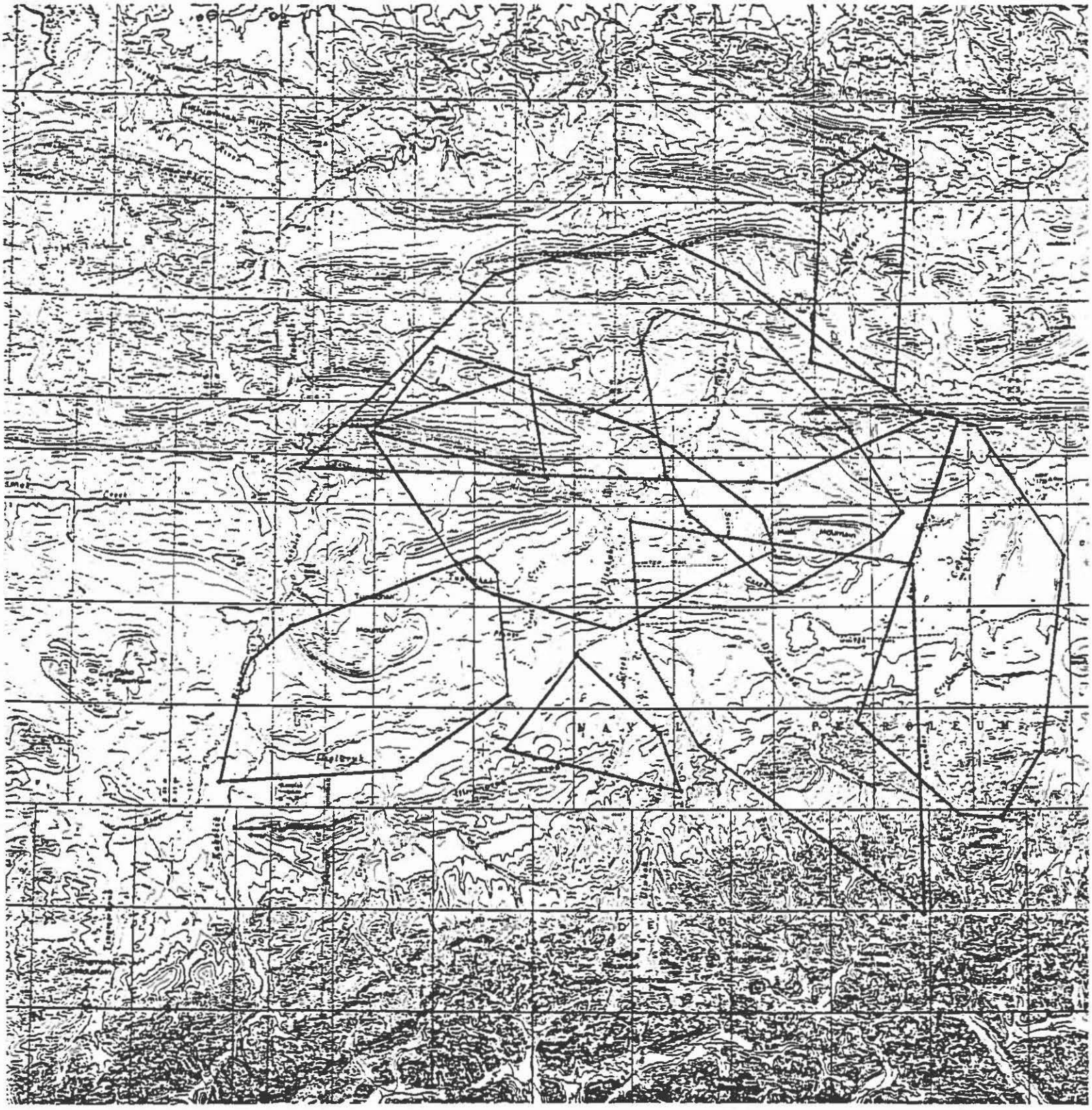

N A V A L
P E T R O L E U M

Figure 7. The 1977 and 1978 home ranges of seven males in the NPR-A study area.

(Note: the range of one bear was determined only during 1977; one 25-year-old male maintained a very small home range during July-August 1978 prior to loss of the radio collar.)

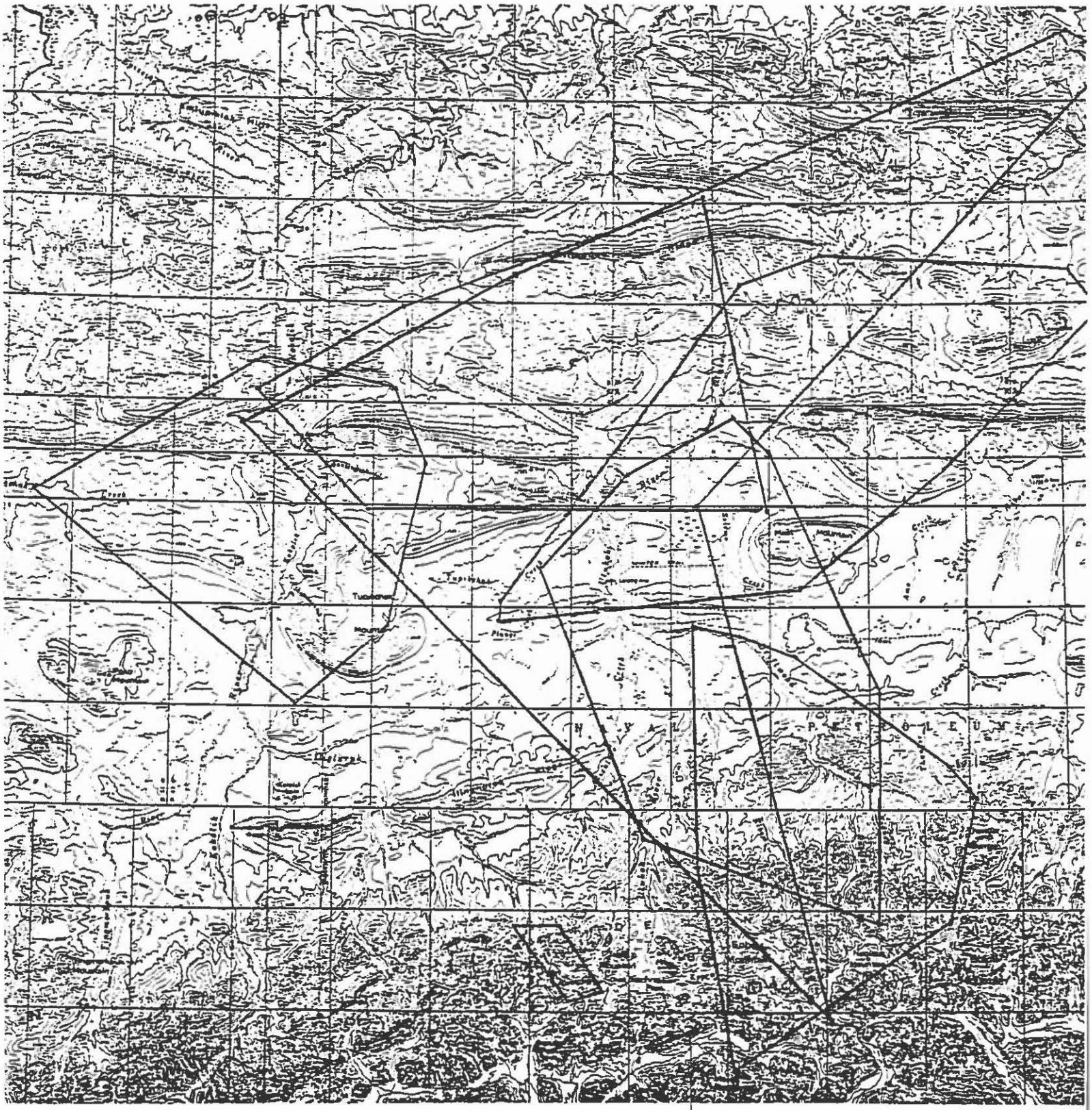


Table 7. A comparison of home ranges for male and female grizzlies in North America calculated by the minimum area polygon method.

Area	Sex	No. in sample	Mean home range size km^2	(mi^2)
Yellowstone Park	males	6	161	(62)
(Craighead 1976)	females	14	73	(28)
Western Montana	males	3	513	(198)
(Rockwell et al.)	females	1	104	(140)
Southwestern Yukon	males	5	287	(111)
(Pearson 1975)	females	8	86	(33)
Northern Yukon	males	9	414	(160)
(Pearson 1976)	females	12	73	(28)
Northwestern Alaska	males	7	764	(295)
(this study)	females	16	246	(95)

Table 8. Home ranges of grizzly bears during 1977 and 1978, grouped by reproductive status of individuals and calculated by the minimum area method (in km^2). Home ranges of individual bears for each of 2 years are indicated by connection with dashed lines; ranges without dashed lines indicate home ranges determined in 1 year only.

Breeding males	Nonbreeding females	Breeding females	Females w/cubs	Females w/ylgs	Females w/2&4-yr-olds	Breeding females
	103-------122		40-------50		75	
233------89	122	211-----206	185-------75		153--------86*	
225-----256		139------83	74-------38			
246-----119		140-----142	38	15--------45		
279-----282		42-----152	87	86--------56		
540-----607		86*		34--------52		
371						
Mean 295	113	132	85	50	76	
Range 89-607	103-122	42-111	38-155	15-86	30-153	

* This female was accompanied by two 4-year-old young in 1977 and bred in 1978; her home range was included with females accompanied by 2-year-old young for comparative purposes.

Fellfield-Barrens	Betula tussock
Talus	Betula thicket
Dryas - dwarf shrub	Wet sedge meadow
Dryas - step and stripe	String bog
Carex Bigelowii meadow	Riparian
Tussock tundra	Late snowbank community

Hechtel (in prep.) followed radio-collared female No. 1086 with her two offspring during 1977 and 1978 to determine habitat use by the family group. His preliminary analysis of seasonal use patterns of habitat type was the following:

Season	Main Habitat Types Used
Pre-growing through early growing season: May through early June	Dryas step and stripe; Dryas dwarf shrub; riparian
Growing season: early June through late July	Wet sedge meadow; late snowbank community; tussocks
Post-growing season: early August through denning in early October	Floodplain; Dryas step and stripe; Dryas dwarf shrub; Betula tussocks; string bogs

These observations, though determined for a single family group, are probably indicative of most bears in the study area. In general, bears observed foraging in the study area used river courses and snow-free ridges and mountain slopes during spring (May-early June), vegetation along the small creeks or moist drainages from early June to late July, and the floodplains of large creeks and rivers as well as dry ridge areas or mountains slopes with ground squirrel (Spermophilus parryii) populations from early August until denning in October. In addition, during the breeding season, from late May through mid-July, bears were observed in all types of terrain, from tussock tundra to talus slopes.

As well as documenting habitat use by No. 1086 and her young, Hechtel (in prep.) determined their seasonal food habits by direct observation and from analysis of scats. The most important seasonal foods, based on frequency of occurrence, were:

Pre-growing season	Growing season	Post-growing season
Hedysarum alpinum-roots	grasses and sedges	Hedysarum alpinum-roots
Oxytropis borealis-roots	Boykinia Richardsonii-leaves, stems & flowers	Arctostaphylos rubra-berries
Arctostaphylos rubra-overwintered berries	Equisetum arvense-fruiting & vegetative stems	Spermophilus parryii ground squirrels

Although bears consume primarily plant foods, they are opportunistic feeders and eat caribou, ground squirrels, marmots (Marmota caligata Braveri), microtine rodents and birds when available. Caribou may be an especially important food resource for bears because they represent a significantly higher total caloric value than other foods, even though caribou are available to any one individual in relatively low numbers.

Denning

A total of 44 newly excavated den sites were located on the study area during fall 1977 and 1978 (Table 9). Because of fall snowstorms and inclement weather, the dates of denning were only determined for a few grizzlies. The weather patterns differed during the denning periods in 1977 and 1978; it is probable that the timing and site selection reflected this difference. During 1977, when bears denned later, snow blanketed most of the study area in mid-September, and by 1 October snow cover in most of the area was about 25 cm (10 in). This was followed by two successive 9-day snowstorms accompanied by 80-130 km/hr (50-80 mi/hr) winds beginning the first week in October. Bears began denning about 2 October and by 23 October all bears were in dens except one adult male which was seen 200 m (660 ft) from a newly excavated den. The mean dates of denning in 1977 were from 12 to 18 October.

During 1978, only a light cover of snow had fallen by late September; from 28 September to 2 October there was light snowfall accompanied by winds. Then a storm lasting from 4 to 10 October brought heavier snowfall; from 11 to 13 October only light snow fell sporadically and the temperature dropped to -20°F. Bears began denning by 29 September-30 October; by 13 October 80 percent of the dens located were occupied. By 17 October only one adult male, No. 1096, had not found a den site and his tracks in the snow showed where a number of excavations had been attempted. Bears denned earlier in 1978 than they had in 1977: the mean range of denning dates in 1977 was from 12 to 18 October, in 1978 from 7 to 9 October.

During both years females denned earlier than males. In 1977 there was no difference in the timing of den construction between solitary females and those with offspring, but in 1978 solitary females denned an average of 6 days earlier than sows with offspring.

Like grizzlies in the eastern Brooks Range (Reynolds et al. 1976), bears in the study area selected, excavated and occupied den sites within a 2- or 3-day period. On the other hand, grizzlies in Yellowstone Park (Craighead and Craighead 1972) constructed dens as much as a month prior to the time of final entry.

Bears denned in a variety of terrain ranging from creek banks at low elevations to mountain slopes near the crest of the Brooks Range (Fig. 8). No special denning areas or concentration sites were found, and dens were distributed throughout the study area, usually well within the individual bear's home range. However, in 1978 four radio-collared

Table 9. Denning characteristics of 29 grizzly bears in southwestern NPR-A, 1977 and 1978.

Bear no.	Reproductive status	Den elevation m(ft)	Den exposure	Terrain	Date of denning	Distance from 1977 den km(mi)
1082	breeding male	300(1000)	S	creek bank	after 24 Oct 1977	
	breeding male	300(1000)	SSW	creek bank	4-8 Oct 1978	17.5(10.9)
1085	breeding female	340(1100)	NE	creek bank	4-10 Oct 1977	
	breeding female	550(1800)	SW	butte slope	1-2 Oct 1978	14.6(9.1)
1086	female with 2 yearlings	730(2400)	NW	butte slope	9-10 Oct 1977	
	female with 2 2-year-olds	730(2400)	SW	butte slope	5-10 Oct 1978	2.1(1.3)
1090	female with 3 yearlings	910(3000)	N	mountain slope	9-14 Oct 1977	
	female with 3 2-year-olds	910(3000)	S	mountain slope	4-10 Oct 1978	
1091	breeding male	980(3200)	NW	mountain slope	10 Oct-1 Nov 1977	
	breeding male	1100(3600)	W	mountain slope	4-10 Oct 1978	4.7(2.9)
1092	female with 1 cub	730(2400)	SW	ridge slope	4-9 Oct 1977	
	(abandoned first den)	610(2000)	S	ridge slope	14 Oct 1977	2.9(1.8)
1096	breeding male	300(1000)	WNW	river bluff	24 Oct 1977	
	breeding male	730(2400)	N	butte slope	about 18 Oct 1978	11.7(7.3)
1097	breeding female	580(1900)	S	ridge slope	10-14 Oct 1977	
	breeding female	370(1200)	S	rolling tundra	1-2 Oct 1978	5.0(3.1)
1099	breeding male	490(1600)	WSW	creek bank	14-23 Oct 1977	
	breeding male	790(2600)	E	creek bank	4-12 Oct 1978	45.7(28.4)
1100	nonbreeding female (young)	430(1400)	S	riverbank	4-9 Oct 1977	
	(abandoned 10-14 Oct, new site not located)					
	breeding female	1280(4200)	NE	mountain slope	4-10 Oct 1978	
1102	nonbreeding young female	580(1900)	N	ridge slope	8-9 Oct 1978	
1103	breeding male	520(1700)	SW	ridge slope	14-23 Oct 1977	
1104	breeding female	730(2400)	SE	ridge slope	10-14 Oct 1977	
	breeding female	610(2000)	N	ridge slope	1-2 Oct 1978	3.9(2.4)
1105	breeding female	790(2600)	SE	ridge slope	13 Oct-1 Nov 1977	
	breeding female	730(2400)	NE	ridge slope	28-30 Sept 1978	2.1(1.3)
1106	female with 3 cubs	490(1600)	S	rolling tundra	13-23 Oct 1977	
	female with 2 yearlings	580(1900)	S	ridge slope	10 Oct 1978	5.1(3.2)
1110	female with 2 cubs	610(2000)	S	ridge slope	12 Oct 1978	
1111	female with 2 4-year-olds	730(2400)	ESE	ridge slope	5-9 Oct 1977	
	breeding female	910(3000)	N	rolling hills	1-2 Oct 1978	35.4(22.0)

Table 9. continued.

Bear no.	Reproductive status	Den elevation m(ft)	Den exposure	Terrain	Date of denning	Distance from 1977 den km(mi)
1121	female with 2 cubs	610(2000)	S	ridge slope	13-24 Oct 1977	
1134	female with 3 yearlings	850(2800)	SSE	ridge slope	2-5 Oct 1977	
	female with 2 2-year-olds	1040(3400)	SE	mountain slope	3 Oct 1978	16.1(10.0)
1139	female with 2 cubs	730(2400)	N	butte slope	12 Oct 1978	
1145	2-year-old female with mother	1200(3900)	NE	mountain slope	5-10 Oct 1978	
UM*	single	670(2200)	N	butte slope	14 Oct 1978	
UNK*		270(900)	N	rolling hills	10-13 Oct 1978	
UNK*		460(1500)	SE	ridge slope	1-2 Oct 1978	
M*	single	550(1800)	NE	ridge slope	10 Oct 1978	
UM*	female with 2 2-year-olds	610(2000)	S	ridge slope	16 Oct 1978	
UNK*		550(1800)	NE	ridge slope	10-16 Oct 1978	
UNK*		460(1500)	N	ridge slope	10-16 Oct 1978	
UNK*	single	550(1800)	SW	ridge slope	16 Oct 1978	

* Bear designations: UM, unmarked; UNK, unknown if marked or unmarked; M, marked but colors of individual markers not determined.

Figure 8. Grizzly bear den sites located during the fall seasons of 1977 and 1978 in southwestern NPR-A.

(+ indicates dens located in 1977, open circle indicates dens located in 1978.)

bears denned from 16.1 km (10.0 mi) to 43.8 km (27.2 mi) outside of their spring, summer and fall ranges; in addition, three bears which had presumably moved from their home ranges to den were not located after intensive searches. In 1977 dens of 17 radio-collared bears were found within their home ranges, but the dens of 3 radio-collared bears were not found after intensive search and these bears may have left their home ranges to den. Similarly, in the eastern Brooks Range Reynolds et al. (1978) found that, although all radio-collared bears denned within their seasonal home ranges, there was evidence that a few visually-marked bears left their seasonal home ranges to den.

Elevations at den sites ranged from 270 to 1,280 m (900 to 4,200 ft). The mean elevation of male bear den sites was 520 m (1,700 ft) in 1977 and 590 m (1,920 ft) in 1978. Female dens were found at a mean elevation of 710 m (2,330 ft) in 1977 and 760 m (2,500 ft) in 1978. The mean elevation for all 44 bear dens located in 1977 and 1978 was 661 m (2,270 ft), compared with a mean elevation of 975 m (3,200 ft) for grizzly bear dens found in the eastern Brooks Range (Reynolds et al. 1976). This difference was probably due to the fact that the eastern Brooks Range study area was located in higher, more mountainous terrain than the NPR-A study area.

The 44 den sites were located on all exposures. There were differences between 1977 when 72 percent of dens (13 of 18) had a generally southern exposure from ESE to WSW and 1978 when 38 percent (10 of 26) faced generally south. Weather, especially wind direction and snow deposition, probably was important in den site selection. With no observed exception, den sites were located in areas of snowdrift deposition. Although the strong winter winds usually blow from the northeast or the northwest in the study area, local topography may cause wind eddies that allow snow deposition facing the general direction of prevalent winds. The selection of den sites in areas of high snow deposition was especially noticeable during spring 1978. Even though snow had melted from most areas in the study area, sites that bears had chosen for dens during fall 1977 were still overlain by snowdrifts. The depth of permafrost which influenced the exposures chosen by bears in the eastern Brooks Range (Reynolds et al. 1976) was not important in this area, possibly due to differences in soil types. Another factor which may be responsible for north- or south-facing den exposures is that the topographic character of the foothill area is dominated by a series of east-west running ridges which have north and south exposures; thus the occurrence of north or south exposures on the study area is probably highest.

Den sites excavated by individual bears in 1978 were separated by distances of 2.1 to 45.7 km (1.3 to 28.4 mi) from those dug by the same bears in 1977 (Table 9, Fig. 9). There does not appear to be a pattern of choice for similar types of terrain, exposure or elevation. For example, in 1977 female No. 1085 denned on a northeast-facing creek bank of 340 m (1,110 ft) elevation, but in 1978 selected a site 14.6 km (9.1 mi) distant on a 550 m (1,800 ft) southwest-facing butte slope.

Three females abandoned their dens during winter 1977-1978. One of these, No. 1100, moved within 2 to 6 days after the den was excavated

Figure 9. The locations of dens dug in 1977 compared to locations of dens dug by the same bears in 1978. The locations for the 2 years are connected by a solid line.

(+ indicates dens located in 1977, open circle indicates dens located in 1978.)

but the new den site was not located. The second female, No. 1092, and her cub moved their den from the southern edge of their home range 12.4 km (7.7 mi) northwest to the center of their range. When den sites were checked in March, it was apparent that she had recently emerged from her relocated den and excavated 5-10 locations on the same hillside. The third female, No. 1105, had bred the previous summer, but did not produce viable offspring in 1978. Examination of her den site in June 1978 revealed that she had abandoned her den during the winter after the depth of a snowdrift below the den site had reached 2 m (6.5 ft), had moved 100 m (330 ft) and then dug through the snowdrift to reach mineral soil. This den was poorly constructed and consisted only of a shallow excavation into the soil.

The causes of abandonment of dens were not known. The only potential source of human disturbance at the den sites was that of aircraft used in the study, but that was unlikely since by fall 1977 most of the bears were well habituated to the sound of aircraft.

Impact of Human Disturbance

Although human disturbance associated with gas or oil development may occur throughout the year, disturbance during the winter when grizzlies undergo long periods of winter dormancy would likely have the most serious effects. During late spring, summer and early fall, bears are mobile and can usually escape sources of disturbance but, during the period of winter denning, disturbance which was serious enough to cause bears to leave dens could result in poor physical condition or death. Also, since female grizzlies give birth in winter dens, disturbance could cause abandonment of dens, resulting in the death of young exposed to winter temperatures.

The sites of 16 winter dens of radio-collared grizzly bears were located in October 1977. In late February, the Bureau of Land Management (BLM) provided the Alaska Department of Fish and Game (ADF&G) with the proposed locations of seismic exploration lines for oil and gas deposits in NPR-A. Nine of 16 dens which were located by radio tracking were in the vicinity of seismic lines and 3 were within 1.6 km (1 mi). On-the-ground observations were made cooperatively by BLM and ADF&G to determine the effect of seismic detonations on two of the denning bears closest to seismic lines. Neither of the bears observed abandoned den sites but radio signal amplitude from the radio collars was erratic immediately after seismic explosions, indicating that some movement occurred within the dens (P. Reynolds, pers. comm.). One of these dens contained a female with three yearlings, all of which survived until emergence from the den (one died shortly after emergence from the den but the death was probably due to other factors). The other den contained an old female which bred in 1977 but did not emerge from the den with cubs in 1978. The latter bear was especially susceptible? to disturbance by aircraft in 1977.

susceptible or over-reactive

The results of these observations and aerial observations of other den sites near seismic lines indicate that no bears abandoned dens because of seismic explosions; however, bears were disturbed enough to

shift their position inside the dens. While such disturbance would not be detrimental to the majority of bears, agitation and disturbance of females with newborn cubs could result in the death of the young; the possibility is not likely, but it could occur, especially with females which are very sensitive to disturbance.

The greatest potential human impact on maintenance of grizzly bear populations is that of wide-scale development and human habitation. Because grizzlies in NPR-A travel widely and have large home ranges, maintenance of enclaves of intact habitat is important; these should be at least as extensive as the 5,200 km^2 (2,000 mi^2) study area.

RECOMMENDATIONS

Although this study resulted in determination of baseline information important to the understanding of grizzly bear populations in NPR-A and the potential impacts that human disturbance may have on grizzly populations in the Arctic, additional information is needed. A technique for comparing the known density of bears in the study with densities throughout NPR-A should be devised and tested. Observation of marked bears should be continued to improve the accuracy or allow calculation of longer-term population productivity, survival rates of young-age and mature grizzlies, and changes in habitat use and home range size. The effect of predation by grizzly bears on caribou of the Western Arctic Herd and the effect of the availability of caribou prey or carrion on grizzly bear productivity may be important and should be addressed in further studies.

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Appendix I. Sex, age, weights and measurements[1] of grizzly bears captured in northwestern Alaska, 1977-1978.

Bear	Date	Sex	Age cem[2] (yrs)	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[3]	Left lower canine
1081	5/24/77	M	5.5	79	170	110	28	52	95	95	--	--	3.5	3.2
1082	5/25/77	M	13.5	168	200	126	32	79	129	117	25.3	39.1	4.2	3.4
	6/13/77	M	13.5	166	--	--	--	--	--	--	--	--	--	--
	6/25/77	M	13.5	172	--	--	--	--	--	--	--	--	--	--
	6/27/78	M	14.5	193	202	128	35	74	133	119	25.5	39.2	4.4	3.5
1083	5/25/77	M	7.5	120	188	115	31	70	117	110	24.0	36.0	3.2	2.8
	7/2/78	M	8.5	163	178	119	34	68	130	116	20.5	36.5	3.4	3.0
1084	5/26/77	M	7.5	100	176	105	25	68	109	101	23.0	32.0	--	--
1085	5/27/77	F	19.5	127	190	102	27	66	119	100	21.2	35.0	2.9b	3.8
1086	5/29/77	F	16.5	93	159	101	24	61	120	98	20.1	31.4	3.2	2.4b
	6/24/77	F	16.5	107	--	--	--	--	--	--	--	--	--	--
	8/8/77	F	16.5	120	168	104	27	61	117	101	19.5	31.6	3.1r	2.6r
1087	5/29/77	F	1.5	14	94	48	18	35	60	53	12.5	18.5	--	--
1088	5/31/77	M	4.5	122	164	110	27	62	112	100	18.5	34.0	3.5	3.4
1089	6/1/77	F	4.5	55	140	97	27	53	84	83	15.8	29.0	3.0	3.0
	6/10/77	F	4.5	57	--	--	--	--	--	--	--	--	--	--
1090	6/1/77	F	18.5	100	169	104	29	62	109	99	19.9	33.1	3.3	2.7w
1091	6/4/77	M	19.5	159	184	117	30	75	128	105	21.6	38.0	3.9	3.9
1092	6/4/77	F	8.5	100	168	92	25	68	107	100	19.9	32.5	3.1	2.8
1093	6/4/77	F	0.5	17	86	48	17	31	58	50	11.4	19.8	--	--
1094	6/5/77	M	4.5	79	165	111	32	57	94	96	17.3	32.2	3.2	3.0
1095	6/5/77	F	6.5	91	143	98	29	63	102	93	18.6	33.3	3.1	2.8
1096	6/5/77	M	7.5	147	180	108	32	71	122	103	20.5	37.2	3.5	2.9
	6/28/78	M	8.5	179	197	115	34	78	126	112	21.6	37.1	3.5	3.1
1097	6/6/77	F	8.5	102	163	--	28	68	112	110	19.7	33.6	3.2	3.0
1098	6/8/77	M	3.5	49	147	94	26	47	86	77	15.0	28.2	3.1	2.9
1099	6/11/77	M	10.5	166	186	129	30	79	128	112	21.9	38.5	3.7	3.5
	6/27/78	M	11.5	204*	198	120	30	76	128	112	22.6	38.8	3.9	3.5
1100	6/11/77	F	6.5	91	163	98	26	59	98	100	17.2	32.4	2.7	2.7
	6/9/78	F	7.5	109	179	103	27	58	100	93	19.0	33.2	2.8	2.6

Appendix I. Continued.

Bear	Date	Sex	Age cem[2] (yrs)	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[3]	Left lower canine
1101	6/12/77	M	3.5	66	138	81	23	55	89	74	15.2	27.2	2.7	2.8
1102	6/12/77	F	3.5	57	138	82	25	50	85	68	14.6	26.7	2.6	2.4
	6/18/78	F	4.5	64	136	87	26	55	99	93	15.6	27.7	2.7	2.4
1103	6/12/77	M	8.5	145	187	120	33	71	117	104	20.3	37.1	3.7	3.1
	6/12/78	M	9.5	--	179	121	31	71	122	115	21.5	37.4	3.6	3.1
1104	6/12/77	F	9.5	98	165	97	30	61	108	88	19.0	32.9	3.3	2.7
1105	6/13/77	F	7.5	102	164	115	32	71	104	99	19.4	32.9	3.1	2.8
	6/28/78	F	8.5	129	170	106	31	66	111	117	19.9	33.8	3.4	3.0
1106	6/14/77	F	11.5	95	170	99	28	63	116	108	19.2	29.0	3.0	2.8
1107	6/14/77	F	0.5	3	--	--	--	--	--	--	--	--	--	--
1108	6/14/77	F	0.5	9	73	49	15	26	43	44	10.5	17.0	1.2	1.2
1109	6/14/77	F	0.5	8	63	49	13	26	45	41	10.1	16.1	1.0	1.1
1110	6/15/77	F	24.5	111	169	109	30	62	120	100	20.6	33.5	3.7	1.8b
	7/1/78	F	25.5	--	174	107	30	63	108	99	20.7	33.6	3.7	1.9b
1111	6/18/77	F	14.5	109	175	97	27	59	128	103	20.0	31.5	3.0	2.7
1112	6/18/77	M	4.5	113	165	103	31	62	109	109	19.1	33.3	3.4	3.0
1113	6/18/77	F	4.5	68*	157	96	--	55	--	84	16.8	29.8	2.9	2.9
1114	6/19/77	M	16.5	204	191	111	29	82	136	122	24.2	37.8	4.2	3.5b
1115	6/22/77	M	5.5	79	159	102	26	58	90	100	17.2	30.5	3.5	3.3
1116	6/23/77	M	5.5	79	170	100	29	53	108	101	17.8	32.1	3.3	3.0
1117	6/23/77	M	19.5	143	195	125	29	72	127	115	23.8	36.0	4.0b	2.9b
1118	6/23/77	F	17.5	84	170	100	27	57	96	105	19.1	21.5	3.1	2.6
1119	6/24/77	F	6.5	86	158	101	23	60	102	86	18.1	30.4	2.8	2.6
1120	6/24/77	M	16.5	177	214	119	32	77	127	120	24.5	36.2	3.9	3.5
1121	6/25/77	F	11.5	111	174	102	24	65	104	122	19.5	33.2	3.0	2.7
1122	6/25/77	M	0.5	14	91	47	15	28	55	43	11.0	17.5	1.3	1.2
1123	6/25/77	F	0.5	12	85	55	16	29	47	49	11.5	16.8	1.3	1.1
1124	6/26/77	M	17.5	163	186	114	33	76	118	104	23.2	36.6	3.5	2.8b
1125	6/27/77	F	3.5	66	160	102	25	54	93	93	16.0	29.6	2.9	2.9
1126	6/28/77	M	13.5	156	181	116	33	77	128	119	24.2	36.9	3.5	3.3

Appendix I. Continued.

Bear	Date	Sex	Age cem[2] (yrs)	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[3]	Left lower canine
1127	6/28/77	F	26.5	134	180	111	31	70	125	115	21.4	36.8	3.5	3.1
1128	6/30/77	F	7.5	109*	174	92	26	57	104	90	19.9	32.4	3.0	2.7
1129	6/30/77	F	1.5	41	128	79	23	43	74	75	14.2	25.1	0.6	0.9
1130	6/30/77	F	21.5	116	178	109	28	62	117	107	20.6	33.0	3.7	2.6
1131	7/1/77	M	8.5	107	176	116	28	63	105	107	19.0	33.0	3.3	3.1
1132	7/2/77	F	2.5	30	118	68	20	39	64	65	12.5	21.4	1.1	1.4
1133	7/2/77	M	2.5	36	123	77	23	43	67	74	13.7	23.7	0.9	0.5e
1134	7/5/77	F	14.5*	104*	175	107	28	64	122	111	20.0	33.7	3.3	2.8
1135	7/5/77	M	1.5	26	100	58	19	38	70	65	12.4	21.8	e	e
1136	7/5/77	F	1.5	22	90	62	19	39	62	60	12.5	21.6	e	e
1137	7/5/77	F	1.5	26	104	52	19	36	59	65	12.8	22.6	e	e
1138	8/10/77	F	23.5	113	165	98	25	61	118	101	21.2	27.9	2.8	2.5b
	6/16/78	F	24.5	120	180	101	28	65	120	101	20.5	31.8	3.1	2.5
1139	6/7/78	F	11.5	91*	166	113	28	62	119	94	19.2	31.9	3.1	3.0
1140	6/7/78	M	0.5	10	70	46	13	28	45	42	10.5	16.0	d	d
1141	6/7/78	F	0.5	7	66	44	13	24	43	34	10.9	15.6	d	d
1142	6/9/78	F	14.5	113*	174	105	29	65	112	111	20.8	34.0	3.3	2.8
1143	6/9/78	F	9.5	95	172	96	27	56	96	101	20.5	32.6	3.2	2.7
1144	6/9/78	F	1.5	17	104	59	19	33	52	58	12.0	21.8	e	e
1145	6/9/78	F	2.5	43	141	77	22	50	77	88	14.5	26.7	2.7	2.5
1146	6/9/78	F	14.5	104*	173	87	26	57	103	110	20.6	33.6	3.2	2.6
1147	6/9/78	M	3.5	93	163	99	27	56	99	94	17.1	33.1	3.8	3.3
1148	6/10/78	M	6.5	93	167	91	27	61	99	100	18.2	32.0	2.8	2.5
1149	6/11/78	F	4.5	82	160	90	26	51	91	90	17.2	30.1	2.7	2.6
1150	6/16/78	M	5.5	84	164	105	28	56	101	101	17.6	31.8	3.5	3.1
1151	6/16/78	F	3.5	51	134	75	24	46	82	73	15.0	26.7	2.8	2.8
1152	6/16/78	M	3.5	64	148	89	27	56	101	93	16.0	29.2	3.1	3.1
1153	6/16/78	F	3.5	32	124	67	21	40	71	68	14.0	23.0	0.9	2.4
1154	6/21/78	F	12.5	100	160	113	27	59	103	101	19.6	32.5	3.2	3.0
1155	6/21/78	M	1.5	34	115	77	21	39	70	67	13.3	24.1	e	d

Appendix I. Continued.

Bear	Date	Sex	Age cem[2] (yrs)	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[3]	Left lower canine
1156	6/21/78	F	6.5	93	169	112	26	65	97	102	17.8	32.0	3.0	2.9
1157	6/24/78	M	5.5	95	165	104	30	65	99	107	18.8	33.7	3.3	3.1
1158	6/24/78	F	7.5	82	153	103	29	53	93	94	17.7	30.8	3.1	2.8
1159	6/24/78	M	10.5	134	184	115	30	71	125	113	21.6	36.0	3.8	3.3
1160	7/1/78	M	0.5	11	76	43	14	27	48	45	10.7	18.1	d	d
1161	7/1/78	M	0.5	10	76	49	15	26	41	41	10.6	17.0	d	d
1162	7/1/78	M	2.5	43	120	82	24	50	75	71	14.4	24.7	2.6	2.9
1163	7/3/78	M	2.5	42	126	83	21	45	81	67	14.7	25.5	2.4	2.7

* Estimate after close examination
-- No data
1 Weights in kg; measurements in cm
2 Age determined by cementum layering
3 Designations of tooth characteristic: b, broken; w, heavily worn; e, erupting; d, deciduous; r, right measured instead of left

Appendix II. Capture and marker characteristics of 83 bears in the western Brooks Range, 1977-1978.

Bear no. and sex	Cem. age	Date of capture	Bear wt.[1]	Location	Drug Dosage[2]	Ear tags[3]	Marking[4]
1081M	5.5	5/24/77	175	Utukok R.	2.6/H	889/890	P/O
1082M	13.5	5/25/77	370	Kokolik R.	2.0/0	892/893	O/G/O (removed)
		6/13/77	365	Kokolik R.	2.3/0	892/893	0948
		6/25/77	380	Kokolik R.	2.7/0	892/893	1077/1127
		8/10/77	--	Kokolik R.	2.7/L	892/893	
	14.5	6/27/78	425	Kokolik R.	2.8/L	892/893	1580/1570 Bk 1640/1680
1083M	7.5	5/25/77	265	Utukok R.	2.0/0	894/895	plaque
		6/2/77	--	Utukok R.	2.6/L	894/895	0998 Bk
	8.5	7/2/78	360	Utukok R.	2.7/0	894/895	
1084M	7.5	5/26/77	220	Utukok R.	M/L	897/896	P/P
		6/2/77	--	Driftwood Cr.	2.2/L	897/896	0898 (lost)
1085F	19.5	5/27/77	280	Meat Mtn.	M/L	899/898	1050
1086F	16.5	5/29/77	205	Meat Mtn.	2.0/L	205/206	1102/1152
		6/24/77	235	Meat Mtn.	1.3/L	205/206	
		8/8/77	265	Driftwood Cr.	1.9/0	205/206	
1087F	1.5	5/29/77	31	Meat Mtn.	0.13/0	207/208	-/G
1088M	4.5	5/31/77	270	Eskimo Hill	2.0/0	210/209	0923
1089F	4.5	6/1/77	122	Adventure Cr.	M/0	214/213	0973 (removed)
		6/10/77	126	Adventure Cr.	1.7/0	243/240	W/W
1090F	18.5	6/1/77	220	Utukok R.	M/H	215/216	0750
1091M	19.5	6/4/77	350	Utukok R.	3.0/H	217/218	0825
1092F	8.5	6/4/77	220	Ilingnorak Ridge	2.2/0	227/226	0775
1093F	0.5	6/4/77	38	Ilingnorak Ridge	0.1/0	228/229	1B/-
1094M	4.5	6/5/77	175	Meat Mtn.	2.0/H	225/230	1B/dB
1095F	6.5	6/5/77	200	N. Meat Mtn.	1.5/0	231/233	O/W
1096M	7.5	6/5/77	325	Meat Mtn.	2.6/0	236/237	0848
	8.5	6/28/78	395	Utukok R.	2.8/0	774/775	1596/1590 1B 1660/1700
1097F	8.5	6/5/77	225	Meat Mtn.	1.8/0	235/234	0874
	8.5	6/19/77	--	Utukok R.	1.4/0	235/234	
1098M	3.5	6/8/77	108	Utukok R.	1.2/H	238/239	O/1B
1099M	10.5	6/11/77	365	Utukok R.	3.2/0	245/244	1023
	11.5	6/27/78	450*	Kokolik R.	2.8/0	773/774	1610/1560 1640/1680
1100F	6.5	6/11/77	200	Meat Mtn.	2.4/0	247/246	0973
	7.5	6/9/78	240*	Utukok R.	2.5/H	247/246	0973P
1101M	2.5	6/12/77	145	Utukok R.	1.2/L	249/248	G/W
1102F	2.5	6/12/77	125	Utukok R.	1.2/L	251/250	W/G
	3.5	6/18/78	140	Utukok R.	1.4/0	251/250	1470
1103M	8.5	6/12/77	320	Utukok R.	2.6/H	253/252	1002 broken
	9.5	6/12/78	--	Utukok R.	M/H	253/252	1510

Appendix II. Continued.

Bear no. and sex	Cem. age	Date of capture	Bear wt.[1]	Location	Drug Dosage[2]	Ear tags[3]	Marking[4]
1104F	9.5	6/12/77	215	Utukok R.	1.6/0	255/254	0800
		6/17/77	--	Utukok R.	1.2/L	255/254	0800
1105F	7.5	6/13/77	225	Kokolik R.	1.5/0	257/256	1098
		6/26/77	245	Tupikchak Mtn.	1.5/L	257/256	1098/1148
	8.5	6/28/78	285	Kokolik R.	1.7/L	257/301	1620/1630
1106F	11.5	6/14/77	210	Adventure Cr.	1.5/H	258/259	0724
1107F	0.5	6/14/77	6.5	Adventure Cr.	none	none	none
1108F	0.5	6/14/77	20	Adventure Cr.	none	-/260	-/W
1109F	0.5	6/14/77	18	Adventure Cr.	none	261/-	W/-
1110F	24.5	6/15/77	245	Ilingnorak Ridge	M/H	262/263	1B/P/1B
	25.5	7/1/78	--	Ilingnorak Ridge	1.9/L	262/263	1074.6 dB
1111F	14.5	6/18/77	240	Colville R.	1.7/0	269/268	0700
1112M	4.5	6/18/77	250	Colville R.	1.7/0	267/266	dB/G
1113F	4.5	6/18/77	150*	Colville R.	1.5/0	270/271	G/dB
1114M	16.5	6/19/77	450	Utukok R.	1.7/L	273/272	O/G/O
1115M	5.5	6/22/77	175	Meat Mtn.	1.5/H	275/274	dB/O
1116M	5.5	6/23/77	175	Utukok R.	1.5/0	276/277	O/dB
1117M	19.5	6/23/77	315	Driftwood Cr.	M/0	279/278	Pp/W/Pp
1118F	17.5	6/23/77	185	Driftwood Cr.	1.3/H	281/280	Pp/W
1119F	6.5	6/24/77	190	N. Meat Mtn.	1.7/L	282/283	O/P
1120M	16.5	6/24/77	390	N. Meat Mtn.	2.6/0	284/285	Pp/1B/Pp
1121F	11.5	6/25/77	245	Kokolik R.	M/H	287/286	1079/1128
1122M	0.5	6/25/77	30	Kokolik R.	0.12/0	-/288	-/G
1123F	0.5	6/25/77	27	Kokolik R.	0.12/0	289/-	G/-
1124M	17.5	6/26/77	360	Tupikchak Mtn.	2.6/0	291/290	dB/W/dB
1125F	3.5	6/27/77	145	Utukok R.	1.4/H	-/292	-/W
1126M	13.5	6/28/77	345	Kokolik R.	2.7/0	293/294	P/W/P
1127F	26.5	6/28/77	295	Kokolik R.	1.5/L	295/-	P/W/P
1128F	7.5	6/30/77	240*	Tupikchak Mtn.	1.8/0	297/296	P/P/P
1129F	1.5	6/30/77	90	Tupikchak Mtn.	0.5/0	299/298	P/P
1130F	21.5	6/30/77	255	Elbow Cr.	1.9/0	300/900	O/O/O
1131M	8.5	7/1/77	235	Driftwood Cr.	2.5/H	3085/2086	G/O
1132F	1.5	7/2/77	67	Archimedes Ridge	--	1498/3082	1B/P
1133M	1.5	7/2/77	80	Archimedes Ridge	--	3088/1499	P/1B
1134F	14.5*	7/5/77	230*	Utukok R.	2.0/L	3089/3090	0947
1135M	1.5	7/5/77	57	Utukok R.	--	3091/3092	O/O
1136F	1.5	7/5/77	48	Utukok R.	--	3093/-	O/-
1137F	1.5	7/5/77	58	Utukok R.	--	-/3094	-/O
1138F	23.5	8/10/77	250	Kantangnak Cr.	1.9/0	none	0898 lost
	24.5	6/16/78	265	Kantangnak Cr.	M/L	759/758	dB/dB/dB
1139F	11.5	6/7/78	200*	Utukok R.	1.3/0	651/654	1549W
1140M	0.5	6/7/78	21	Utukok R.	none	655/-	O/-
1141F	0.5	6/7/78	16	Utukok R.	none	-/656	-/O

Appendix II. Continued.

Bear no. and sex	Cem. age	Date of capture	Bear wt.[1]	Location	Drug Dosage[2]	Ear tags[3]	Marking[4]
1142F	14.5	6/9/78	250*	Utukok R.	M/H	658/657	1520 Bk
1143F	9.5	6/9/78	210*	Utukok R.	1.8/H	704/705	1?B/W
1144F	1.5	6/9/78	38	Utukok R.	0.4/H	717/718	Pp/G
1145F	2.5	6/10/78	95	Elbow Cr.	1.7/H	720/719	1457
1146F	14.5	6/10/78	230*	Elbow Cr.	2.5/H	721/722	G/1B
1147M	3.5	6/10/78	205	Utukok R.	1.3/0	723/724	P/G
1148M	6.5	6/10/78	205	Utukok R.	1.3/0	725/728	dB/W
1149F	4.5	6/11/78	180	Utukok R.	1.3/0	736/733	W/dB
1150M	5.5	6/16/78	185	Utukok R.	1.2/0	751/747	Bk/P
1151F	3.5	6/16/78	112	Kantangnak Cr.	--	752/753	Bk/Bk
1152M	3.5	6/16/78	142	Kantangnak Cr.	--	754/755	1450 O/Bk
1153F	3.5	6/16/78	70	Kantangnak Cr.	--	756/757	Bk/O
1154F	12.5	6/21/78	220	Tupik Cr.	1.8/0	760/761	WOW
1155M	1.5	6/21/78	75	Tupik Cr.	0.5/0	763/762	G/W
1156F	6.5	6/21/78	205	Kogruk Cr.	2.0/0	765/764	P/Bk
1157M	5.5	6/24/78	210	Driftwood Cr.	M/H	766/767	P/G/P
1158F	7.5	6/24/78	180	Elbow Cr.	1.4/0	769/768	P/W
1159M	10.5	6/24/78	295	Driftwood Cr.	1.7/0	770/771	G/P
1160M	0.5	7/1/78	25	Ilingnorak Ridge	none	303/-	dB/-
1161M	0.5	7/1/78	21	Ilingnorak Ridge	none	-/302	-/dB
1162M	2.5	7/1/78	95	Iligluruk Cr.	1.1/0	304/305	1490 1B/Bk
1163M	2.5	7/3/78	92	Iligluruk Cr.	M/H	306/307	1440 Bk/1B

* Estimate after close examination.

1 Weight in pounds.

2 Dosage in cc of Phencyclidine hydrochloride; M denotes multiple dosage with unknown effective dosage. Drug effects were as follows: L, light, O, optimum, H, heavy.

3 left/right

4 Marker designations:
Colors: P, pink; W, white; G, light green; O, orange; dB, dark blue; 1B, light blue; Bk, black; Pp, purple.
Marker types:
One or two color combinations were used for ear flags; e.g. O/W is orange in left ear, white in right ear; -/G is no flag, left; green, right.
Three flag combinations were used in nylon rope collars; e.g. OOW is two identical clusters of OOW flags on opposite sides of the collar.
Numbers, such as 1470, designate a radio collar with a frequency of 151.470 kHz; some radio collars were also marked with a flag and some transmitted more than one frequency.

Appendix III

PRELIMINARY REPORT

Behavioral Ecology of a Barren-Ground Grizzly Bear Female and Her Young in the National Petroleum Reserve-Alaska

by

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This two-year study has been funded by the Alaska Department of Fish and Game through the U.S. Fish and Wildlife Service, the Arctic Institute of North America, the Audubon Society, the National Wildlife Federation, the Theodore Roosevelt Fund of the American Museum, the Naval Arctic Research Laboratory and the University of Montana.

INTRODUCTION

During 1978 various aspects of the ecology of a barren-ground grizzly bear female and her offspring were examined. Basic food habits and habitat use information were already available as a result of work done in the summer of 1977 (Hechtel 1977). This work was continued in 1978 and, in addition, data on movement, home range, activity patterns and behavior were collected. In order to correlate habitat use with habitat availability, sampling of important vegetation types in the area was conducted.

OBJECTIVES

1. To examine in detail the seasonal food habits of a female grizzly and her two offspring, and to provide a general account of bear food habits on the western North Slope.

2. To determine daily movement and activity patterns, seasonal movements and the home range of the bears.

3. To describe and map portions of habitat within the home range of the family group.

4. To determine the seasonal habitat use patterns of the bears.

5. To conduct qualitative analysis of important bear food items.

PROCEDURES

The study area centered around Meat Mountain (68°56'N 160°45'W), National Petroleum Reserve-Alaska (NPR-A). Meat Mountain was chosen for the study area because of the presence of a female grizzly with offspring on the slopes of this large mesa. This situation provided excellent viewing conditions from the top of the mesa while generally separating observers from bears by a steep talus slope. The open nature of tundra vegetation as well as the extended period of daylight in midsummer also facilitated observation.

The study was conducted in cooperation with an ongoing Alaska Department of Fish and Game (ADF&G) bear research program in the NPR-A (Reynolds 1977). Field work was carried out from 28 May 1977 through 11 September 1977, and from 19 May 1978 through 21 September 1978. Detailed information obtained on one family group by ground tracking and direct observation in this study was planned to complement broad scale population biology, movement, habitat use data gathered through capture and radio tracking of grizzlies by ADF&G. Bears were captured using a helicopter and marked with individually-coded colored flags or fitted with radio transmitters of specific frequencies. During 1977 grizzly no. 1086, a female accompanied by two yearlings, was fitted with a radio collar. The radio collar permitted tracking of no. 1086 and her offspring throughout the 1977 and 1978 field seasons. Periodic aerial tracking by ADF&G located the bears when we were unable to locate them from the

ground. In addition to no. 1086 and her cubs, at least nine other bears used the study area periodically and were watched for brief periods of time. In order to compare food habits and habitat use patterns of no. 1086 with those of other bears, female no. 1092 and her yearling were observed from 12-19 June 1978 in the vicinity of Ilingnorak Ridge, about 25 miles southwest of Meat Mountain.

Observations of these grizzlies provided information on habitat use, food habits, home range, movements and activity patterns. Feeding sites or areas actively used by bears were examined when the bears moved away. Descriptions of habitats, plant species presence and feeding site information were recorded. Voucher specimens of plants and bear scats were collected. Samples of important plant species utilized by bears were also collected from the feeding sites and frozen, dried or preserved in ethanol. Scat samples from eight immobilized bears collected during ADF&G research will be analyzed for parasite content. Eight phenology plots, 4 each on the north and south exposures, and 15 vegetation transects in various habitats were run.

PRELIMINARY FINDINGS

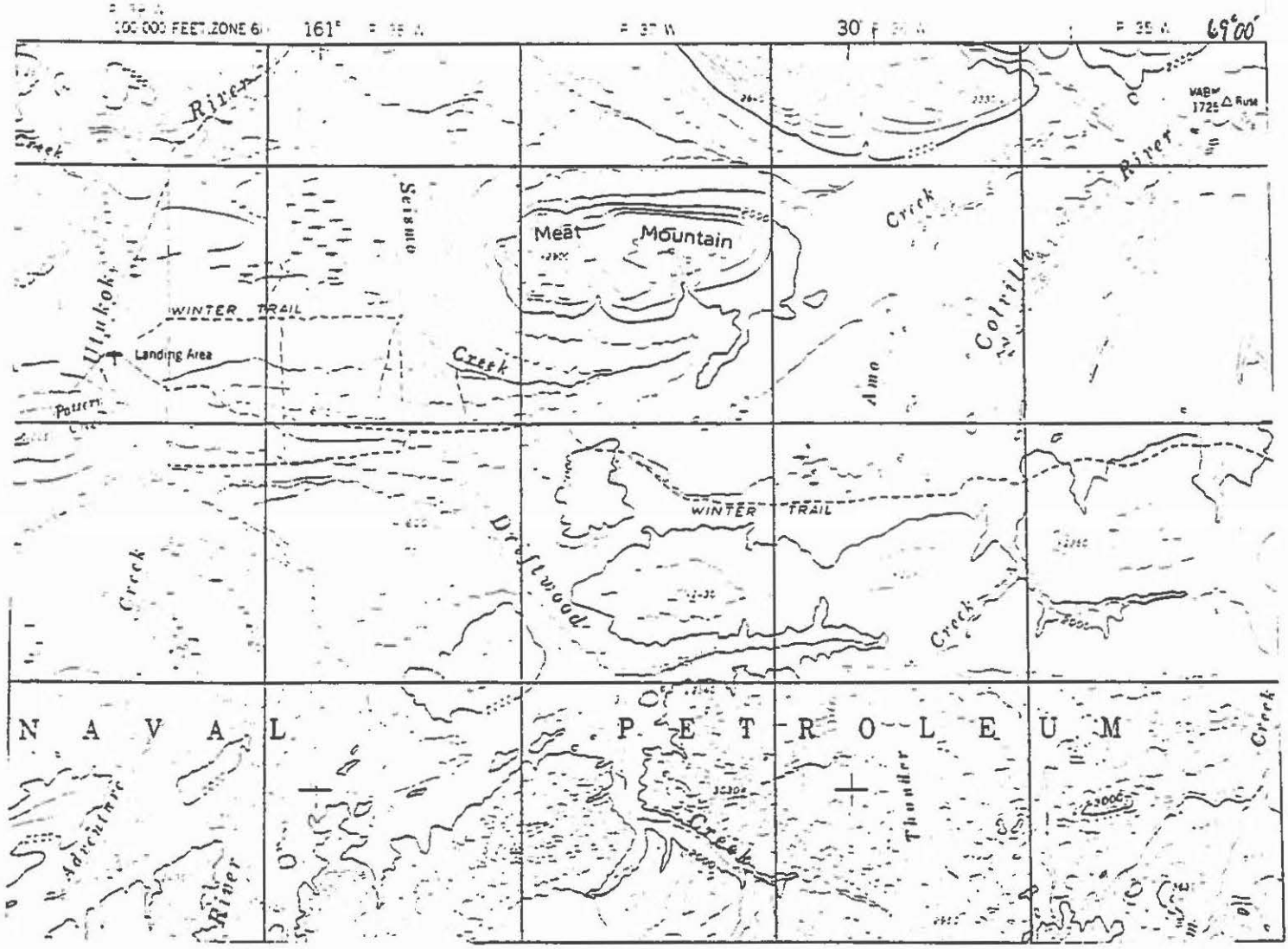
Movement, Home Range and Activity Patterns

During 1977 no. 1086 and her yearlings occupied a home range of approximately 112 sq. mi. in the vicinity of Meat Mountain (Fig. 1) (Reynolds 1977). Their movements in the early spring were restricted to the relatively steep, north-facing slope of Meat Mountain. As the season progressed movements became more extensive. The bears wandered as far as the junction of Driftwood Creek and the Utukok River, even though they still spent most of their time on the slopes of Meat Mountain. They denned together on the northwest side of Meat Mountain on 9-10 October 1977 (Reynolds 1977).

In 1978 they emerged from the den between 20 April and 12 May. The offspring, now 2-year-olds, remained with no. 1086 the entire field season. Their home range was essentially the same as the year before, except that movements, especially in early spring, were more extensive. During direct observation sessions movement of the family group was recorded on mylar overlays on airphotos. Movement data will be analyzed and presented in the final report. The bears denned together on Meat Mountain between 4-9 October at the head of a drainage on the southwest side of the mountain within 1 mile of the 1977 den site.

The home range of the bears includes a mosaic of most available habitat types. The diversity of habitats is due to the varied nature of local relief in the northern foothills. From almost any portion of the bears' home range it is not necessary to move more than a few miles to reach almost any other vegetation type. However, the bears wander more widely than necessary to satisfy their vegetative needs. For instance, the family group often traveled several miles while feeding in wet sedge meadows, leaving behind an apparently abundant food source of

Figure 1. Topographic map of Meat Mountain, around which the home range of female no. 1086 and her young was centered.



the same type to move to areas that are ostensibly similar in composition and phenology. One explanation for such moves could be that as long as their basic vegetative needs are supplied throughout a large area it is more efficient for them to move while feeding in order to take advantage of chance food items such as a vulnerable caribou, carrion, or nesting birds. When they do encounter a limited food source of high energy value, such as dead caribou, it is probably advantageous to remain at the site until the carcass is consumed.

The direct observation sessions not only provided data on habitat use and movements, but provided the opportunity to watch the bears' behavior. Table 1 lists the dates and times when direct observations of individual bears were made. A total of 278.7 hours of direct observation were logged during the 1978 season. Bear activity was broken down into a number of categories: resting, feeding (nursing, grazing, digging roots, digging ground squirrels), foraging, travel and play. Data from observation periods are now being analyzed. A certain amount of information on the bears' activity patterns can be extracted from the data. There was an apparent tendency, for example, for an extended sleep period during midday, although a considerable amount of variation is involved. Observations of nursing behavior, some data on success rates when digging ground squirrels, observations of intraspecific encounters and some information on the effects of disturbance were recorded. Differences in behavior of females toward their offspring were noted between no. 1086 and no. 1092. Female no. 1086 was much more tolerant to crowding by her young during feeding and even permitted them to take ground squirrels from the holes she was digging. Female no. 1092, on the other hand, made her cub keep its distance and in the short time we observed her was more aggressive toward it. The behavioral data will be presented in detail in the final report.

Habitat

In order to describe and map portions of bear habitat and to record habitat use patterns for no. 1086 and her young, a general reconnaissance of the major vegetation types was conducted in 1977. Important plants were identified, voucher specimens were collected, and plant species lists for some of the habitats begun. During 1978 more detailed analysis was carried out including phenology plots and vegetation transects. General habitat mapping was done on aerial photographs of the area. In addition, direct observations of the bears' activities revealed actual use of the different habitat types during the study periods.

A tentative breakdown of the major habitat types found in the study area includes:

Fellfield-Barrens
Talus
Dryas - dwarf shrub
Dryas - step and stripe
Carex Bigelowii meadow
Tussock tundra
Betula tussock
Betula thicket
Wet sedge meadow
String bog
Riparian
Late snowbank community

Table 1. Periods of intensive observation of grizzly bear activity, 1978.

Date	Time	Hours of Observation	Bear
30-31 May	2400-2400	24:00	1086/2 young
2-3 June	1200-1315	25:15	1086/2 young
8 June	2030-2245	2:15	1086/2 young
9 June	1200-1240	:40	1086/2 young
12 June	1200-2045	8:45	1092/1 young
15 June	1530-2400	8:30	1092/1 young
24 June	1115-1243	1:28	1086/2 young
24 June	1430-2100	6:30	Unmarked
24 June	1725-2100	3:35	1114 male
25 June	2030-2210	1:40	1086/2 young
26 June	1530-1645	1:15	1086/2 young
27 June	1445-1700	2:15	1086/2 young
29-30 June	1400-1830	28:30	1086/2 young
2 July	1330-2210	8:40	1086/2 young
3-8 July	Transmitter Problem		
14 July	1230-1415	1:45	1086/2 young
14-15 July	1630-1630	24:00	1086/2 young
23 July	2030-2105	:35	1096 male
23-24 July	2100-0303	6:03	1086/2 young
24 July	0100-0205	2:05	1096 male
24 July	0446-0453	:07	1086/2 young
24 July	0658-2359	17:01	1086/2 young
25 July	1530-1942	4:12	1086/2 young
31 July	1100-2400	13:00	1086/2 young
2-3 August	2230-0116	2:46	1086/2 young
4 August	2400-1314	13:14	1086/2 young
15 August	0430-0530	1:00	1131 male
16 August	1435-1506	:31	1096 male
16 August	2100-2210	1:10	1131 male
16 August	2030-2300	2:30	1086/2 young
17 August	1000-1430	4:30	Unmarked
17 August	1745-2005	2:20	Unmarked
17 August	1849-2328	4:39	1086/2 young
19 August	2200-2330	1:30	1086/2 young
25 August	0925-2028	11:03	1086/2 young
30 August	1545-2224	6:39	1086/2 young
31 August	0700-2132	14:32	1086/2 young
7 September	1500-2045	5:45	1086/2 young
11 September	0945-1630	6:45	1086/2 young
13 September	1330-2111	7:41	1086/2 young
		278:41 total	

This is not a final breakdown but gives an idea of the range of vegetation types encountered. One of the problems of working with tundra vegetation is the lack of a good, standard classification system. Systems in use range from the simple classifications of Spetzman (1959) to an attempt to synthesize the various named botanical units into a comprehensive, provisional classification of Alaskan arctic tundra by Murray and Batten (1977). In-depth habitat discussion and the relative merits of different systems for classifying grizzly habitat will be dealt with in the final report.

Habitat data will be analyzed this winter. The occurrence of important bear foods will be correlated with habitat types. Species lists, composition and phenology information will be presented, as well as the data on seasonal habitat use by bears. Habitat use patterns can be summarized as follows:

Season	Main Habitat Types Used
Pre-growing through early growing season: May through early June	Dryas step and stripe; Dryas dwarf shrub; floodplain
Growing season: early June through late July	Wet sedge meadow; late snowbank community; tussocks
Post-growing season: early August through denning in early October	Floodplain; Dryas step and stripe; Dryas dwarf shrub; Betula tussocks; string bogs

This summary is preliminary and generalized; a more detailed breakdown and explanations beyond the scope of this progress report and will be dealt with in the final report.

Apparently the major habitat use patterns outlined above are primarily a function of plant availability. However, superimposed on the vegetation-influenced use patterns, the search for carrion and prey, especially ground squirrels, draws bears into areas where the vegetation of a habitat type is not used as food. Thus in midsummer grizzly bears may be found most often in wet sedge meadows along small drainageways feeding on the vegetation, yet they also travel to raised frost-scarred Dryas areas in search of ground squirrels.

Habitat use is also affected by local variations in the availability and abundance of potential food sources. An abundant crowberry crop (Empetrum nigrum) might shift fall use more to Betula tussock areas, or a good blueberry crop (Vaccinium uliginosum) might draw bears into the string bogs. No. 1086 was observed in the fall of 1978 in a string bog digging up microtine sedge root caches. In years of high microtine populations, an increased incidence of cache-raiding and predation on microtines would be expected. Bears are opportunistic omnivores, and their habitat use patterns reflect it.

Portions of the bears' habitat are being mapped on airphotos with data collected during the 1977 and 1978 field seasons. In addition, two different LANDSAT vegetation maps of the area are available, and high altitude infrared photos were obtained. These will be compared to the grizzly habitat use maps in order to determine their applicability for bear habitat inventory. High altitude color photography at certain key times in spring and fall can be an extremely valuable aid to mapping of tundra. Differences in the timing of the spring emergence of plants and the change to fall colors between vegetation types can be used to separate locations and boundaries of habitat types that would otherwise be very difficult to map from the ground. A serious limitation, however, is the fact that the period when differentiation between types is evident often lasts only a few days so that inclement weather or problems with aircraft may preclude plans for obtaining the photographs.

Food Habits

Direct observations of feeding activity, feeding site examinations, field observations on scat contents during 1977 and 1978, and preliminary lab analysis of scats from 1977 were all used to document bear food habits. Table 2 outlines the generalized food habits of grizzly bears in the study area. This summary is based on the intensive work on no. 1086 and her young and on occasional data from other bears.

While many foods are eaten, grizzlies seem to concentrate on relatively few. The most important seasonal foods are:

Pre-growing season	Growing season	Post-growing season
Hedysarum alpinum-roots	grasses and sedges	Hedysarum alpinum-roots
Oxytropis borealis-roots	Boykinia Richardsonii-leaves, stems & flowers	Arctostaphylos rubra-berries
Arctostaphylos rubra-overwintered berries	Equisetum arvense-fruiting & vegetative stems	Spermophilus parryii-ground squirrels

The majority of their diet consists of plant material; whenever possible, however, caribou, ground squirrels, marmots, microtine rodents and birds are eaten.

Over 350 scats were collected during the 1978 field season and will be analyzed this winter. In addition, 198 scats were collected during 1977 and analyzed last winter. The scats were labeled with as much information as possible, including date collected, location, vegetation type, relative age, bear number and (during 1978) diameter in millimeters. Black bears do not occur in the area so there were no problems identifying grizzly scats.

Table 2. Preliminary seasonal food habits summary for grizzly bear No. 1086 and her young based on direct observations, feeding site examination and some scat analysis.

Type of Food	Species	Amount of use: Den emergence to early growing season (May-early June)	Amount of use: Growing season (early June-end of July)	Amount of use: Late growing season to denning (August-early October)
Roots	Hedysarum alpinum	4-5	0	5
	Oxtropis borealis	3-5	0	0
	Sedge (from microtine caches)	2*	0	2*
Leaves and stems	Grasses and Sedges	0	5	0
	Boykinia Richardsonii	3	5	0
	Equisetum arvense (both brown fertile stems and vegetative stems used)	3	4-5	0
	Oxyria digyna	0	2	0
	Salix sp. (leaf buds)	1	0	0
Flowers	Oxytropis borealis	0	2	0
	Boykinia Richardsonii	0	4	0
	Salix sp. (catkins)	1	0	0
Fruit	Arctostaphylos rubra	3	0	5
	Vaccinium uliginosum	0	0	*
	Vaccinium vitis-idaea	0	0	*
	Empetrum nigrum	0	0	*
Carrion	Rangifer tarandus	2-3	2	2
	Alces alces	0	0	0
Prey	Rangifer tarandus	3	2	1
	Spermophilus parryii	4	3-4	5
	Marmota browerii	1	1	1
	Lagopus sp.	1	1	1
	Microtine rodents	*	*	*
	Bird eggs	1	1	0
	Insects	1	1	1

0 = none observed; 1 = rare; 2 = occasional; 3 = light; 4 = moderate; 5 = heavy;
* = use fluctuates greatly with food availability

Qualitative Food Analysis

Calorimetry Studies

During 1977 major food items used by grizzly bears were identified, and samples of both individual plant species used as food and the same plant species from a bear scat were collected. In 1978 some additional samples were obtained for calorimetric analysis. These matched food/scat samples are being analyzed as part of a digestive efficiency study by Dr. Erich Follmann of the Naval Arctic Research Lab at Barrow.

Crude Protein and Crude Fiber Analyses

Samples of important food items identified in 1977 were gathered and dried during the 1978 field season and will be analyzed for crude protein and crude fiber. In addition to the single samples of most of the foods, a series of samples of the roots of Oxytropis borealis and Hedysarum alpinum were obtained.

Soluble Carbohydrate

Soluble carbohydrate content is probably one of the best indications of food value for grizzly bears. Difficulty in preparing specimens under field conditions prevented the collection of very many samples. However, Peggy Kuropat, a graduate student from the University of Alaska working on caribou foods, was collecting plant samples for soluble carbohydrate analysis. A number of the plant species she will be analyzing, such as Boykinia Richardsonii and Equisetum arvense, are used by grizzlies, so Kuropat's data on a number of important midsummer foods will be available. It was also possible to use her equipment to obtain a number of samples of fall grizzly foods which John Bryant (University of Alaska) has agreed to analyze this winter.

Table 3 lists the various food items and samples collected. The numbers of samples to be analyzed for crude fiber and crude protein will depend on the adequacy of available funding.

Table 3. Samples of plant food items used by grizzly bears which were obtained for qualitative analysis.

Type of Food	Species	In Literature	Observed	Samples obtained: Calorimetry Food	Calorimetry Scat	Soluble Carbohydrate	Crude protein and fiber
Roots	Hedysarum alpinum	X	X	X	X	X	X
	Oxytropis borealis	-	X	X	X	X	X
	Sedges (Carex sp. or Eriophorum sp.)	?	X	X	?	X	X
	Petasites sp.	X	-	X	-	-	-
Leaves and Stems	Boykinia Richardsonii	X	X	X	X	X*	X
	Equisetum arvense	X	X	X	X	X*	X
	Oxyria digyna	X	X	X	?	?	X
	Grasses and sedges	X	X	-	-	-	-
	Arctagrostis latifolia	X	-	-	-	-	-
	Calamagrostis canadensis	X	-	-	-	-	-
	Salix sp. (buds)	X	X	-	-	X*	-
Flowers	Oxytropis borealis	-	X	X	-	-	-
	Boykinia Richardsonii	X	X	X	-	-	-
	Salix sp. (catkins)	X	X	-	-	-	-
Fruit	Arctostaphylos rubra	X	X	X	X	X	X
	Vaccinium uliginosum	X	-	X	-	X	-
	Vaccinium vitis-idaea	X	-	X	-	X	X
	Empetrum nigrum	X	-	X	-	X	X
	Shepherdia canadensis	X	(not found in study area)				

*Being analyzed as part of a caribou study by Peggy Kuropat, University of Alaska.

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