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STRUCTURE, STATUS, REPRODUCTIVE BIOLOGY, MOVEMENT, DISTRIBUTION, AND HABITAT UTILIZATION OF A GRIZZLY BEAR POPULATION

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SUMMARY

Specific aspects of grizzly bear (Ursus arctos) population biology in the western Brooks Range were studied during 1982. These included age at 1st production of offspring, length of reproductive life, litter size, reproductive interval, and mortality of young. During 1977-82, the mean litter size for 57 litters was 1.98/year (ave. ann. range 1.67-2.50). Mean reproductive interval in this area is at least 4.0 years. Mortality rates for offspring accompanied by marked adult females remained high: cub mortality, 44%; yearling mortality, 19%; and 2-year-old mortality, 14%. Mortality rates calculated from changes in litter sizes of cubs, yearlings, and 2-year-old and 3-year-old age classes were low and inaccurate, since most mortality occurred to entire litters and not single members of litters. To examine causes of cub mortality, 3 females with cubs and 2 females with yearlings were kept under intensive observation from 16 May to 13 June. The 2 cubs of female No. 1178 were apparently killed by a large adult male which was seen with 1 cub in his mouth. The other 4 family groups under observation did not experience any mortality.

Key words: Alaska, cub mortality, grizzly bears, litter size, population biology, reproductive interval.

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BACKGROUND

The brown/grizzly bear (Ursus arctos) populations inhabiting the mountains and foothills of the Brooks Range are very susceptible to the impacts of increased human population and development and to overexploitation by hunting. In this region, the grizzly is at the northern extent of its range; the period of food availability during summer 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 (Crook 1971, 1972; Reynolds 1974, 1976, 1980, 1981; Reynolds et al. 1976; Reynolds and Hechtel 1982). The increase in exploration and exploitation for oil and mineral resources can only be expected to continue. Improved access to the area provided by such development will probably be followed by increased bear-human contact and conflict. Confrontations could result in depletion of grizzly populations unless the baseline population information necessary for wise management is gathered.

Investigations of grizzly bears conducted in the central Brooks Range have included those by Rausch (1969) on dentition and Crook (1971, 1972) on survey techniques, distribution, and abundance. In the eastern Brooks Range, survey techniques, population discreteness, denning characteristics, movement, and population characteristics were studied (Quimby 1974; Quimby and Snarski 1974; Reynolds 1974, 1976; and Reynolds et al. 1976).

In the western Brooks Range, intensive studies designed to provide baseline information on grizzly bear population structure, reproductive biology, movement characteristics, and habitat utilization were conducted in 1977 and 1978 (Reynolds 1978). In 1979, these studies continued on a much-reduced scale and included investigations of grizzly bear predation on caribou (Rangifer tarandus) (Reynolds 1980). These past and present studies have addressed many of the information gaps in the knowledge of grizzly bear ecology in the Brooks Range.

The answers to some questions of bear biology require long periods of study because arctic grizzlies are long-lived and have low reproductive rates. Emphasis of fieldwork during 1980-82 was directed toward those aspects of bear biology which require long-term investigation. Those aspects include the following: factors affecting age at 1st production of young and reproductive interval, causes of mortality of cubs-of-the-year, survival rates and emigration of young-age bears, and impacts of human disturbance including gas and oil exploration and development. The population size has been determined and the majority of bears in the study area are marked, so these additional data can be collected with minimum effort and expense.

OBJECTIVES

To determine the movement patterns, structure, size, status, reproductive biology, denning characteristics, and mortality rates of the grizzly bear population, and to assess potential effects of human disturbance on grizzlies in the western Brooks Range. During this reporting period, the major effort was directed toward determining the reproductive biology and mortality rates for the population.

PROCEDURES

During 1977 through 1982, intensive studies were carried out in a 5,200-km^2 (2,000-mi^2) area in the mountains and foothills of the western Brooks Range. The approximate boundaries of the study area were Archimedes Ridge (69°10'N latitude) on the north, the Kokolik River on the west, the crest of the Brooks Range on the south, and a line running from Thunder Mountain to the Utukok River (160°15'W longitude) on the east.

During 1977-79, baseline data were collected on population size, structure, movement patterns, habitat utilization, and denning characteristics. Parameters describing productivity, especially reproductive interval and survival of young, must be recorded over a 5- to 10-year period to be accurate. Field investigations during 1980-82 were oriented toward studying these long-term aspects of reproductive biology. In addition, data were collected regarding migration, changes in movement, and home range use, as well as fidelity to areas used in denning. This information was determined from observations of radio-collared or individually marked bears (Appendix A). Fifty-one bears were fitted with radio transmitters (Telonics, Inc., Mesa, Ariz.) during the course of the study. Since methods and baseline information for the study population were described previously (Reynolds 1978, 1980, 1981; Reynolds and Hechtel 1982), this report will contain only data gathered in 1982 or, where appropriate, information which substantially affects previous calculations.

During 1982, fieldwork was again conducted from the base camp at Driftwood Creek airstrip near the Utukok River. Observations were made from 9 May through 14 June and on 2 October. To determine causes of cub mortality, 2 field crews made intensive observations of radio-collared females with cubs or yearlings and followed these family groups on foot. In addition, all radio-collared females with cubs were located daily by aircraft, weather permitting.

FINDINGS AND DISCUSSION

Operational Life of Radio Collars

During the 6 years of this study, 51 radio collars were placed on 39 grizzly bears (Table 1). Range of operational life varied from 0 days to 46 months. Of the collars placed on bears, 30 functioned for varying periods and then stopped transmitting, 13 are presently functional, 6 were replaced while they were functional, and the status of 2 was unknown. The mean functional life of all collars, excluding the 1 which never worked, was 18.6 months; however, this includes collars which are still functioning so the final mean life will be longer. Causes of failure included damage by bears, water entry into the transmitter, and electronic malfunction. A number of nonfunctional collars which were undamaged by bears were recovered and returned to the manufacturer for failure analysis. As a result, the mean life of all collars placed on bears since 1979 has improved to 24.0 months; this includes all functional collars and is a minimum figure. We recommend that, for projects in which continuity of observation is important, collars be replaced when they reach 24 months of functional life.

Reproductive Biology

During 1980-82, special effort was made to monitor changes in the reproductive status of previously marked females. Table 2 summarizes the reproductive history of 49 potentially productive females. Detailed analyses must await additional observations, but the data confirm some patterns reported in past reports (Reynolds 1978, 1980, 1981; Reynolds and Hechtel 1982).

Reproductive rates for bears depend upon age at 1st 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 has ranged from 3.5 to 6.5 years on the Alaska Peninsula and Kodiak Island (Hensel et al. 1969; Glenn et al. 1976) and from 6.5 to 12.5 years in the eastern Brooks Range (Reynolds 1976). In southwestern Yukon Territory, females are 1st capable of conception at 6.5 years, but in northern Yukon Territory, age at 1st conception was 7.5 years (Pearson 1975, 1976). In Yellowstone National Park, Craighead et al. (1969) reported females bred at 4.5-8.5 years of age and had

their 1st cubs the following spring. Moreover, they observed that some 3.5-year-old females copulated, but none bore cubs the following spring.

The average age of females at their 1st production of young during 1977-79 was calculated at 8.4 years based on 11 observations (Reynolds 1980). During 1980, 5 additional observations were made which resulted in a calculated mean age of 8.1 years (Reynolds 1981). During 1981, female No. 1087 bred for the 1st time as a 5-year-old, did not produce cubs as a 6-year-old, but did breed again in 1982. Female No. 1141 bred in 1982 as a 4.5-year-old; based on ages of other females at 1st production, it is unlikely she will have cubs in 1983. No other young, marked females were observed breeding or accompanied by cubs in 1982.

Since calculations were based on actual observations and extrapolations, the results represent minimum values. Actually, the timing of 1st breeding and production of offspring is probably more closely related to the nutritional status and weight of a female than to age. Subsequent litters and survival of cubs are also likely tied to nutrition. Adequate data to substantiate this relationship are difficult to obtain in the western Brooks Range because of the high costs of capture operations; however, the relationship has been shown for black bears (Ursus americanus) in Minnesota (Rogers 1976) and Idaho (Beecham 1980, Reynolds and Beecham 1980).

Litter sizes ranged from 1 to 3 cubs. The mean size of 57 litters over the 6-year period was 1.98 but ranged from 1.67 to 2.50 among years (Table 3). Such variability has far-reaching management implications because litter size may greatly affect the calculations of productive capacity. For example, using the 1980 litter size of 1.67, calculation of the reproductive rate for the population yields a mean rate of 0.41 cubs/adult female/year. If, on the other hand, the 1981 litter size of 2.50 was used, the mean reproductive rate would be 0.62 cubs/adult female/year, an increase of 51% over the 1980 figures. Further, if reproductive rates were calculated using high litter sizes found during 1 or 2 years, levels of sustained yield would be overestimated, possibly resulting in overharvest of bear populations. These differences illustrate the importance of gathering such information from long-term studies prior to setting appropriate harvest levels.

The reasons for variations in litter size were not determined. Inclusion of cohorts older than cubs-of-the-year in calculations did not result in low litter sizes since older cohorts displayed litter sizes similar to, or larger than, cub cohorts. Since many litters were not observed until early June, prior cub mortality could result in low litter sizes. However, evidence from family groups observed shortly after emergence from winter dens indicates that the great majority of cub mortality results in deaths of entire litters, not a reduction in litter size (Reynolds

1981). The most reasonable explanation for differences in yearly litter size is that cub production is dependent on the nutritional state of females, which may vary according to yearly differences in food availability and quality, or even winter den conditions affected by weather.

Reproductive interval is the time between breeding by a mature female and subsequent weaning of offspring (Reynolds and Hechtel 1982). The interval begins at breeding rather than conception and therefore includes those years in which a bear breeds but does not produce offspring. The mean reproductive interval was 4.0 years from 1977-79 and at least 4.0 years during 1980-82. Of 11 females accompanied by offspring in this period, only 2 weaned their young as 2-year-olds and then bred. Of the 9 others, 4 had intervals of at least 4 years, and 5 of at least 5 years.

Mortality

During 1982, 3 mortalities were documented: an emaciated young (4- to 5-year-old) male was killed at the Driftwood airstrip when he advanced to within 7 m of researchers despite shouts and warning shots; 2 5-month-old cubs of female No. 1178 were apparently killed by an adult male and at least 1 was eaten.

Most observed mortality of cubs-of-the-year occurred from 1-4 weeks after emergence from maternal dens (Table 4). Although the highest number of cubs was lost during 1979, this same degree of cub mortality could have occurred in 1980. Adult females Nos. 1134, 1100, and 1166 probably bred in 1979 but were not seen with young after 9 June 1980 when observations began. Therefore, during 1980, it may have been possible these females produced cubs and lost them before observations began. However, observations made during 1981 and 1982 indicate that females seen without offspring in early spring did not lose young after emerging from winter dens; instead, either offspring were not produced or they died in dens during winter. For example, 3 females which bred in 1980 and were presumed pregnant did not have offspring by 7 May 1981 and were not near den sites. This contrasts to 4 other females with cubs or yearlings which were still in or close by dens on the same date. Similarly, 3 females which bred in 1981 neither had offspring with them nor were near their den sites on 19 May 1982; 6 other females with cubs or yearlings were still at or close to den sites on the same date. Therefore, we assumed the following: 1) females with offspring in early May should have been in or near den sites; and 2) females away from dens had not emerged from winter dormancy with cubs.

Analysis of mortality rates for cubs, yearlings, and 2-year-olds is presented in Table 5. Cubs sustain the highest mortality rate; most mortality in that age class occurs to entire litters. In yearling and 2-year-old age classes, however, mortality rates are lower and usually involve only 1 member of the litter.

In the past, differences in mean litter sizes of cohorts have been used as indicators of survival or mortality rates between successive age classes (Martinka 1974, Dean 1976). Litters in the study area were comprised of from 1 to 3 offspring (Table 6). Over the 6-year period, composite litter sizes of cubs, yearlings, 2-year-olds, and 3-year-olds were 1.95, 1.86, 1.70, and 1.70, respectively. Using these figures, survival rate from cub to yearling age class can be calculated as 0.95; from yearling to 2-year-old age class, 0.91; and from 2-year-old to 3-year-old, 1.00. From comparing the observed mortality rates presented in Table 5 with the rates calculated from Table 6, however, it is apparent that using the decline in litter sizes of subsequent age classes greatly underestimates actual mortality rate. The reason for the discrepancy between the differences in mean litter sizes of age classes and observed rates of mortality for those same age classes is that when mortality occurs, it often involves entire litters, rather than partial litters.

The causes of all cub mortality in this study have not been determined. Cannibalism by adult males has been documented in the Brooks Range (Reynolds 1974, 1976, 1978, 1980), elsewhere in Alaska (Troyer and Hensel 1962, Glenn et al. 1976), and in Canada (Mundy and Flook 1973; Pearson 1975, 1976). However, the comparative extent of cannibalism in cub mortality has not been established. Some mortality probably occurs within winter dens. Other cub deaths could result from disease, natural accidents, or sibling rivalry.

To better understand causes of cub mortality, in 1981, 3 females with cubs were placed under intensive observation from early May until mid-June. Two of these family groups were watched by ground-based crews on a 24-hour basis, weather permitting; the 3rd was observed daily from aircraft (Reynolds and Hechtel 1982). In 1982, similar observations were made of 4 females with cubs and 2 females with yearlings. Three family groups (1 comprised of female No. 1169 and her 2 cubs, 1 of an unmarked female with a single cub, and 1 of female No. 1166 and her single yearling offspring) were watched by ground-based crews; the other 3 (No. 1097 and her 3 yearlings, No. 1102 and her 2 cubs, and No. 1178 and her 2 cubs) were observed daily from aircraft.

Female No. 1178 was still in her den when located on 9 May. By 16 May, she had moved with her 2 cubs 2 km east and was observed near that same location on 21, 22, and 23 May. On 24 May when she was located, she appeared very agitated and was not accompanied by her offspring. After an intensive search of the vicinity, a large blond adult male was sighted with the remains of a cub in its mouth. The aircraft made 2 passes to observe the male, which dropped the cub and ran. The carcass of the cub was collected and found to be a female; the head and most of the groin area had been eaten. When further search for the 2nd cub was unsuccessful, it was presumed dead as well.

It did not appear that the habitat used by this female differed from that used by other females with cubs in the same locality. The area which had been used by the family group from 16-24 May was on the east end of a ridge about 240 m above the nearby Utukok River. The slope of the ridge was moderate and provided little escape cover, but steeper rock faces and talus slopes were available in the vicinity. Another female, No. 1102, used an area on the same ridge 10 km west where even less escape cover was available and she was able to keep her offspring until at least late June. Female No. 1169 also safely reared 2 cubs until at least mid-June. She used an area of Tupikchak Mountain with little escape cover, even though steep south-facing talus slopes were less than 2 mi away. She safely reared 2 cubs until mid-June.

Movement and Home Range

Movements of the 13 radio-collared bears during 1982 indicated there were no substantive movements outside the home ranges used during 1977-80 (Reynolds 1980, 1981). At least 3 females and probably 1 male, which were captured before or shortly after they were weaned as offspring, have continued to remain in or near their maternal home ranges. The females were 4.5, 6.5, and 7.5 years old in 1982; the male was tentatively identified (by torn, unconclusive ear-flag markers) as the sibling of the 6.5-year-old female.

This fidelity to maternal home ranges contrasts to the 110- and 115-km movements by 2 4.5-year-old males which were reported in 1980 and 1981 (Reynolds and Hechtel 1982). Although not enough data have been collected to confirm such a pattern, it may be that young grizzly bear females are prone to stay within or near their maternal home ranges while males are more likely to range more widely and establish themselves in other areas. Such patterns have been documented for black bears in Minnesota (Rogers 1977).

RECOMMENDATIONS

This study adds important baseline data that will help us better understand grizzly bear populations in northwestern Alaska. However, additional information is needed. A technique for comparing the known density of bears in the study area with densities throughout the Brooks Range should be developed and tested. We should continue to observe marked bears to improve the accuracy of reproductive data, allow calculation of long-term population productivity, and better determine survival rates and causes of mortality of young-age and mature grizzlies.

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Table 1. Operational life and history of radio collars placed on grizzly bears in the western Brooks Range, 1977-82.

Collar frequency (MHz)	Bear No. and sex	Date collared	Last date signal received	Months functional[a]	Present status
150.080	1176F	7/13/80	9/19/81	14	Nonfunctional, not recovered
150.698	1111F	6/18/77	7/11/79	25	Nonfunctional, not recovered
150.724[b]	1106F	6/14/77	5/4/79	23+	Functional, recovered when 1106 killed by male
150.724[b]	1110F	6/30/79	5/7/81	46[b]	Nonfunctional, not recovered
150.750	1090F	6/1/77	10/12/78	16	Nonfunctional, not recovered
150.750	1102F	8/18/80	6/14/82	22+	Functional, on bear
150.772	1166F	7/7/80	6/8/82	23+	Functional, on bear
150.773	1092F	6/4/77	9/19/78	15	Nonfunctional, replaced 1980
150.798	1104F	6/12/77	5/4/79	23	Nonfunctional, replaced 1980
150.825	1091M	6/4/77	10/12/78	16	Nonfunctional, collar recovered minus transmitter
150.848	1096M	6/5/77	6/28/78	12+	Functional, replaced 1978
150.873	1097F	6/5/77	7/6/80	37+	Functional, replaced 1980
150.898[b]	1084M	5/26/77	6/2/77	1[b]	Functional, shed and recovered
150.898[b]	1138F	8/10/77	8/19/77	2[b]	Functional, shed and recovered
150.898[b]	1166F	9/18/79	7/80	12[b]	Functional, shed in 3 days
150.898[b]	1178F	8/18/80	6/15/82	37+[b]	Functional, on bear
150.923	1088M	5/31/77	6/3/79	24	Unknown, not recovered
150.943	1134F	7/12/80	10/2/82	27+	Functional, on bear
150.948[b]	1082M	6/13/77	6/25/77	0[b]	Functional, replaced with temperature collar
150.948[b]	1134F	7/5/77	10/3/79	27[b]	Nonfunctional, replaced 1980
150.972	1105F	7/10/80	6/11/82	23+	Functional, on bear
150.973[b]	1089F	6/1/77	6/10/77	0[b]	Functional, removed
150.973[b]	1100F	6/11/77	10/2/78	16[b]	Nonfunctional, replaced 1979
150.973	1096M	8/17/80	10/2/82	26+	Functional, on bear
150.998	1083M	6/2/77	10/3/78	16	Nonfunctional, replaced 1979
150.998	1082M	8/17/80	9/22/81	13	Nonfunctional, not recovered
151.000	1092F	8/19/80	6/12/82	22+	Functional, on bear
151.002	1103M	6/12/77	6/9/78	12	Nonfunctional, replaced 1978
151.007	1082M	6/28/79	5/3/80	10	Nonfunctional, recovered
151.023[b]	1099M	6/11/77	6/27/78	12[b]	Functional, replaced 1978
151.023[b]	1083M	6/30/79	5/8/81	34[b]	Nonfunctional, not recovered
151.050	1085F	5/27/77	8/20/80	39	Nonfunctional, not recovered
151.073	1169F	7/5/80	6/14/82	23+	Functional, on bear

Table 1. Continued.

Collar frequency (MHz)	Bear No. and sex	Date collared	Last date signal received	Months functional[a]	Present status
151.074	1110F	7/1/78	10/12/78	3	Nonfunctional, replaced 1979
151.074	1086F	9/16/79	7/80	10+	Functional, shed in den
151.077	1082M	6/25/77	6/27/78	12+	Functional, replaced 1978
151.079	1121F	6/25/77	8/23/78	14	Nonfunctional, not recovered
151.098[b]	1105F	6/13/77	6/28/78	12[b]	Functional, replaced 1978
151.098[b]	1100F	7/1/79	8/20/80	26[b]	Nonfunctional, not recovered
151.102	1086F	5/29/77	9/16/79	28+	Functional, replaced 1979
151.440[b]	1163M	7/3/78	8/23/78	2[b]	Functional, shed, recovered
151.440[b]	1087F	7/7/80	7/7/80	2[b]	Nonfunctional, not recovered
151.450[b]	1152M	6/16/78	8/11/78	2[b]	Functional, shed
151.450[b]	1164M	7/6/80	7/6/80	2[b]	Nonfunctional, not recovered
151.457	1145F	6/10/78	7/28/79	13	Nonfunctional, not recovered
151.470	1102F	6/18/78	5/5/79	11	Nonfunctional, shed, not recovered
151.470	1097F	7/6/80	6/13/82	23+	Functional, on bear
151.480	1087F	6/30/79	9/17/79	3	Nonfunctional, shed, not recovered
151.490[b]	1162M	7/1/78	7/26/78	1[b]	Functional, recovered after bear died
151.490[b]	1141F	7/13/80	6/13/82	24+[b]	Functional, on bear
151.498	1164M	5/7/79	9/17/79	4	Nonfunctional, replaced 1980
151.510	1103M	6/12/78	6/12/78	0	No signal, fate unknown
151.520	1142F	6/9/78	9/18/78	3	Nonfunctional, not recovered
151.520	1104F	7/10/80	10/2/82	27+	Functional, on bear
151.533	1167F	9/18/79	6/13/82	33+	Functional, on bear
151.540	1099M	6/26/79	5/3/80	10	Nonfunctional, not recovered
151.549	1139F	6/7/78	5/3/80	23	Nonfunctional, not recovered
151.570	1082M	6/27/78	6/28/79	12+	Functional, replaced 1979
151.590	1096M	6/28/78	11/16/80	5	Nonfunctional, recovered
151.590	1081M	7/7/80	6/14/82	23+	Functional, on bear
151.610	1099M	6/27/78	5/9/79	11	Nonfunctional, recovered
151.620	1105F	6/28/78	6/23/79	12	Nonfunctional, recovered

[a] When a bear shed a radio collar, it was not always recovered immediately; therefore, the number of months represents the months the collar was functioning whether or not it was on a bear.

[b] When 1 collar was placed on more than 1 bear, the months functional for the additional bears reflects the total for all preceding bears.

Table 2. Reproductive history and litter size for female grizzlies in the western Brooks Range.[a]

Bear No.	Age[b] in 1982	Offspring No.	Reproductive history and litter size[c]						
			pre-1977	1977	1978	1979	1980	1981	1982
1085	23.5		PO	B	B	NB?	NB	UN	UN
1086	20.5	1087, 1164; 2UM	PO	2ylg	2 2yr	2 3yr/B	2cb	UN	UN
1087	6.5	None					NB	B	B
1089	9.5	2UM	NPO	NB	B	2cb	UN	UN	1cb?
1090	21.5	3UM	PO	3ylg	3 2yr	3 3yr/?B	UN	UN	UN
1092	13.5	1093	UN	1cb	1ylg	1 2yr	B	B	B
1095	11.5	None	NPO	?B	?B	UN	UN	UN	UN
1097	13.5	2UM	NPO	B	B	2cb/B	2cb/B	3cb	3ylg
1100	11.5	2UM	NPO	NB	B	2cb/B	B	UN	UN
1102	7.5	1180, 1181	NPO	NB	NB	B	2cb	B	1cb
1104	14.5	1101?, 1102?		2 2yr/B	1cb/B	1cb	1ylg	1 2yr/B	B
1105	12.5	1UM; 1173, 1174	NPO	B	B	1cb/B	2cb	2ylg	2 2yr
1106	14.5	1107, 1108, 1109		3cb	2ylg	2 2yr/dead			
1110	29.5	1160, 1161	PO	B	2cb	2ylg	2 2yr	2 3yr	UN
1111	19.5	1112, 1113; 3UM		2 4yr/B	B	3cb/B	UN	UN	UN
1118	22.5	2UM	PO	B	2cb	2ylg	UN	UN	UN
1119	11.5	None	PO	B	B	UN	UN	UN	UN
1121	16.5	1122, 1123		2cb	2ylg	2yr/B	2cb	UN	UN
1127	27.5	None	PO	B	UN	UN	UN	UN	UN
1128	12.5	1129; 3UM		1ylg/B	3cb	UN	UN	UN	UN
1130	26.5	2UM		2cb	1ylg	UN	UN	UN	UN
1134	19.5	1135, 1136, 1137		3ylg	2 2yr	2 3yr/B?	cb?/B?	B	3cb
1138	25.5	1151, 1152, 1153		2 2yr, 1ylg	2 3yr, 1 2yr	UN	UN	UN	UN
1139	15.5	1140, 1141		UN/B	2cb	2ylg	2 2yr/B	3cb?	3ylg?
1141	4.5	None						NB	B
1142	18.5			PO	B	UN	UN	UN	1 2yr?
1143	13.5	1144, 1UM		2cb	2ylg	2 2yr	UN	UN	UN
1146	18.5	1145, 1UM		1-2ylg	1 2yr	1 3yr/B	UN	UN	UN
1154	16.5	1155		1cb	1ylg	1 2yr	1 3yr/B	2cb	UN
1156	10.5	None			B	UN	UN	UN	UN
1158	11.5	None			B	UN	UN	UN	UN

Table 2. Continued.

Bear No.	Age[b] in 1982	Offspring No.	Reproductive history and litter size[c]						
			pre-1977	1977	1978	1979	1980	1981	1982
1166	12.5	3UM			NO	B?	B	3cb	1y1g
1167	13.5	1168			UN/B	1cb	B	B	B
1169	13.5	1170, 1171; 2UM			UN	B	2cb	B	2cb
1176	20.5	2UM					UN/B	2cb	1y1g
1178	15.5	1179; 2UM					1 2yr	1 3yr/B	2cb/B
UM		2UM		2cb	2y1g				
UM		3UM			3cb				
UM		2UM			2cb	2y1g			
UM		2UM			2cb	1-2y1g	1 2yr		
UM		2UM		2cb					
UM		1162, 1163		2y1g	2 2yr/?B				
UM		3UM		3y1g					
UM		2UM		2 2yr					
UM		3UM				3cb			
UM		2UM			2cb	2y1g	2 2yr		
UM		1UM				1cb			
UM		1UM							1cb
UM									3y1g

[a] Designations are as follows: PO, evidence of previous offspring; NPO, no evidence of previous offspring; UM, unmarked; UN, unobserved; B, bred during that season; NB, did not breed; cb, yrl, 2yr, 3yr, female accompanied by cub, yearling, 2-year-old, 3-year-old young; cb/B, cubs lost prior to breeding season, subsequent breeding by female; y1g/B, 2yr/B, etc., offspring weaned, then subsequent breeding by female.

[b] These ages were determined from cementum annuli during the year of capture, but the ages reported here include years subsequent to the bear's capture. However, in cases of bears known or presumed dead, the data listed represent their ages when last known to be alive.

[c] Litter sizes should be viewed as minimum since mortality to other offspring may have occurred prior to observation.

Table 3. Litter sizes for grizzly bears in the western Brooks Range, 1977-82.

Year	Age of offspring when first observed or captured				Total	Litter size
	Cubs/litters	Ylg/litters	2-yr/litters	3-yr/litters		
1977	15/8	16/7	2/1	2/1	35/17	2.06
1978	17/8	0	0	0	17/8	2.13
1979	15/8	2/1	0	0	17/9	1.89
1980	14/8	0	1/1	0	15/9	1.67
1981	15/6	0	4/3	0	15/6	2.50
1982	10/6	3/1	1/1	0	14/8	1.75
1977-82	86/44	21/9	4/3	2/1	113/57	
Mean litter size	1.95	2.33	1.3	2.0	1.98	

Table 4. Known mortality of offspring of grizzly bears in the western Brooks Range, 1977-81.

Adult female bear	No. of offspring in litter	No. of offspring lost	Age of offspring lost[a]	Last date young observed	1st date young observed missing	Comments
1086	2	2	cub	7/19/80	8/14/80	Entire family group not resighted
1097	2	2	cub	5/9/79	5/15/79	1097 observed breeding 6/7/79
1097	2	2	cub	5/3/80	6/18/80	1097 observed breeding 6/18/80
1100	2	2	cub	5/5/79	6/29/79	1100 observed breeding 6/29/79
1104	1	1	cub	5/28/78	6/8/78	Male 1099 25 yd away on 6/8; 1104 bred again in 1978
1105	1	1	cub	5/22/79	5/31/79	1105 observed breeding 5/31/79
1111	3	3	cub	5/5/79	7/11/79	1111 not resighted again
UM[a]	3	1	cub	8/11/78	9/12/78	Wolf seen harassing UM/3 cubs; UM/2 cubs later seen in same vicinity
1166	3	1	cub	6/4/81	6/5/81	
	2	1	cub	7/9/81	9/19/81	Female lost 1 cub earlier in summer
1178	2	2	cub	5/23/82	5/24/82	Male observed feeding on 1 cub; 1178 breeding by 6/7/82
1176	2	1	cub or ylg	9/19/81	5/25/82	
1102	2	2	cub or ylg	8/20/80	5/12/81	
1130	2	1	cub or ylg	6/30/77	8/2/78	
1167	1	1	cub or ylg	9/18/79	6/10/80	1167 observed breeding 6/22/80
1169	2	2	cub or ylg	7/18/80	5/7/81	
1106	3	1	ylg	4/20/78	5/20/78	Runt yearling found dead at den site
1134	3	1	ylg or 2yr	9/16/77	5/18/78	
1146	2	1	ylg or 2yr	7/21/77	6/6/78	
1106	2	2	2yr	10/10/78	5/4/79	1106 probably killed by male 1099; young not sighted again, presumed dead

[a] Designations are as follows: UM, unmarked female; cub, cub of the year; ylg, yearling; 2-yr, 2-year-old.

Table 5. Mortality rates for age classes of offspring accompanied by marked female grizzlies, 1977-81.

Age class	Young/litters in early spring	Young/litters in fall	Mortality rate of age class (%)
Cubs[a] (1st year)	59/31	33/19	44
Yearlings[a] (2nd year)	33/16	30/16	9
2-year-olds[b]	14/8	12/7	14

[a] When it was unknown whether a mortality occurred between age classes (i.e., between cub and yearling), it was assigned to the younger age class. This included 7 deaths of cubs or yearlings and 2 of yearlings or 2-year-olds.

[b] Of the 3 young accompanying female No. 1138 at capture, Nos. 1151 and 1152 were 2-year-olds and No. 1153 was a yearling. This "mixed" litter was presumably the result of an adoption by No. 1138, but which offspring were adopted is unknown. For purposes of this table, the 2 oldest were placed in the 2-year-old category, but the youngest was not included in the yearling cohort.

Table 6. Observed litter size and number of offspring in cub, yearling, 2-year-old, and 3-year-old age classes, 1977-82.

Age class	Litter size	No. of litters 1977	1978	1979	1980	1981	1982	Total litters	No. of offspring	$\bar{x}$ litter size
Cub	1	2	1	3	2	0	3	11	11	
	2	5	5	3	6	3	2	24	48	
	3	1	2	2	0	3	1	9	27	
No. offspring		15	17	15	14	15	10		86	1.95
Yearling	1	2	3	2	1	1	1	10	10	
	2	2	4	5	0	1	0	12	24	
	3	3	0	0	0	0	3	6	18	
No. offspring		15	11	12	1	3	10		52	1.86
2-year-old	1	0	1	2	2	1	1	7	7	
	2	2	3	3	3	0	1	12	24	
	3	0	1	0	0	0	0	1	3	
No. offspring		4	10	8	8	1	3		34	1.70
3-year-old	1	0	0	1	1	1	1	4	4	
	2	1	0	2	0	1	0	4	8	
	3	0	0	1	0	0	0	1	3	
No. offspring		2	0	8	1	3	1		15	1.70

APPENDIX A. Capture and marking characteristics of 101 bears in the western Brooks Range, 1977-82.

Bear No. and sex	Cem. age (yr)	Date of capture	Bear wt. (lb)	Location	Drug dosage[a]	Ear tags (left/right)	Marking[b]
1081M	5.5	5/24/77	175	Utukok R.	2.6/H	889/890	P/O
	7.5	9/17/79	430	N. Meat Mtn.	M/O	17827/17826	P/O
	8.5	7/7/80	380	Disappointment Cr.	2.8	504/503	1590 P/O
		8/15/80	400	Utukok R.	3.0/L	504/503	1590 P/O
1082M	13.5	5/25/77	370	Kokolik R.	2.0/O	892/893	O/G/O (removed)
		6/13/77	365	Kokolik R.	2.3/O	892/893	0948
		6/25/77	380	Kokolik R.	2.7/O	892/893	1077/1127
		8/10/77		Kokolik R.	2.7/L	892/893	1077/1127
	14.5	6/27/78	425	Kokolik R.	2.8/L	892/893	1580/1570 Bk 1640/1680
	15.5	6/28/79	480	Kokolik R.	M/O	313/312	1420/1007
	16.5	8/17/80	520	Kokolik R.	5.0/L	538/539	0998 dB/P
1083M	7.5	5/25/77	265	Utukok R.	2.0/O	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/O	894/895	0998 Bk
	9.5	6/30/79	355	Utukok R.	3.4/H	894/	1023
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) Bk/W
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	1102/1152
		8/8/77	265	Driftwood Cr.	1.9/O	205/206	1102/1152
	18.5	9/16/79	400[c]	N. Meat Mtn.	M/L	205/206	1074.5/1410
1087F	1.5	5/29/77	31	Meat Mtn.	0.13/O	207/208	/G
	3.5	6/30/79	170	Meat Mtn.	1.1/O	314/208	1480 Bk/
	4.5	7/7/80	205	Meat Mtn.	M/O	506/505	1440 lB/Bk
1088M	4.5	5/31/77	270	Eskimo Hill	2.0/O	210/209	0923
1089F	4.5	6/1/77	122	Adventure Cr.	M/O	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/O	227/226	0775
	11.5	8/19/80	320	Ilingnorak Ridge	4.0	549/548	1000 O/G
1093F	0.5	6/4/77	38	Ilingnorak Ridge	0.1/O	228/229	lB/
1094M	4.5	6/5/77	175	Meat Mtn.	2.0/H	225/230	lB/dB
1095F	6.5	6/5/77	200	N. Meat Mtn.	1.5/O	231/233	O/W
1096M	7.5	6/5/77	325	Meat Mtn.	2.6/O	236/237	0848
	8.5	6/28/78	395	Utukok R.	2.8/O	774/775	1596/1590 lB 1660/1700
	9.5	6/28/79		N. Meat Mtn.	M/H	774/775 & 893	/lB
	10.5	8/17/80	505	Meat Mtn.	4.2/L	536/537	0973 O/lB

APPENDIX A. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Bear wt. (lb)	Location	Drug dosage[a]	Ear tags (left/right)	Marking[b]
1097F	8.5	6/5/77	225	Meat Mtn.	1.8/O	235/234	0874
		6/19/77		Utukok R.	1.4/O	235/234	0874
	11.5	7/6/80	300	Utukok R.	1.8/O	510/511	1470 Pp/P
		8/16/80	270	Utukok R.	M/L	510/511	1470/1430 Pp/P
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/O	245/244	1023
	11.5	6/27/78	450[c]	Kokolik R.	2.8/O	773/772	1610/1560 1640/1680
	12.5	6/26/79	450	Utukok R.	3.0/O	773/772	1540
1100F	6.5	6/11/77	200	Meat Mtn.	2.4/O	247/246	0973
	7.5	6/9/78	240[c]	Utukok R.	2.5/H	247/246	0973P
	8.5	7/1/79	220	Driftwood Cr.	1.9/O	247/246	1098P
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/O	251/250	1470
	5.5	8/18/80	210	Kokolik R.	3.0	544/545	0750 W/G
1103M	8.5	6/12/77	320	Utukok R.	2.6/H	253/252	1002
	9.5	6/12/78		Utukok R.	M/H	253/252	1510
1104F	9.5	6/12/77	215	Utukok R.	1.6/O	255/254	0800
		6/17/77		Utukok R.	1.2/L	255/254	0800
	12.5	7/10/80	250	Nimwutik Cr.	1.5/L	517/518	1520 P/G
1105F	7.5	6/13/77	225	Kokolik R.	1.5/O	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
	10.5	7/10/80	260	Iligluruk Cr.	1.8/O	522/521	0972 W/O
1106F	11.5	6/14/77	210	Adventure Cr.	1.5/H	258/259	0724
1107F	0.5	6/14/77	7	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
	26.5	6/30/79	235	Ilingnorak Ridge	1.7/H	262/263	0725
1111F	14.5	6/18/77	240	Colville R.	1.7/O	269/268	0700
1112M	4.5	6/18/77	250	Colville R.	1.7/O	267/266	dB/G
1113F	4.5	6/18/77	150[c]	Colville R.	1.5/O	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/O	276/277	O/dB
1117M	19.5	6/23/77	315	Driftwood Cr.	M/O	279/278	Pp/W/Pp
1118F	17.5	6/23/77	185	Driftwood Cr.	1.3/H	281/280	W/Pp
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/O	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/O	/288	/G
1123F	0.5	6/25/77	27	Kokolik R.	0.12/O	289/	G/
1124M	17.5	6/26/77	360	Tupikchak Mtn.	2.6/O	291/290	dB/W/dB

APPENDIX A. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Bear wt. (lb)	Location	Drug dosage[a]	Ear tags (left/right)	Marking[b]
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/O	293/294	O/W/O
1127F	26.5	6/28/77	295	Kokolik R.	1.5/L	295/	P/W/P
1128F	7.5	6/30/77	240[c]	Tupikchak Mtn.	1.8/O	297/296	P/P/P
1129F	1.5	6/30/77	90	Tupikchak Mtn.	0.5/O	299/298	P/P
1130F	21.5	6/30/77	255	Elbow Cr.	1.9/O	300/900	O/O/O
1131M	8.5	7/1/77	235	Driftwood Cr.	2.5/H	3085/3086	G/O
1132F	2.5	7/2/77	67	Archimedes Ridge		1498/3082	1B/P
1133M	2.5	7/2/77	80	Archimedes Ridge		3088/1499	P/1B
	3.5	6/27/79	150	Utukok R.	1.4/O	310/309	P/1B
1134F	14.5[c]	7/5/77	230[c]	Utukok R.	2.0/L	3089/3090	0947 O
	17.5[c]	7/12/80	285	Utukok R.	2.8/H	526/527?	0943 Bk/G
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/O	None	0898 O
	24.5	6/16/78	265	Kantangnak Cr.	M/L	759/758	dB/dB/dB
1139F	11.5	6/7/78	200[c]	Utukok R.	1.3/O	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/
	2.5	7/13/80	165	Utukok R.	2.1	532/533	1490 W/O
1142F	14.5	6/9/78	250[c]	Utukok R.	M/H	658/657	1520 Bk
1143F	9.5	6/9/78	210[c]	Utukok R.	1.8/H	704/705	1B/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 1B/G
1146F	14.5	6/10/78	230[c]	Elbow Cr.	2.5/H	721/722	G/1B
1147M	3.5	6/10/78	205	Utukok R.	1.3/O	723/724	P/G
	5.5	7/10/80	305	Tupikchak Cr.	2.8/H	516/515	P/dB
1148M	6.5	6/10/78	205	Utukok R.	1.3/O	725/728	dB/W
1149F	4.5	6/11/78	180	Utukok R.	1.3/O	736/733	W/dB
1150M	5.5	6/16/78	185	Utukok R.	1.2/O	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	2.5	6/16/78	70	Kantangnak Cr.		756/757	Bk/O
1154F	12.5	6/21/78	220	Tupik Cr.	1.8/O	760/761	W/O/W
1155M	1.5	6/21/78	75	Tupik Cr.	0.50/O	763/762	G/W
1156F	6.5	6/21/78	205	Kogruk Cr.	2.0/O	765/764	P/Bk
1157M	5.5	6/24/78	210	Driftwood Cr.	M/H	766/767	P/G/P
	6.5	6/30/79	275	Driftwood Cr.	2.4/H	766/767	Bk/P
1158F	7.5	6/24/78	180	Elbow Cr.	1.4/O	769/768	P/W
1159M	10.5	6/24/78	295	Driftwood Cr.	1.7/O	770/771	G/P
	12.5	8/16/80		Utukok R.	M/L	535/534	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/O	304/305	1490 1B/Bk
1163M	2.5	7/3/78	92	Iligluruk Cr.	M/H	306/307	1440 Bk/1B

APPENDIX A. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Bear wt. (lb)	Location	Drug dosage[a]	Ear tags (left/right)	Marking[b]
1164M	3.5	5/7/79	185	Meat Mtn.	1.3/O	308/311	1498 G/Bk
	4.5	7/6/80	270	Meat Mtn.	1.9/O	512/311	1450 Bk/G
1165M	3.5	9/17/79	200[c]	N. Meat Mtn.	M/H	318/319	G/dB
1166F	10.5	9/18/79	390	N. Meat Mtn.	M/L	284/317	0898 dB/O
	11.5	7/7/80	265	Utukok R.	2.1/H	502/317	0772 lB/O
1167F	7.5	9/18/79	235	N. Meat Mtn.	2.8/H	271/315	1533 O/dB
1168F	0.5	9/18/79	55	N. Meat Mtn.	0.60/O	274/296	None
1169F	11.5	7/5/80	290	Kokolik R.	2.2/L	513/514	1073 Bk/dB
1170F	0.5	7/5/80	34	Kokolik R.	0.10	114/112	dB/
1171M	0.5	7/5/80	32	Kokolik R.	0.10	115/113	Bk/
1172M	11.5	7/6/80	360	Utukok R.	3.2/H	509/508	W/lB
1173M	0.5	7/10/80	32	Kokolik R.	0.14	525/101	/O
1174F	0.5	7/10/80	28	Kokolik R.	0.14	501/507	O/
1175M	7.5	7/12/80	400	Iligluruk Cr.	2.6	528/529	lB/lB
1176F	18.5	7/13/80	345	Utukok R.	2.0/O	531/530	0080 G/G
1177F	1.5	7/13/80	91	Nimwutik Cr.	0.38/L	520/519	G/G
1178F	13.5	8/18/80	250	Utukok R.	3.0	540/541	0898 lB/Bk
1179F	2.5	8/18/80	135	Utukok R.	1.4/L	542/543	lB/O
1180F	0.5	8/18/80	31	Kokolik R.	0.30/L	/547	/lB
1181F	0.5	8/18/80	34	Kokolik R.	0.40/O	546/	lB/

[a] Dosage in cc of phencyclidine hydrochloride/acepromazine maleate; M denotes multiple injections with unknown effective dosage. Drug effects were as follows: L = light, O = optimum, H = heavy.

[b] Marker designations:
Colors: P, pink; W, white; G, light green; O, orange; dB, dark blue; lB, light blue; Bk, black; Pp, purple.
Marker types:
One or 2 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 2 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 MHz; some radio collars were also marked with a flag and some transmitted more than 1 frequency.

[c] Estimate after close examination.