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POPULATION STRUCTURE, REPRODUCTIVE BIOLOGY, AND MOVEMENT PATTERNS OF GRIZZLY BEARS IN THE NORTHCENTRAL ALASKA RANGE

By

Harry V. Reynolds
and
John L. Hechtel

Final Report
Federal Aid in Wildlife Restoration

Projects W-21-2, W-22-2, W-22-3, and W-22-4, Job 4.16R

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FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: U.S. Army 172D Infantry Brigade, Ft. Wainwright, Alaska: 222nd Aviation Battalion, Natural Resources Office of the Facilities Engineers, and VETACT

Project No.: W-21-2, W-22-1, W-22-2, W-22-3, W-22-4 Project Title: Big Game Investigations

Job No.: 4.16R Job Title: Population Structure, Reproductive Biology, and Movement Patterns of Grizzly Bears in the Northcentral Alaska Range

Period Covered: 1 July 1981-30 June 1985

SUMMARY

In 1981 a study was begun to determine the status and reproductive biology of a grizzly bear (Ursus arctos) population in the northcentral Alaska Range. During the years 1981-85, 66 bears (33 males, 33 females) were captured; 54 of these bears were radio-collared. Currently, 21 bears are radio-collared (7 males, 14 females). The estimated population declined from 97-107 in 1982 to 79-89 in 1985. Minimum estimated population density for the study area in 1985 was 1.64 bears/100 km^2. Analysis of the structure of the population showed that few mature males were present, possibly as the result of hunting pressure, and that by 1985 both male and female numbers had declined. In addition, there were fewer females in the 3- to 5-year-old age class. Evidence suggests that females have a potentially long reproductive life span; at age 7 years some produce their 1st surviving litter and 1 25.5-year-old female bred again after weaning her 2.5-year-old offspring. Based on 24 litters of both cub and yearling age classes, mean litter size was 2.00. Minimum reproductive interval was 4.1 years and the production success rate was 73%.

During the years 1981-85, 65 mortalities were recorded in the study area: 34 hunter kills, 2 illegal kills, 1 "defense of life or property" kill, 7 capture-related deaths, 19 offspring

which were presumed dead, and 2 adult natural mortalities. Based on the present harvest rate, the reduced number of adult females in the population, and the few females in the 3- to 5-year-old age classes, we feel the population will continue to decline. Movements ranging from 44 to 78 km were recorded for 4 3.5-year-old males. Eleven other bears 2-4 years of age (8 males, 3 females) remained within their maternal home ranges.

Key words: grizzly bear, harvest rates, home ranges, Interior Alaska, mortality, movement, population biology, Ursus arctos.

CONTENTS

BACKGROUND

As problems concerning the management of Alaska's wildlife become more complex, there is a growing need for specific biological information on wild species. Human populations are rapidly increasing in Alaska; consequently, user demands on wildlife (including hunting) are increasing. Concurrently, the amount of public land available for wildlife habitat and accessible to wildlife consumers has declined due to resource development and changes in land status resulting from Alaskan lands legislation. Grizzly bears (Ursus arctos) are among the large mammals that are the most susceptible to these changes because of their requirements for large home ranges and their low reproductive potential.

Few research studies have addressed aspects of grizzly bear biology necessary to solve problems of increased exploitation and loss of habitat. Specifically, no population dynamics data are available for Interior Alaska north of the Alaska Range

except for 2 studies in Denali National Park (Dean 1976, Valkenburg 1976). Elsewhere in Alaska, baseline biological information has been determined for brown/grizzly bear populations on the south side of the Alaska Range (Ballard et al. 1982; Miller and Ballard 1982; Miller 1983, 1984), on the Alaska Peninsula (Lentfer et al. 1969, Glenn et al. 1976), and in the Brooks Range (Crook 1971, unpubl. data; Reynolds 1976, 1978, 1981). However, there is no evidence that data from these areas are applicable to the northcentral Alaska Range.

Assessment of the impacts of changes in user pressure or changes in availability of habitat requires knowledge of bear population status. Management decisions have been based on trends in the number, sex, and age of bears harvested and general estimations of the status of grizzly populations. Use of these data as a basis for past management for regulating harvest rates has been adequate in many cases, but more detailed information is needed as management becomes more intensive. Management strategies for any area must take into consideration the relative numbers of, and relationships among, wildlife species. Management goals for grizzly bears may require increasing, decreasing, or maintaining populations to reach densities that are compatible with desired population levels of ungulates.

Although annual harvest rates of 2-4% of the grizzly population have been proposed for areas of similar habitat in Canada (Lortie, unpubl. data), and rates of 2-3% have been used as a basis for harvest in the Brooks Range (Reynolds 1976), additional information is necessary before appropriate harvest rates can be estimated for the Alaska Range. The following baseline information, including the degree of natural variability, must be known to accurately predict the response of a population to human-caused mortality: population density and structure; movement and home range patterns; mortality rates for age classes; and reproductive potential including age at 1st breeding, litter size, and interval between litters (Craighead et al. 1974, Reynolds 1978, Bunnell and Tait 1980).

OBJECTIVES

The general objective for this study was to describe baseline grizzly bear population biology in the study area. Specific objectives were:

1. To determine the size, density, and sex and age structure of the grizzly bear population.

2. To determine measures of reproductive biology, including the age at 1st production of young, reproductive interval, and mean litter size.

3. To determine natural mortality rates for sex and age classes within the population.

4. To determine harvest rates for sex and age classes within the population.

5. To determine movement patterns and home range sizes for grizzly bears of various sex and age classes within the population.

STUDY AREA

The 3,900-km² (1,500-mi²) study area is located in the mountains and foothills of the northcentral Alaska Range (Fig. 1) and is included within Game Management Subunit 20A. The boundaries are the Gold King Creek drainage and the Wood River drainage downstream from Virginia Creek to the west, the crest of the Alaska Range to the south, the Delta Creek drainage to the east, and the southern edge of the Tanana Flats (approx. 64° north latitude) to the north. The study area includes portions of 2 U.S. Army reservations, Ft. Wainwright and Ft. Greely.

Elevations in the area range from 500 to 3,700 m (1,600 to 12,000 ft). Most rivers flow through U-shaped, glacially formed valleys and are fed by active glaciers. Treeline occurs at approximately 900 m (3,000 ft). Dense patches of willow (Salix spp.) or alder (Alnus crispa), which bears use for cover, may be present up to approximately 1,200 m (4,000 ft).

METHODS

A long-term investigation of the effects of different harvest rates on a grizzly bear population was begun in 1981 (Reynolds 1982, Reynolds and Hechtel 1983, 1984, 1985). A study area in the northcentral Alaska Range was chosen as being representative of typical Interior Alaska grizzly bear habitat with a moderate population density. Prior to the onset of this study, management biologists felt that the kill of grizzly bears in this area was not excessive, based on trends of average annual harvest size, mean age of bears taken, and the proportion of males in the harvest (Hinman 1980). The emphasis of Phase I (1981-85) was to gather baseline information on population dynamics of northcentral Alaska Range grizzly bears. Most data necessary for initial baseline description and population modeling were collected during 1981-85, but will be supplemented by information gathered in future years. Harvest levels during the years 1965-78 were generally low at 3-5%. Beginning in 1979, harvest increased to approximately 9%. In Phase II of the study, scheduled to start in 1986, annual harvest rates

will be maintained at approximately 8-15% through manipulation of seasons and by directing public hunting effort through use of the news media. Changes in population size and productivity will be monitored and analyzed to determine the effects of increased harvest on population size and reproductive parameters and to determine if population compensatory mechanisms occur as harvest level is increased.

Bears were captured from helicopters using immobilizing drugs Sernylan (phencyclidine hydrochloride, Bio-Centic Laboratories, St. Joseph, Mo.) or M99 (etorphine hydrochloride, D-M Pharmaceuticals, Inc., Rockville, Md.) administered by dart guns. Acepromazine maleate was used as a tranquilizer in conjunction with Sernylan injections. All bears captured were marked with individually coded ear flags visible from the air, and selected bears were fitted with radio collars (Telonics, Mesa, Ariz.). Most relocations of bears were observed from aircraft either by radio-tracking bears fitted with transmitters or by locating bears through visual searches. Relocations were used to construct minimum home range polygons, a standard method used in other grizzly bear studies (Craighead and Craighead 1972). Measurements and weights were recorded for each captured bear (Appendix A). Blood samples were collected from most bears; in cooperation with University of Alaska graduate student R. Brannon, some of these samples were used to assess the relationships between blood characteristics, capture stress, and body condition (Brannon 1983, 1985a, b).

Age structure, age at 1st production of cubs, mean litter size, and reproductive interval were used as indicators of population productive potential. Ages were determined by examination of cementum annuli of premolar teeth (Mundy and Fuller 1964, Stoneburg and Jonkel 1966, Craighead et al. 1970). In our discussions of age classes, we define "offspring" as cub, yearling, and 2-year-old cohorts; "young-age" is 3- to 5-year-olds; and "adults," all cohorts 6 years of age and older. Reproductive status was determined from (1) the size, coloration, and lactating condition of mammae; (2) observations of male-female pairing; and (3) the number and age of offspring observed in family groups (Reynolds, in press).

RESULTS AND DISCUSSION

Bears Captured and Radio-collared

In the study area, 66 individual bears were captured: 5 in 1981, 30 in 1982, 21 in 1983, 2 in 1984, and 8 in 1985 (Table 1). In addition, 32 bears were recaptured to replace radio collars: 2 in 1983, 18 in 1984, and 12 in 1985 (Appendix B). Radio collars were placed on 54 bears; 16 on young-age

males (≤5.5 years), 11 on adult males (≥6.5 years), 10 on young-age females, and 17 on adult females. By fall 1985, 21 bears still carried functioning radio collars; 10 bears had shed collars; 17 bears had died; and 6 bears could not be located, presumably because of long-range movements or collar failure (Appendix C).

Population Size and Density

Population density, a measure of the number of bears in the area, was calculated for both minimum and probable values during the years 1982-85. As the study continues, these estimated values will converge as unmarked resident breeding adults associating with radio-collared bears are captured, and as monitoring of young-age bears born and weaned in the study area improves our understanding of dispersal and mortality rates.

The minimum spring 1982 population of the study area was 82 grizzly bears, a density of 2.10 bears/100 km² (5.47/100 mi²). These bears included the 63 marked individuals which were alive in early May 1982 and 19 unmarked individuals which were either observed during 1982-85 capture operations or later killed by hunters. Similar calculations of minimum spring grizzly bear numbers and population density were made for 1983-85. In 1983, at least 74 bears were present in the study area, a density of 1.90 bears/100 km² (4.93/100 mi²); for 1984, a minimum of 77 were present for a density of 1.97 bears/100 km² (5.13/100 mi²). For 1985, a minimum of 64 were present for a density of 1.64 bears/100 km² (4.27/100 mi²). Differences between the 1982 and 1985 estimated minimum population sizes indicate a decline of 18 bears from the 1982 population.

These minimum densities are underestimates because they do not include bears that were not observed during the study or killed by hunters. Based on the home range size and distribution of marked bears living in major drainages of the area and the fact that vegetative cover and rugged terrain can allow resident bears to escape capture for several years, the available habitat likely supports an additional 15-25 bears. Therefore, the probable 1985 bear population in the area is approximately 79-89, a decline from the 1982 probable population of 97-107. These estimates are similar to the density estimate of 2.44 bears/100 km² (6.3/100 mi²) reported south of the Alaska Range in the upper Susitna River (Miller and Ballard 1982).

The accuracy of the population estimate depends on the proportion of the population that is marked. One indication of the success of the capture efforts is the percentage of marked animals in the harvest. From 1982 through 1985, 22 bears were reported killed by hunters; eleven of these were marked. Two of the marked bears were killed in 1982, 0 in 1983, 7 in 1984,

and 2 in 1985. Sample sizes are small and variable, but it appears that more than half the bears in the study area have been marked. Additional intensive capture effort and harvest data are needed to test this assumption.

Another indicator of the accuracy of a population estimate is a comparison of the known number of young-aged bears (3-5 years of age) in the population (those killed by hunters, captured, or observed), with the known and extrapolated production of weaned offspring by adult females in the area. Assuming that the number of adult females in the population has ranged from 18 to 20 (Table 2); that these females weaned 2- or 3-year-old offspring in the proportions observed during 1982-85 (see Litter Size discussion); and that reproductive intervals were similar to those observed/projected for 1982-85 (see Table 5 and Reproductive Interval discussion), then an estimated 52 2- or 3-year-olds were weaned during 1980-85. During the same period, 49 2- or 3-year-olds were accounted for as present in the population, emigrants, or mortalities. The similarity between theoretical productivity and observed numbers of young-age bears in the population lends credence to our estimates of population size.

There are some obvious biases with this treatment of the data; it assumes that: (1) all adult females were located and that there were no mortalities which were not observed or accounted for through harvest records; (2) emigration by young-age 3- to 5-year-old bears from the area equals immigration into the area; and (3) there are low mortality rates for young-age bears.

In assessing the effects of these biases, we concluded that our estimate of adult females for 1980-81 was 2-4 bears fewer than were actually present (Table 2). Emigration by young bears was probably similar to immigration, based on similarity of habitat in contiguous areas. Moreover, if greater numbers of young-age bears emigrated than immigrated, then there would have been even fewer young-age bears present than were actually accounted for because hunter access and hunting pressure are greater outside the study area. In addition, we speculate that assumption (3) above is not correct and that mortality rates for recently weaned bears are probably higher than those for most other age classes, as reported by Craighead et al. (1974). This means that for our calculations of estimated population size to be reasonable, more 2- to 3-year-olds, and therefore more productive females, must have been present. However, based on capture and hunting kill records, it is not likely that many of these have survived to 1985. Although the population size in 1980-81 may have been higher than our estimates, the population size estimates calculated since 1981 are likely to be more accurate.

Both minimum and probable population size estimates indicate that the population declined between 1982 and 1985: minimum population size dropped from 82 in 1982 to 64 in 1985 and probable population size dropped from 97-107 in 1982 to 79-89 in 1985. The decline is due to at least 2 factors: the complete loss of the 1983 cub cohort when only 1 cub (which did not survive) was produced; and the increased harvest of adult females during the 1981-85 period, which in turn has resulted in lower production of young (Table 2). Loss of the 1983 cub cohort may have been due to a berry crop failure such as that which occurred in Southcentral Alaska during 1981 (Miller 1983, Schwartz et al. 1983), or to a combination of unseasonably alternating warm and cold conditions with little snow during winter 1982-83. Harvest rates for both young-age (3- to 5-year-olds) and mature (≥6 years old) female grizzly bears have increased. For the 10 years from 1971 through 1980, 8 young-age and 3 mature females appeared in the harvest; for the 5 years from 1981 through 1985, 11 young-age and 11 mature female bears were taken (2 were capture-related deaths). One initial outgrowth of this heavier mortality is that fewer bears are present in the young-age classes which eventually serve to replace mortalities which occur in productive age classes.

Biases in the data and small sample sizes precluded our use of standard techniques such as the Petersen/Lincoln Index to estimate population size. The population is not closed; variation in rates of births, deaths, ingress, and egress is still under study. Future data from radio-collared animals will indicate the extent to which these factors are influencing the population. Also, calculations of a Petersen/Lincoln Index require equal probability of taking marked and unmarked bears, an assumption that cannot be made (see Mortality section). A capture/recapture technique modified to account for lack of closure has recently been developed for bears in Southcentral Alaska (Miller and Ballard, pers. commun.). This technique may be applied to our Alaska Range study area in 1986.

Population Structure

Of the 75 bears captured in the course of the study or killed by hunters during 1981-85, 48% were males and 52% were females. The 36 males included 14 offspring of marked females (0.5-2.5 years of age), 8 young-age bears (3.5-5.5 years), and 14 adults (≥6.5 years of age). The 39 females included 7 offspring, 12 young-age, and 20 adults. This sex and age structure is likely representative of the population at the beginning of the study. As reported in other studies (Miller 1984), we found an apparent bias against capture of females with cubs of the year, but this bias is minimized as the study continues because breeding females (which subsequently have cubs) are captured, and those that do have cubs but are missed at the study's onset are more readily captured in subsequent years when accompanied by yearlings or 2-year-olds.

A comparison of the sex and age structure of hunter-killed bears (Fig. 2) with that of captured bears (Fig. 3) illustrates that males are more heavily harvested in the study area. The sex ratio of bears killed by hunters in the study area since 1979 is 67 males:33 females. This difference is expected because males have larger home ranges and travel more widely than females (see Movement section) and thus are more likely to encounter hunters (Bunnell and Tait 1980). In addition, because regulations prohibit taking cubs (including yearlings) or females accompanied by cubs, productive females are less vulnerable to hunters. During 1981-85, for those adult females whose reproductive status was known, only 24% were vulnerable to hunters during spring hunting seasons; 54% were vulnerable during fall. All adult males were vulnerable during both seasons.

If we assume that the 75 bears killed or captured on the study area provide an accurate representation of sex and age structure in 1982 (Fig. 4), then 3 patterns are evident. More males than females are present in the cub to 2.5-year-old cohorts. However, more females than males are present in both the 3- to 5-year-old age class and the $\geq$6-year-old age class. These patterns are primarily due to hunting; since 1979, hunter harvest accounted for 23 males and 11 females in the 1- to 5-year-old class and 17 males and 8 females for bears $\geq$6 years old. In addition, few bears of either sex survive beyond age 16, primarily due to harvest by hunters.

Although offspring observed as cubs had an even sex ratio, 3 males:3 females:1 unknown sex, we rarely attempted to capture cubs, and as a result our sample size was low and likely biased, especially when compared with sex ratios of older cohorts. Yearlings had a sex ratio of 10 males:6 females:2 unknown sex; 2-year-olds, 9 males:4 females:1 unknown sex; and 3-year-olds, 6 males:3 females. Of those 2- and 3-year-olds which were observed at weaning, 11 were males and 5 were females. Although it is possible that this bias is the result of lower survival rates of females in litters, it appears more likely to be a function of initial production. Of 13 litters, 5 were all male, 2 were all female, 4 were a mixture of both sexes, and 2 were composed of a male and a female with an unknown-sex litter mate. Similar patterns favoring males have been recorded in Yellowstone National Park; Craighead et al. (1974) found 57% of 74 cubs captured during 1959-70 were males, and Knight and Eberhardt (1985) reported that 67% of 24 cubs captured during 1974-82 were males.

By 1985, population size had declined; age structure (Fig. 5) showed the same basic patterns as in 1982. However, there were fewer females present, primarily because of hunting mortality in the population, and there were more males than females present in the 3- to 5-year-old age class. A major change from

the 1982 structure is that the 2-year-old cohort is missing, a result of the cub cohort failure in 1983.

Reproductive Biology

Age at 1st Production of Young:

The age at which females first produce cubs in this area ranged from 6.5 to 7.5 years, but the age at which females produce cubs which are successfully reared may be 7.5-8.5 years (Table 3). None of 8 females aged 4.5-5.5 were observed with cubs or showed evidence of suckling, although 6 had been observed consorting with males. Of 5 females 6.5 years old, 2 produced cubs which did not survive, 2 bred and produced surviving cubs as 7.5-year-olds, and 1 did not breed.

The age at which females in the study area produce their 1st litter is greater than that observed in southern Alaska, but less than that observed in northern Alaska. Females produce 1st litters between 4.5 and 7.5 years of age in the Nelchina Basin (Miller and McAllister 1982), Kodiak Island (Hensel et al. 1969), and the Alaska Peninsula (Glenn et al. 1976). The bear populations in these areas are highly productive. On the other extreme, in the eastern Brooks Range, age at birth of 1st litter ranged from 6.5 to 12.5 years ($\bar{x}$ = 10.1) (Reynolds 1976) and in the western Brooks Range, 5.5 to 11.5 years ($\bar{x}$ = 8.0) (Reynolds and Hechtel 1982; Reynolds, in press).

Pearson (1975, 1976) concluded that females in southwestern Yukon Territory are first capable of conception at age 6.5, but in the northern part of the province the age at 1st conception was 7.5 years. In Yellowstone National Park, Craighead et al. (1969, 1976) observed that some 3.5-year-old females copulated, but none were accompanied by cubs the following spring, and that females first bred successfully at 4.5-8.5 years.

Maximum Productive Age:

All 16 females older than 10 years of age were accompanied by offspring, or were in breeding condition and showed evidence of previous offspring. The maximum ages at which females were observed with cubs were 18.5, 19.5, 20.5, and 23.5 years. This suggests that females continue to breed and rear young until death.

Reproductive Interval:

"Reproductive interval," or "reproductive cycle," is the period between weaning of 1 litter by an adult female and the successful rearing and weaning of her subsequent litter. For females producing cubs for the 1st time, intervals begin at the 1st

breeding which results in offspring. Years in which a female breeds but fails to conceive or loses her litter are included in a reproductive interval. Therefore, observations of the length of time offspring accompany females before weaning should be viewed as minimum values of reproductive intervals since females may not always produce young subsequent to breeding efforts following weaning (Craighead et al. 1969, 1976; Reynolds 1974, 1976, 1980, in press; Glenn et al. 1976; Reynolds and Hechtel 1982). This definition differs from that used by others. Craighead et al. (1976) defines a cycle as the interval from pregnancy to pregnancy. Craighead's analysis was based on the most complete data set yet available for grizzly bears in which a population of over 200 bears was studied over a 12-year period; other studies have used the results of this analysis as the basis for their calculations. Bunnell and Tait (1981) use the terms "birth interval" and "breeding interval" interchangeably; Knight and Eberhardt (1985) define reproductive cycle as the interval between births.

Variations in definition may result in more than semantical differences in the results of data analysis. Definitions used by Craighead et al. (1976) were based on a relatively productive population in Yellowstone Park during 1959-70, when mortality of whole litters in the park was rare. In such populations, application of definitions using pregnancy, birth, or weaning as beginning and ending points of cycles would yield similar results. In this Alaska population, however, because many litters die prior to weaning, only a definition using weaning as the standard measure is useful.

For example, using our definition, a female that weaned her offspring and bred in the 1st season, produced cubs but lost them during the subsequent season, again produced cubs but lost them the following season, and then finally produced offspring and weaned them as 2-year-olds, would have a reproductive interval of 5 years. Using the other definitions would result in intervals of 1 year, 1 year, and 3 years, with a mean cycle length of 1.7 years.

In the study area, offspring were weaned as 2-year-olds (n = 2 litters) or 3-year-olds (n = 5 litters). Mean minimum reproductive interval, however, was 4.1 years (n = 17), based on those cycles which were observed plus those which were projected by assuming weaning of offspring as 2-year-olds (Table 4). Alternately, if we project minimum cycle length based upon observed proportions of those litters weaned as 2- and 3-year-olds, then a mean reproductive interval of 4.6 years results. All 5 intervals greater than 4 years resulted from interruption of the breeding cycle due to mortality of litters or to breeding which did not produce cubs the following year.

Production Success:

Production success rate, or the proportion of breeding activity by adult females which results in the production of cubs, was 73%. This rate was based on the outcome of 15 observations of breeding activity by 10 individual females ≥6 years of age between 1982 and 1985. In addition, 1 female bred both as a 4- and 5-year-old, producing young as a 6-year-old; another 5-year-old bred without producing cubs. Production success could depend on weather conditions, food availability, or other unknown factors either in the year that breeding occurs or during the winter/spring following breeding. Only 1 of 3 females observed breeding in 1982 produced cubs in 1983. In addition, there were at least 3 other females that were later either captured or killed in the study area, and that may have bred in 1982 but were not accompanied by surviving offspring in spring 1983. In comparison, 6 of 8 females that bred in 1983 produced young in 1984, and all 5 that bred in 1984 produced cubs in 1985.

Litter Size:

Mean litter size was 2.07 for 15 litters first observed as cubs and 1.89 for 9 litters first observed as yearlings. When we combine litters first seen as cubs or yearlings, the mean litter size was 2.00. Mean cub litter size is small, especially compared with an average litter size of 2.3 found in the Nelchina Basin (Miller and McAllister 1982); however, mean yearling litter size was only 1.6 for the Nelchina Basin.

The number of females producing cubs varied from year to year: during 1981, 5 females produced a minimum of 9 cubs; in 1982, 6 females produced 11 cubs; in 1983, 1 female produced 1 cub; in 1984, 6 females produced 14 cubs; and in 1985, 5 females produced 11 cubs (Table 5). Poor cub production in 1983 may have been due to failure of berry crops in 1982 (Miller 1984) or to the weather patterns of winter 1982-83, in which little snow fell and temperatures fluctuated widely.

Although the difference in mean litter size between cub and yearling age classes is small in our study, this is not indicative of high survival rates, but of mortality of entire litters. Similar patterns of loss of cub litters have been recorded in northwestern Alaska (Reynolds, in press).

The mean size of 7 litters weaned as 2- or 3-year-olds was 1.86. The annual number of adult females in the population since 1982 has ranged from 18 to 20 (Tables 2 and 3) and the observed annual numbers of cub litters were 7, 1, 6, and 5 during 1982-85, respectively. The observed annual numbers of weaned litters, however, have only been 1-2, 0-1, 4, and 2.

This pattern also reflects mortality of entire litters, mostly in cub or yearling age classes.

Mortality

During 1981-85, at least 65 bears died in the study area: 14 in 1981, 11 in 1982, 11 in 1983, 18 in 1984, and 11 in 1985. These mortalities included 34 hunter kills, 2 illegal kills, 1 defense of life or property kill, 7 capture-related mortalities, 2 natural mortalities for which carcasses were found, and 19 offspring which were missing from family groups and presumed dead (Table 6). During 1985, mortality included only 1 hunter kill, 1 illegal kill, 1 capture mortality, and 8 missing offspring which were presumed dead.

The causes of mortality for cubs, yearlings, and 2-year-olds which disappeared while accompanying their mothers could not be determined. Cannibalism by adult males was suspected as the major cause and has been documented in Alaska in the Brooks Range (Reynolds 1976, 1980, in press; Reynolds and Hechtel 1982), south of the Alaska Range (Troyer and Hensel 1962, Glenn et al. 1976, Miller 1984), and in Canada (Mundy and Flook 1973; Pearson 1975, 1976). Natural mortality rates (i.e., excluding those caused by humans) for offspring under maternal care were 44% for cubs (n = 25), 12% for yearlings (n = 24), and 8% for 2-year-olds (n = 12).

Annual mortality rates for 26 radio-collared females, aged 2 to 25 years, that were monitored for at least one year, were 10% due to sport hunting, 4% from causes other than man, and 2% due to capture-related mortalities. Only 2 of the deaths were not man-caused: 1 female was killed and eaten by an adult male, presumably as a result of defense of her single 2-year-old, and the other was found dead in her den.

Sport hunting is a major source of mortality in this population. Annual harvest has ranged from 1 to 14 during the years 1961-80 (Table 7). Prior to 1981 the mean annual take was 5.0. If the population remained relatively stable during the 1961-80 period and if future research confirms a density estimate of 2.5 bears/100 km^2 (6.5/100 mi^2), the average annual harvest rate has been approximately 4.8-5.3% of the population with a range of 0.9-14.4%.

Harvest rates can be estimated using a variety of methods when a proportion of the population is marked. Three estimates of harvest rates were calculated using the 1984 data, because by then approximately 45-50% of the probable total population was marked and hunting harvest was large enough to illustrate differences depending on the calculation method. During 1984, hunters killed 7 marked and 3 unmarked bears in the study area.

The harvest rate, based on a total kill of 10 animals from an estimated probable population of 92-102 bears, is 10-11%. In 1984 a maximum of 46 marked bears were present in the study area. The minimum harvest rate, based on the total number of marked bears, is therefore 7 of 46 or 15%; however, because females with cubs or yearlings are protected from hunting by regulation and are not available for harvest, the harvest rate based on the available number of marked bears was 7 of 40 or 18%.

The harvest rate estimates have a number of limitations and biases. The rate, based on the estimated population, is contingent on the accuracy of the population estimate; biases of the population estimate were previously discussed. Because sample sizes are small and hunter numbers, distribution, and effort can vary widely from year to year, small changes in numbers of marked bears killed could result in large changes in the estimated rate of harvest. The harvest rate for marked bears is not necessarily representative of the population unless there is an equal probability of a hunter killing a marked or an unmarked bear. Factors that could influence harvest rates of marked bears are: (1) some hunters have reported a reluctance to shoot marked bears; (2) marked bears may either be more vulnerable to hunters due to habituation to aircraft used to monitor their movements, or less vulnerable due to increased wariness resulting from capture and handling; and (3) marked bears might be more visible. The harvest rates for marked bears are minimums because marked bears of unknown status were counted as alive, in the study area, and available. In addition, the number of bears counted as available is a maximum figure because it also includes females and their 2-year-olds which may legally be taken, but which in practice are often passed up by hunters unable to differentiate between yearlings and 2-year-olds or reluctant to shoot females with offspring.

More than a simple calculation of harvest rate is necessary to evaluate the effects of harvest or to correlate harvest rates with population trend. Both Craighead et al. (1974) and Knight and Eberhardt (1985) emphasize that the number of productive females within a population is the most important factor in the rate of growth or decline in grizzly bear populations. Our data also indicate the importance of adult females to population dynamics. Since 1982, the harvest has resulted in annual declines in the numbers of adult females during 3 of 4 years and a net change from 20 females in 1982 to a projected total of 17 in 1986 (Table 2). Similarly, the number of females in the 3- to 5-year-old age class, which act as replacements when adults die, has declined from 10 in 1982 to 5 in 1985. At the same time, the population within the study area has declined from an estimated 97-107 in 1982 to 79-89 in 1985, and this

trend is expected to continue. And, although compensatory changes in production or survival rates may occur in reduced populations as suggested by Stringham (1983) and McCullough (1981), such mechanisms have yet to be documented. No compensatory mechanisms are evident at the present level of exploitation on the study area.

Although these biases undoubtedly affect the validity of harvest rate estimates, their impact may be reduced through collection of additional data and by directing research to address these problems. Before a sustained harvest rate can be calculated, more conclusive data on sex- and age-specific mortality, population structure, productivity, and survival must be gathered (Bunnell and Tait 1980, 1981).

Hunting season timing and the degree of overlap of open seasons for grizzlies with those for moose (Alces alces) and caribou (Rangifer tarandus) appear to have strong effects on harvest within Game Management Subunit 20A, which includes the study area (Fig. 6). Fall grizzly bear seasons opening on 1 September are more likely to result in high levels of harvest than those which open on 15 September. This may be due to a greater likelihood of snowfalls after 15 September, which affects access to the area, or to the fact that open bear seasons concurrent with those open for moose and caribou in early September often result in higher harvest. There are generally more moose and caribou hunters afield than bear hunters; this increase in the number of hunters, in conjunction with the attraction of bears to the entrails of hunter-killed ungulates, accounts for greater harvest of bears. The highest levels of bear harvest were observed when bear seasons opened by 1 September and moose and caribou seasons were also open. An exception to this pattern was observed in 1985, when inclement weather during the 1st 2 weeks of the season, when moose and caribou seasons were open, probably resulted in a marked decline in the number of bears taken.

Movements and Home Range Size

Movements and home ranges during the years 1982-85 were determined for 53 bears equipped with radio collars. The time between sightings varied from 4 days to 5 weeks due to weather, sighting conditions, or available flight time. On this basis, general patterns of movement were identified, but more specific measures, such as daily movement patterns, could not be calculated. Preliminary data on movements and home range for each bear were calculated (Table 8). Mean home ranges for adults based on at least 10 locations, were 1,035 km² (400 mi²) for males (n = 5) and 233 km² (90 mi²) for females (n = 18). For young-age bears aged 3-5 years, mean home ranges were 284 km² (110 mi²) for males (n = 3) and 140 km² (54 mi²) for females

(n = 2); not included in these figures were 25 bears with fewer than 10 relocations.

Some adult male bears moved outside the study area and returned after traveling as far as 40 km (25 mi) north of the study area. Female bears generally stayed within the drainage where they were captured.

The fidelity of young-age bears to their maternal home ranges varied (Table 9). Of 12 2.5- and 3.5-year-old males followed after they had been weaned, 4 moved from 44 to 74 km (27 to 46 mi) outside their maternal home ranges. Of those that stayed within their maternal home ranges, 3 were only observed the year following weaning, 2 were killed during the year of weaning, and 3 stayed for more than 1 year following weaning. The 3 females which were monitored stayed within their maternal home ranges, 2 for at least 1 year and 1 for 2 years. Based on this limited number of observations, we speculate that females tend to remain close to their maternal home ranges following weaning but that less than half of the males remain.

Denning

Sixty-four dens of radio-collared bears were located during 1981-85. These bears denned in a variety of terrain ranging from creek banks at 900 m (3,000 ft) elevation to precipitous mountain slopes above glaciers in the Alaska Range at 1,600 m (5,300 ft). No special denning areas or concentration sites were found and dens were distributed throughout the study area; bears tended to den within their home ranges. During 1982-85, grizzlies in the Alaska Range denned a mean distance of 5.8 km (range 0.5-20.9 km) (3.6 mi, range 0.3-13.0 mi) from the dens they had used in previous years. During the 1st year following weaning, 5 young bears denned 2.7, 2.7, 8.2, 5.2, and 4.0 km (1.7, 1.7, 5.1, 3.2, and 2.5 mi) from the dens they occupied with their mothers prior to weaning. No reuse of dens was documented.

CONCLUSIONS AND RECOMMENDATIONS

This study has resulted in collection of the baseline data necessary to assess the effects of high harvest rates on a grizzly bear population through observation of the collective response of individual bears. Major findings of importance in the determination of the effects of harvest on the population for the 1981-85 period included:

1. Probable population size was 97-107 in 1982 but declined to 79-89 by 1985; this reduction in numbers resulted in fewer productive females and fewer females in the 3- to 5-year-old age class being available for recruitment.

2. The age at which females were first observed with cubs which survived was 7.5 years; preliminary observations indicated that females have a mean cub litter size of 2.07 and a reproductive interval of 4.1-4.7 years.

3. Observed natural mortality rates were 44% for cubs of the year, 12% for yearlings, 8% for 2-year-olds, and 4% for adult females.

4. Harvest mortality (including nonhunting and capture-related deaths) was 8.4-9.3% during the period, with a range of 3.4-14.9%. Harvest rates of 10% were observed for adult radio-collared females.

5. Based on a limited number of observations, it was found that young, recently weaned females tend to remain within their maternal home ranges; in contrast, about half of the males observed left their maternal home ranges.

Continuation of this study should place us in a position to learn what responses occur in the population as a result of high harvest levels, including:

1. Whether continued harvest at current levels will result in further decline of population size;

2. Whether changes in litter size, reproductive interval, or the age at which females first successfully produce cubs will follow population reduction, and if changes do occur, how they affect population productivity;

3. Whether declines in the population size will reduce natural mortality rates of adult females or their offspring; and

4. Whether patterns of immigration and emigration of young-age bears will affect population trend.

The answers to these questions should allow managers to better predict the effects of increased bear harvest and to assess the impacts of various levels of harvest on grizzly populations. Therefore, we recommend that the increase in harvest rates which began during Phase I of this study be allowed to continue. Concurrently, research effort should continue to monitor population size changes, production, and the number of adult females, to document any compensatory changes in production or survival of offspring. Use of an improved technique, developed by Miller and Ballard (pers. commun.), for determining population size and density, should be applied in the area. Emphasis should be directed toward determining the response to high harvest levels by individual members of the population and how individual responses affect the population as a whole.

Further attention should be given to constructing and testing population dynamics models based on measurable productivity and harvest parameters.

ACKNOWLEDGMENTS

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Locating and capturing bears in this area was a particularly arduous task due to heavy vegetative cover and precipitous terrain. The success we experienced was due in large part to the abilities of the UH-1 helicopter pilots-in-command, especially Bruce Watson, Frank Wilson, and Jim Watson, and the crews of the 222nd Aviation Battalion. All contributing individuals from this unit participated in a competent and professional manner. Super Cub pilot Bill Lentsch again demonstrated his unequaled ability to spot bears in alder patches, glacial moraines, and fog banks. Robert Brannon, University of Alaska, did an excellent job as a field assistant and instructor in field surgical techniques.

Ft. Wainwright U.S. Army personnel provided welcome and able assistance in all aspects of field research. Retired Captain Michael Terry, VETACT, originally proposed the cooperative aspects of the study. He instructed us in veterinary procedures for collecting samples; Major Harold Smith and Captain William E. Clymer, VETACT, provided veterinary expertise for the project as well as supporting and contributing to the concept of this project. Junior Kerns, Jim Clark, and Steve Harrington, Natural Resources Office, Ft. Wainwright, and Alan Bennett, 172nd Infantry Brigade, Ft. Richardson, assisted in data collection, observation, and handling of bears; Junior Kerns and Major Harold Smith helped coordinate the project.

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PREPARED BY:

Harry V. Reynolds
Game Biologist III

APPROVED BY:

W. Lewis Pamplin, Jr.
Director, Division of Game

Steven R. Peterson
Research Chief, Division of Game

SUBMITTED BY:

Wayne L. Regelin
Regional Research Coordinator

John L. Hechtel
Game Technician III

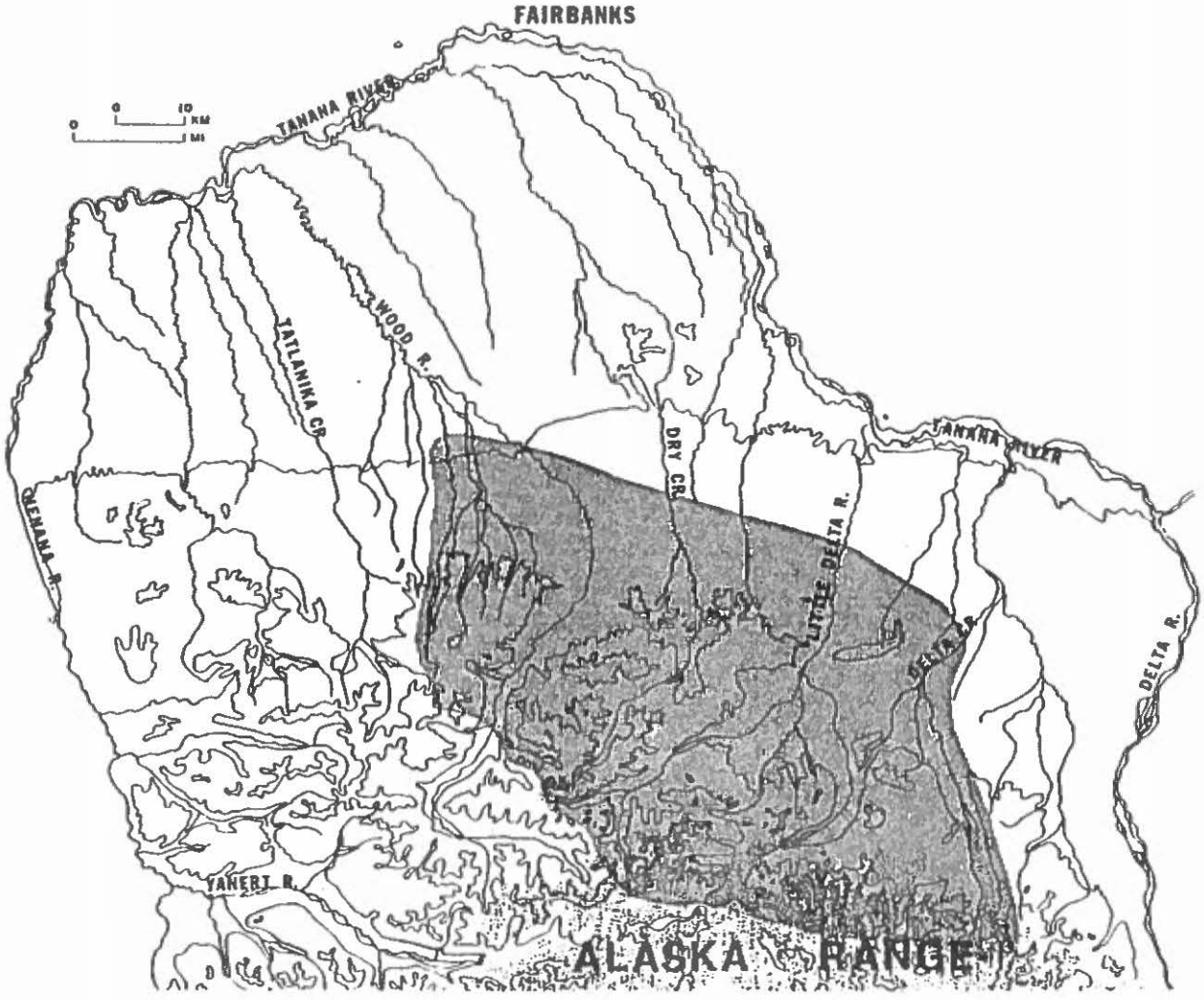

Fig. 1. Grizzly bear study area in the northcentral Alaska Range.

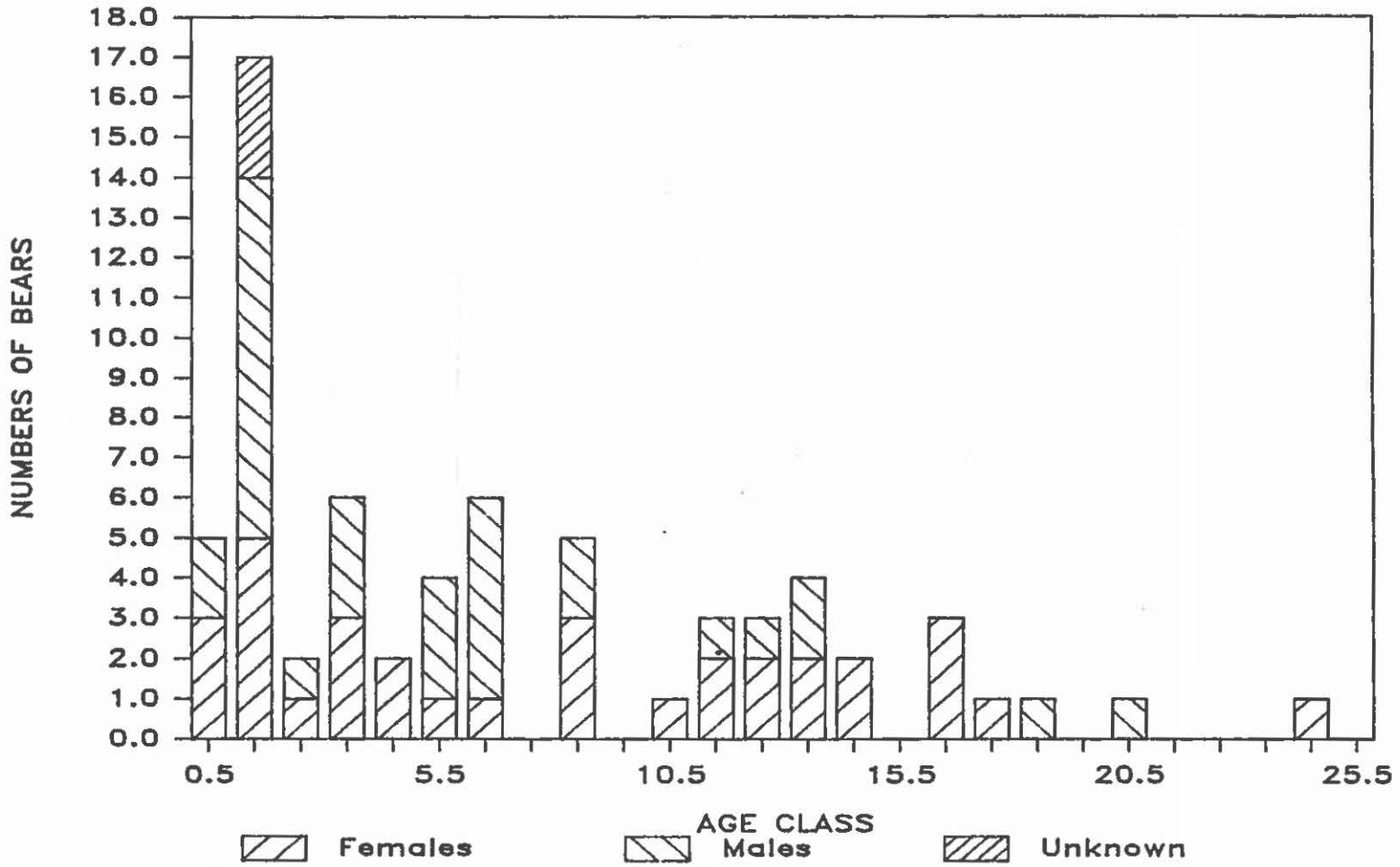

Fig. 2. Sex and age structure of initial captures of grizzly bears in the northcentral Alaska Range, 1981-85. Most offspring were not captured until they reached 2 or 3 years of age; however, for purposes of this figure, these bears are included with the age class in which they were first observed.

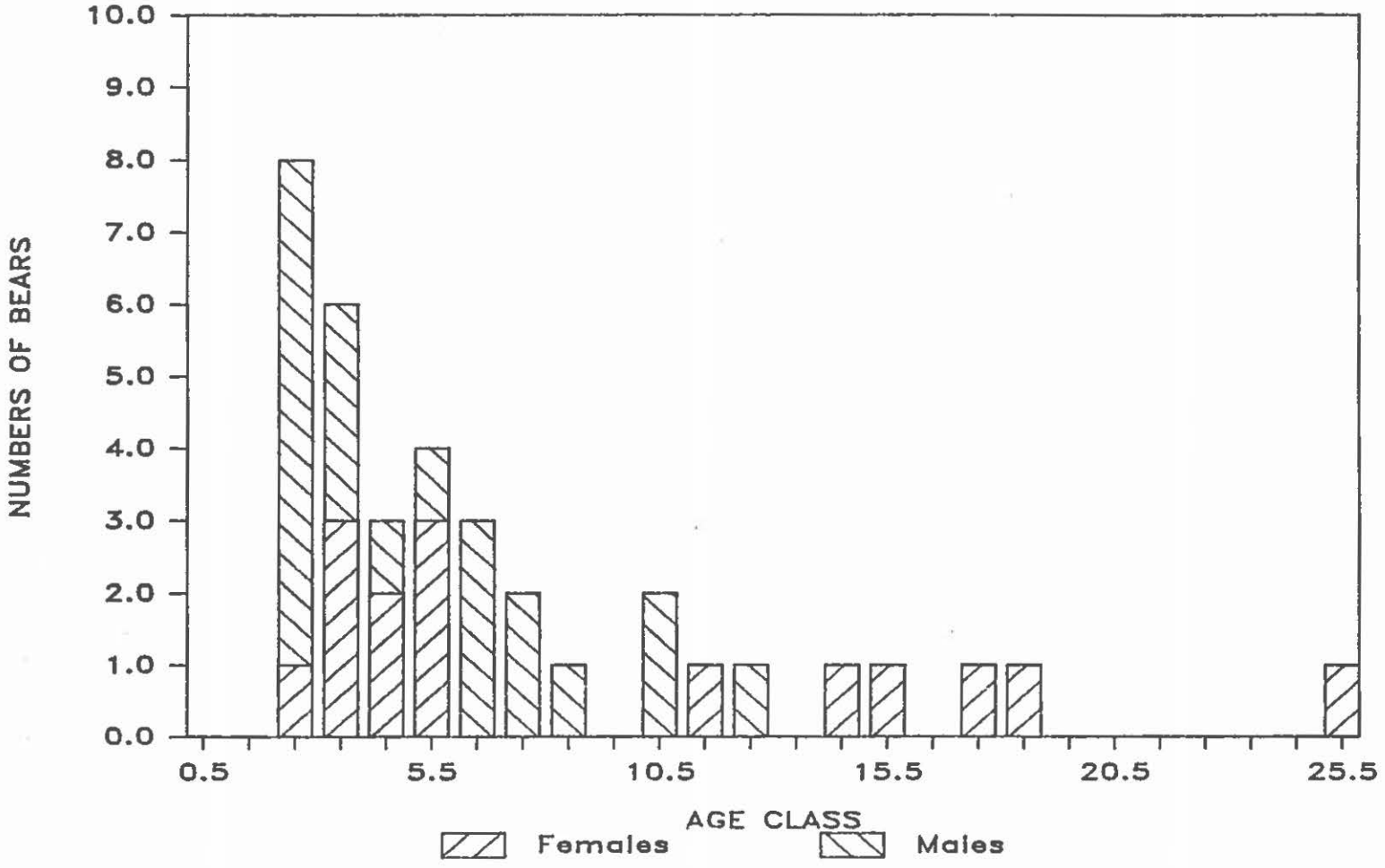

Fig. 3. Sex and age structure of grizzly bears killed by hunters, or in defense of life or property, or illegally in the study area, 1981-85.

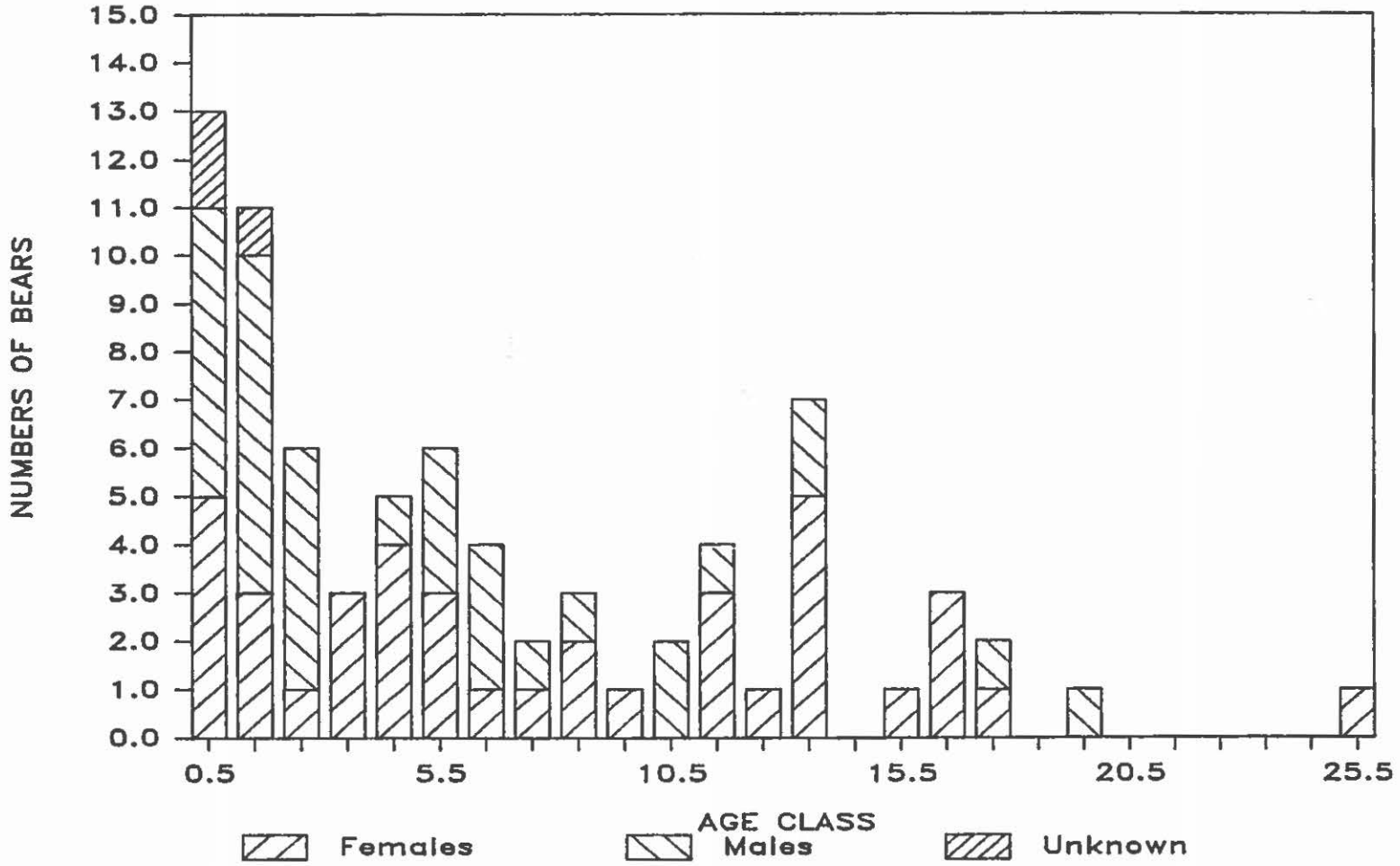

Fig. 4. Population sex and age structure for grizzly bears present in the northcentral Alaska Range study area, 1982.

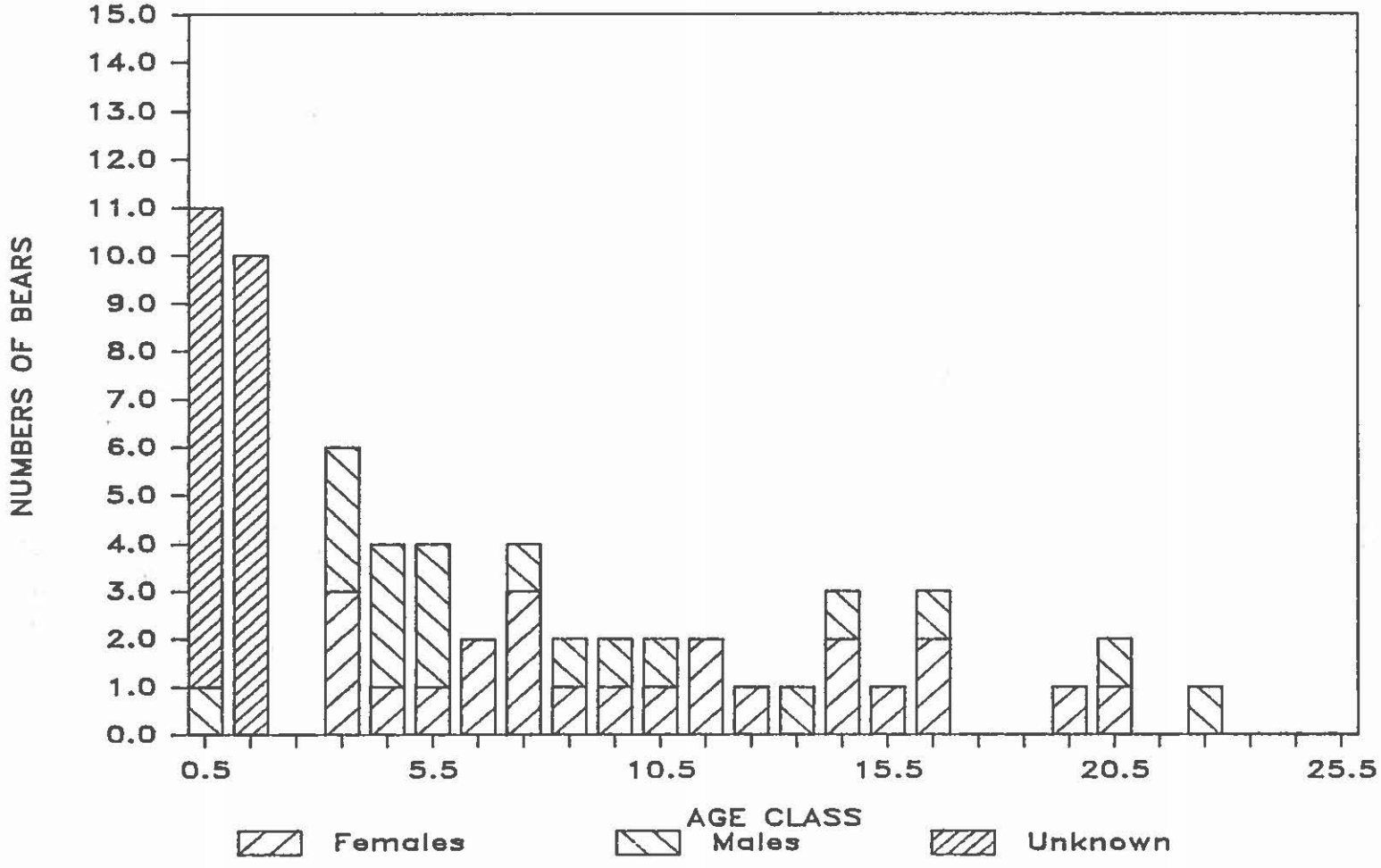

Fig. 5. Population sex and age structure for grizzly bears present in the northcentral Alaska Range study area, 1985.

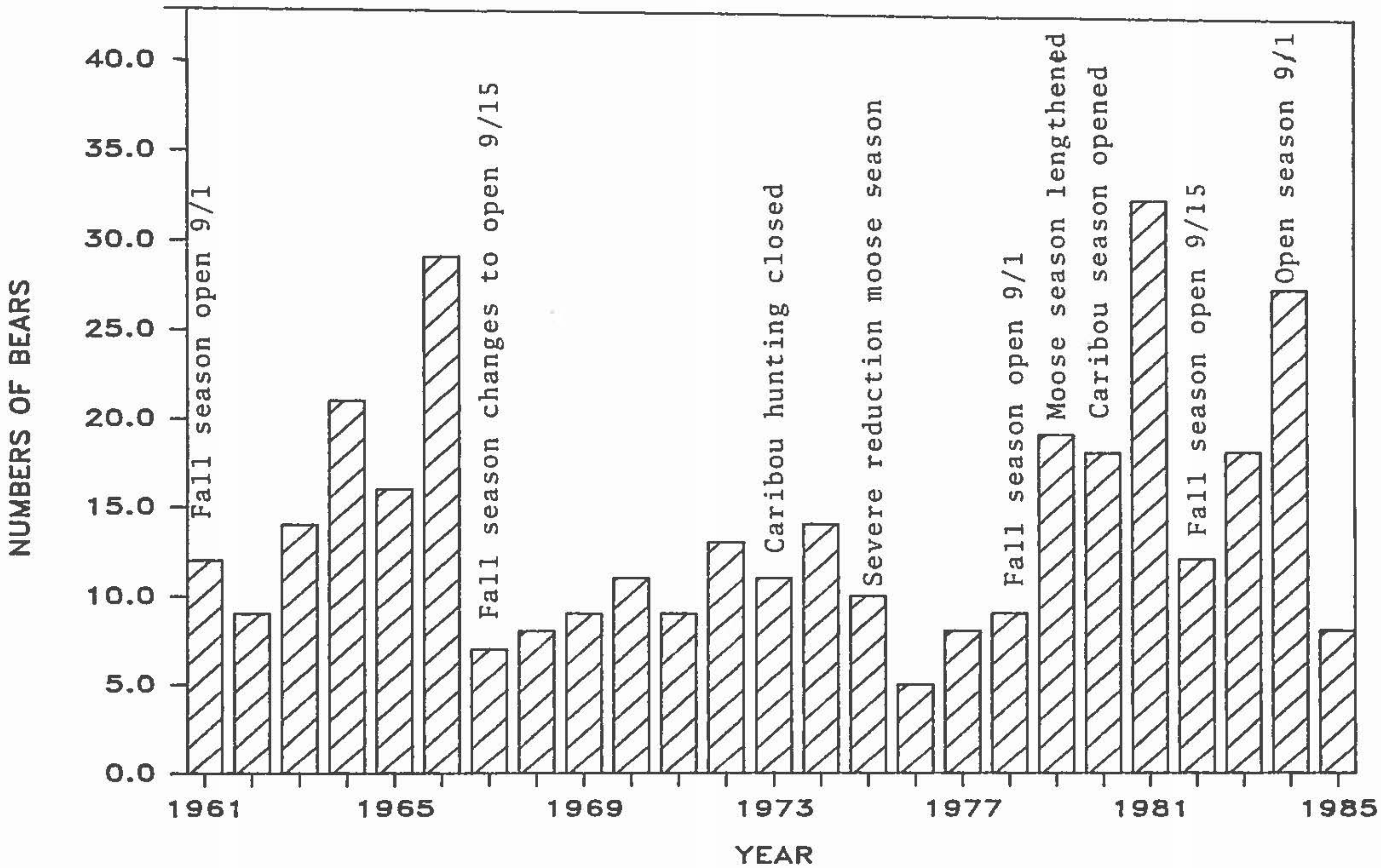

Fig. 6. Annual harvest of grizzly bears by hunters in Game Management Subunit 20A, 1961-85.

Table 1. Capture and marking characteristics of 66 bears captured in the northcentral Alaska Range, 1981-85.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1301 M	6.5	5/18/81	120(265)	Buchanan Cr.	1.8/1.2 H	373/374	G/G
1302 F	3.5	5/19/81	75(165)	E. Fork Delta	1.0/1.0 M	368/367	R/G
1303 F	2.5	6/17/81	57(125)	Mystic Mtn.	1.4/1.4 M	524/523	R/R
	4.5	6/27/83	82(180)	Herst Cr.	5.0 M99 M	3227/3214	R/R
	6.5	6/14/85	73(160)	Upper Gold King	2.0/2.0 M	486/487	R/R
1304 M	5.5	6/19/81	136(300)	W. Fork Delta	2.4/2.0 M	451/452	1B/R
1305 F	24.5	6/19/81	114(250)	Slate Cr.	AM	453/454	O/R
1306 M	2.5	5/24/82	44(97)	W. Fork Delta	1.0/1.0 L	3151/3086	G/1B
1307 M	2.5	5/24/82	44(98)	W. Fork Delta	1.0/1.0 H	3087/3152	1B/G
	5.5	6/17/85	114(250)[d]	Sheep Cr.	2.4/2.6 L	3087/3152	1B/G
1308 F	6.5	5/25/82	111(245)	Dry Cr.	--[e]	3001/3154	O/Pp
	8.5	6/20/84	120(265)[d]	Dry Cr.	5.0 M99 M	3001/471	O/Pp
1309 M	8.5	5/25/82	318(700)[d]	Dry Cr.	AL	3153/3101	dB/Bk
1310 M	13.5	5/25/82	250(550)	Buchanan Cr.	2.0/2.0 M	No tags	
	15.5	6/20/84	241(530)	Molybdenum Rg.	4.0/2.0 M	467/473	O/W
1311 F	12.5	5/26/82	120(265)	Molybdenum Rg.	1.9/2.1 M	3106/3107	W/W
	14.5	6/21/84	116(255)	Molybdenum Rg.	2.0/2.2 M	466/455	W/W[f]
1312 F	0.5	5/26/82	12(26)	Molybdenum Rg.	0.1/0.1	3104/3155	O/W[f]
1313 F	0.5	5/26/82	12(27)	Molybdenum Rg.	0.08/0.13	3156/3105	W/O[f]
1314 M	6.5	5/27/82	116(255)	Iowa Rg.	2.1/1.9 H	3088/3002	dB/1B
1315 M	13.5	6/4/82	272(600)	Buchanan Cr.	1.9/2.1 L	3102/3157	Bk/O
	15.5	5/17/84	295(650)	Hayes Cr.	AH	3322/none	Bk/-
1316 M	11.5	6/7/82	236(520)	W. Fork Delta	3.8/0.0 H	3089/3090	O/1B
1317 F	3.5	6/8/82	36(80)	Forgotten Cr.	1.2/1.8 L	3091/3003	1B/O
	5.5	5/16/84	55(122)	Upper West Fk.	AL	3486/3239	1B/O
	6.5	5/23/85	59(130)	Upper Wood R.	7.0 M99	497/498	1B/O
1318 F	13.5	6/8/82	104(230)[d]	Buchanan Cr.	AL	3004/3103	W/G
	15.5	6/22/84	118(260)[d]	Slate Cr.	AM	458/472	W/G

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1319 M	0.5	6/8/82	12(26)	Buchanan Cr.	0.15/0 L	3005/3092	R/Y[f]
1320 F	17.5	6/8/82	102(225)	Trident Gl.	AM	3158/3093	G/B
	19.5	6/25/84	139(305)	E. Hayes Cr.	5.0 M99 M	463/461	G/B
1321 F	16.5	6/9/82	141(310)	Snow Mt. Glch.	2.1/1.9 M	3028/3108	G/W
	17.5	5/17/83	127(280)	Dry Cr.	1.8/2.2 M	3028/3427	G/W
	19.5	7/22/85	218(480)	N. VABM Wood	2.6/1.0 L	399/398	G/W
1322 F	8.5	6/9/82	91(200)	Sheep Cr.	1.9/2.1 M	3051/3159	W/lB
1323 F	11.5	6/10/82	95(210)	Mystic Mt.	1.9/2.1 M	3160/3030	G/G
	13.5	6/29/84	132(290)	VABM Wood	AM	579/582	G/G[f]
1324 F	0.5	6/10/82	12(26)	Mystic Mt.	0.12/0 M	3027/3162	R/W[f]
1325 M	0.5	6/10/82	12(27)	Mystic Mt.	0.10/0 M	3161/3031	W/R[f]
	2.5	5/15/84	67(148)	Mystic Cr.	1.0 M99 M	3233/3394	R/W
1326 F	4.5	6/18/82	93(205)	Buchanan Cr.	2.2/1.8 M	3008/3163	W/R
	6.5	6/21/84	109(240)	Buchanan Cr.	1.8/2.2 M	468/462	W/R
	7.5	6/27/85	111(245)	Slate Cr.	2.4/1.6 L	426/427	W/W
1327 F	16.5	7/8/82	127(280)	Whistler Cr.	2.2/1.8 M	3134/3192	G/R
	18.5	6/23/84	125(275)	Whistler Cr.	AH	458/192	G/R
1328 F	1.5	7/8/82	43(95)	Whistler Cr.	0.9/1.1 M	3115/3014	dB/G
1329 F	13.5	7/9/82	120(265)	Buchanan Cr.	2.4/1.6 M	3026/3111	W/R
1330 M	1.5	7/9/82	48(106)	Buchanan Cr.	-- M	--/--	R/W
	3.5	6/28/84	102(225)	E. Fk. Delta	2.6/3.0 M	597/598	R/W
1331 F	4.5	7/10/82	77(170)	Trident Gl.	2.4/1.6 M	3120/3194	Bk/O
1332 F	5.5	7/12/82	104(230)	Gillam Gl.	2.4/1.6 M	394/190	R/dB
1333 F	16.5	7/13/82	141(310)	Buchanan Cr.	AM	474/469	G/R
1334 M	1.5	7/13/82	49(108)	Buchanan Cr.	1.0/1.0 M	395/392	Y/G
	3.5	6/27/84	107(235)	McGinnis Cr.	AM	585/583	O/G
1335 F	1.5	7/13/82	38(84)	Buchanan Cr.	1.0/1.0 M	32/456	G/Y
	3.5	6/25/84	80(175)	Gilliam Gl.	1.5/3.0 M	465/464	dB/G

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1336 F	2.5	5/16/83	47(104)	Kansas Cr.	1.0/1.0 M	3201/3204	Bk/mG
	3.5	6/26/84	89(195)	Copper Cr.	2.0/3.0 M	470/595	Bk/mG
	4.5	6/17/85	102(224)	Wood R.	AL	470/595	Bk/mG
1337 M	20.5	5/18/83	289(635)	Sheep Cr.	3.5/3.5	3209/3205	R/O
1338 M	6.5	5/20/83	111(245)	Molybdenum Rg.	AM	3203/3202	O/Bk
1339 M	6.5	5/23/83	120(265)	Trident Gl.	-- M	3286/3351	lB/W
	7.5	5/17/84	168(370)	E. Fk. Delta	6.0 M99 H	3254/3398	lB/W
1340 F	3.5	5/23/83	71(157)[d]	Hayes Cr.	1.2/0.8 H	3277/3208	G/O
	4.5	5/19/84	91(200)[d]	Molybdenum Rg.	4.0 M99 M	3277/3208	mG/O
	5.5	6/27/85	100(220)	W. Hayes Cr.	2.4/1.6 L	590/596	mG/mG
1341 F	10.5	5/23/83	107(235)	NE Portage	1.5/1.5 H	3210/3428	R/dB
	12.5	6/13/85	107(235)	E. Fk. Delta	2.0/2.0 M	442/none	O/-
1342 M	2.5	5/24/83	49(108)	Threemile Cr.	0.6/1.2 M	3354/3207	W/dB
1343 M	2.5	5/24/83	43(95)	Threemile Cr.	0.6/1.2 M	3426/3285	R/Bk
1344 M	2.5	5/24/83	56(123)	Threemile Cr.	0.6/1.2M	3361/3433	lB/Bk
	3.5	6/23/84	123(270)	Hayes Cr.	2.2/3.2 M	475/460	lB/Bk
1345 F	8.5	5/24/83	--	Upper W. Fork	1.2/1.8 L	3206/3352	O/O
	10.5	5/23/85	105(230)[d]	Upper W. Fork	1.2/1.8 M	3206/3352	O/O
1346 M	5.5	5/25/83	114(250)	Hayes Gl.	AM	3359/3356	lB/lB
1347 M	6.5	5/31/83	189(415)	Coal Cr.	--	none	dead
1348 F	12.5	5/31/83	--	Mystic Mtn.	AM	3363/3372	W/O
1349 M	18.5	6/2/83	264(580)	O'Brien Cr.	3.8/1.2L	3364/3292	R/lB
1350 M	8.5	6/2/83	202(445)[d]	Ptarmigan Cr.	3.0/2.0L	3432/3430	dB/R
1351 F	14.5	6/23/83	114(250)[d]	Dry Cr.	4.0M99M	3217/3390	dB/W
	16.5	6/10/85	111(245)	Little Delta R.	2.0/2.0 M	477/436	dB/W
1352 F	14.5	6/27/83	111(245)	W. Fork Delta	--	3215/3316	O/W
1353 M	1.5	6/27/83	27(60)	W. Fork Delta	--	3310/none	O/-
1354 F	1.5	6/27/83	12(27)	W. Fork Delta	--	none/3314	-/O

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1355 M	3.5	6/30/83	60(133)	E. Fork Delta	4.0M99H	3232/3473	O/Bk
	5.5	6/3/85	70(155)	Whistler Cr.	2.2/1.8 H	586/587	O/Bk
1356 M	2.5	6/30/83	50(110)	Little Delta R.	2.0M99H	3234/3392	Bk/O
1357 M	2.5	5/15/84	63(138)	Dry Cr.	1.1 M99 M	3323/3235	W/Bk
	3.5[d]	6/24/85	93(205)	Dry Cr.	1.5/1.5 M	447/448	W/Bk
1358 M	12.5[d]	5/18/84	205(450)	Hayes Cr.	AL	3318/3447	lB/dB
1359 M	3.5[f]	5/28/85	61(134)	Snow Mt. Glch.	4.0 M99 M	489/488	dB/O
1360 F	11[f]	5/28/85	95(210)	Snow Mt. Glch.	7.0 M99 H	none	none
1361 F	3.5	5/28/85	63(138)	Dry Cr.	4.0 M99 M	482/483	mG/R
1362 F	6.5	6/5/85	--	Glacier Cr.	2.0/2.0 L	none	none
	6.5	6/24/85	114(250)	Threemile Cr.	2.2/1.8 L	443/490	dB/dB
1363 M	3.5	6/5/85	43(95)	Slide Cr.	1.0/2.0 M	592/593	dB/lB
1364 M	0.5	6/14/85	7(15)	Gold King Cr.	0.7/-M	none	none
1365 M	5.5	6/19/85	118(260)	Wood R.	AM	476/441	lB/G
1366 M	8.5	7/22/85	234(515)	Tatlanika R.	3.2/1.0	390/391	mG/R

[a] Dosage in ml of phencyclidine hydrochloride/acepromazine maleate; use of M-99 is designated M99; A denotes multiple injections with unknown effective dosage. Drug effects were as follows: L = light, M = optimum, H = heavy.

[b] Ear tag numbers, left/right.

[c] Marking designations:

Colors: R, red; G, light green; mG, medium green; O, orange; lB, light blue; dB, dark blue; W, white; Bk, black; Pp, purple; Y, yellow.

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.

[d] Estimated.

[e] Data collected but not recorded.

[f] Ear tags only and not ear flagging material were used to mark cubs of the year; therefore, for these bears only, marker colors indicate ear tags and not ear flags.

Table 2. Minimum number of female grizzly bears present in the study population in northcentral Alaska, 1980-86.

Year	Minimum number of females in population								
		3-5 yrs old				≥6 yr old			
			Change from previous year				Change from previous year		
	≤2 yr old[a]	No.	+	-	Net	No.	+	-	Net
1980	b	c	c	4	c	18[d]	2	0	+2
1981	b	c	c	5	c	20[d]	1	1	0
1982	9-12	10	1	3	-2	20	1	2	-1
1983	6-8	8	2	5	-3	19	3	2	+1
1984	9-12	5	3	3	0	20	2	4	-2
1985	8-11	5	0	1	-1	18	1	2	-1
1986	b	3				17			

[a] No special effort was made to capture offspring of females until just prior to weaning; therefore, these figures are estimates based on sex ratios of captured offspring.

[b] Because cub production is so variable, no estimates were projected for years when observations were not made.

[c] Prior to 1982, production or survival was not observed; therefore, for bears less than 6 years of age, only known losses in these age categories are listed.

[d] Calculations of the number of adult females were based on those bears killed by hunters or captured during the study; therefore, figures for 1980-81 are probably underestimates because natural mortality is not accounted for. The probable number of adult females present during 1980-81 was more likely 20-24.

Table 3. Reproductive status and litter sizes of females in the northcentral Alaska Range, 1981-85.

Bear No.	Age in 1985[a] (yrs)	Offspring No.	Reproductive status[b] 1981	1982	1983	1984	1985	Reproductive history
1302	7		NB	UN	UN	UN	UN	No offspring prior 1981
1303	6	1364, 1UM	NB	NB	B?	B	2cubs/B	No offspring prior 1981; lost cubs in 2 separate incidents 1985
1305	25	1306, 1307	2yrlg	2 2 yr/B/Dead				Hunter kill fall 1982
1308	9	2UM		?/B	B	2cubs	2yrlgs	Offspring 1982 or before
1311	15	1312, 1313, 2UM	UN/B	2cubs	B	2cubs	2yrlgs	Lost cubs August 1982; lost 1 yrlg 1985
1317	6			NB	NB?	NB	NB	Hunter kill fall 1985
1318	16	1319, 2UM	UN/B	1cub/B	B	B	2cubs	Lost cub 1982
1320	20			?/B	1cub/B?	B	3cubs	Weaned or lost offspring 1982; lost cub 1983
1321	19	1342, 1343, 1344, 3UM	UN/3+cubs	3yrlg	3 2-yr	2 3-yr/B	3cubs	1342 killed illegally fall 1983; lost cubs 1985?
1322	11	1336	UN/1+cubs	1yrlg	1 2-yr	1 3-yr/B	UN	
1323	14	1324, 1325	UN/B	2 cubs	2yrlgs	2 2-yr/B	UN	
1326	7	UM		NB	B	B	1cub	No offspring prior 1982; lost cub 1985?
1327	18	1328, 1UM, 3UM	UN/2+cubs	2yrlg	B	3cubs/ Dead		1UM yrlg capture mortality; lost 1328 in 1982; 1327 capture mortality? 1984
1329	14	1330	UN/1+cubs	1yrlg	1 2-yr/Dead			Killed by male May 1983
1331	7			NB	B	UN	UN	No offspring prior 1982
1332	6			NB?	Dead			No offspring prior 1982; died in den 1983
1333	18	1334, 1335	UN/2+cubs	2yrlg	2 2-yr	2 3-yr/ B/Dead		Hunter kill 1984
1336	4				NB	NB	B	No offspring prior 1983

Table 3. Continued.

Bear No.	Age in 1985[a] (yrs)	Offspring No.	Reproductive status[b] 1981	1982	1983	1984	1985	Reproductive history
1340	5				NB	NB	B	No offspring prior 1983
1341	12	1UM, 2UM		UN/1+cubs	1yrlg/B	2cubs	2yrlgs	Lost yrlg 1983
1345	10	2UM			B	2cubs	1yrlg	Lost 1 cub 1984; lost 1 yrlg 1985?
1348	14	3UM			?/B	3cubs	UN	Probably weaned or lost offspring 1983
1351	16	1357, 1361, 1UM	UN/B	UN/3+cubs	3yrlgs	3 2-yr	2 3-yr	Lost 1UM offspring 1984
1352	16	1353, 1354	UN/B	UN/2+cubs	2yrlgs	2 2-yr/Dead		Hunter kill 1984; 1353, hunter kill 1984
1360	11[c]	1359, 1363	UN/B	UN/2+cubs	UN/2+yrlgs	UN/2+2-yr	2 3-yr/Dead	Capture mortality 1985
1361	3					NB	NB	No offspring prior to 1985
1362	8					UN	B	

[a] Age in 1985 or last year in which bear was alive.

[b] Designations: NB, not observed in breeding condition; UN, not observed in that year; B, observed in breeding condition; ?, status unknown; UM, unmarked; cub, cub of year; yrlg, yearling; 2-yr, 2-year-old; +, offspring first observed in subsequent year and therefore litter size may have been larger.

[c] Estimate, based on tooth wear.

Table 4. Observed and projected minimum reproductive intervals for adult female grizzly bears in the northern Alaska Range, 1981-85.

Bear No.	Maximum age at beginning of interval	Minimum cycle length[a]	Annual reproductive status for adult females[b]						
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
1303	5	4	B	C/B	C	Y	2/B		
1305	22	3	W/B	C	Y	2/B			
1308	6	4	C?/B	B	C	Y	2/B		
1311	10	5	W/B	C	B	C	Y	2/B	
1318	12	6	W/B	C/B	B	B	C	Y	2/B
1320	17	5	W/B	C/B?	B	C	Y	2/B	
1321	14	4	W/B	C	Y	2	3/B	C/B?	
1322	6	4	B	C	Y	2	3/B		
1323	11	3	W/B	C	Y	2/B			
1326	6	4	B	C/B?	C	Y	2/B		
1329	11	3	W/B	C	Y	2/D			
1333	14	4	W/B	C	Y	2	3/B		
1341	10	5	W/B	C	Y/B	C	Y	2/B	
1345	8	5	B	C	Y/B?	C	Y	2/B	
1348	12		W/B	C	?				
1351	12	4	W/B	C	Y	2	3/B?		
1352	13	3	W/B	C	Y	2/D			
1360	7	4	B	C	Y	2	3/D		

[a] All reproductive cycles or intervals were minimum values because they were partially based on projections prior to or after years when actual observations were made. In addition, all projected calculations assume weaning of young as 2-year-olds; however, in weanings which were observed, 5 of 7 females weaned offspring as 3-year-olds.

[b] Underlining indicates reproductive status was projected to allow minimum cycle length calculation; status which was observed is not underlined. Designations are: B, bred; W/B, weaned offspring, then bred; C/B, lost cubs, then bred; Y/B, lost yearling, then bred; C, with cubs; Y, with yearlings; 2, with 2-year-olds; 3, with 3-year-olds; D, died.

Table 5. Observed litter size and number of offspring in cub, yearling, 2-year-old, and 3-year-old age classes, 1982-85.

Age class	Observed no. of litters				Total		Mean litter size
	1982	1983	1984	1985	No. of litters	No. of offspring	
Cub							
litter size 1	1	1	0	1	3	3	
litter size 2	2	0	4	2	8	16	
litter size 3	0	0	2	2	4	12	
total	3	1	6	5	15	31	2.07
Yearling							
litter size 1	2	1	0	1	4	4	
litter size 2	2	2	0	3	8[a]	16[a]	
litter size 3	1	1	0	0	2	6	
total	5	4	0	4	14[a]	26[a]	1.86[a]
2-year-old							
litter size 1	0	2	0	0	2	2	
litter size 2	1	1	2	0	4	8	
litter size 3	0	1	1	0	2	6	
total	1	4	3	0	8	16	2.00
3-year-old							
litter size 1	0	0	1	0	1	1	
litter size 2	0	0	2	1	3	6	
litter size 3	0	0	0	1	1	3	
total	0	0	3	2	5	10	2.00

[a] One litter with 2 yearling offspring was first observed in 1981 and is included in these calculations.

Table 6. Mortality of grizzly bears in Alaska Range study area, 1981-85.

Bear No.[a]	Sex[b]	Age[c]	Date of capture	Date of death	Location	Cause of death
UM	F	3	--	5/16/81	Dry Creek	Hunter kill
UM	M	6	--	5/18/81	Buchanan Creek	Hunter kill
1301	M	6	5/18/81	5/18/81	Buchanan Creek	Capture mortality
UM	M	2	--	5/23/81	Wood River	Hunter kill
UM	M	3	--	5/25/81	W. Fk. Little Delta	Hunter kill
UM	M	2	--	9/4/81	Wood River	Hunter kill
UM	F	2	--	9/6/81	Iowa Ridge[d]	Hunter kill
UM	M	12	--	9/7/81	Wood River[d]	Hunter kill
UM	M	2	--	9/12/81	W. Fk. Little Delta	Hunter kill
UM	F	3	--	9/28/81	Wood River[d]	Hunter kill
UM	M	7	--	10/2/81	E. Fk. Little Delta	Hunter kill
UM	M	Unk	--	10/8/81	Wood River[d]	Hunter kill
UM	F	5	--	10/9/81	Wood River[d]	Hunter kill
UM	M	8	--	10/17/81	Gold King	Hunter kill
UM	M	10	--	5/22/82	Gold King	Hunter kill
1319	M	Cub	6/8/82	6/18-7/2/82	W. Fk. Little Delta	Unk, offspring of 1318
UM	Unk	1	7/8/82	7/8/82	E. Fk. Little Delta	Capture mortality, offspring of 1327
1312	F	Cub	5/26/82	8/5-27/82	Molybdenum Ridge	Unk, offspring of 1311
1313	F	Cub	5/26/82	8/5-27/82	Molybdenum Ridge	Unk, offspring of 1311
1328	F	1	7/8/82	8/27-9/23/82	E. Fk. Little Delta	Unk, offspring of 1327
UM	F	5	--	9/15/82	W. Fk. Little Delta	Hunter kill
UM	M	2	--	9/15/82	Dry Creek	Hunter kill
1305	F	25	6/19/81	9/15/82	Dry Creek	Hunter kill
1314	M	6	5/27/82	9/15/82	Little Delta River	Hunter kill
UM	F	11	--	9/17/82	E. Fk. Little Delta	Hunter kill
1332	F	6	7/12/82	winter 82/83	Buchanan Creek	Unk, den mortality
UM	F	4	--	5/1/83	Trident Glacier	Hunter kill
1329	F	14	7/9/82	5/15/83	Buchanan Creek	Killed and eaten by 1315M

Table 6. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of capture	Date of death	Location	Cause of death
1338	M	6	5/20/83	5/20/83	Molybdenum Ridge	Capture mortality
UM	F	5	--	5/24/83	W. Fk. Little Delta	Hunter kill
1347	M	6	5/31/83	5/31/83	Wood River	Capture mortality
UM	Unk	Cub	--	6/83	Delta Creek	Unk, offspring 1320
UM	Unk	1	--	5/23-8/21/83	Little Delta River	Unk, offspring 1341
UM	F	14	--	9/16/83	Kansas Creek	Hunter kill
UM	M	7	--	9/19/83	Little Delta River/ Ten Mile Creek	Hunter kill
1342	M	2	5/24/83	10/83	Wood River	Nonsport illegal kill
1315	M	15	6/4/82	5/17/84	Delta Creek	Capture mortality
1306	M	4	5/24/82	5/20/84	W. Fk. Little Delta	Hunter kill
1356	M	3	6/30/83	5/20/84	Gerstle River[e]	Hunter kill
1333	F	18	7/12/82	5/22/84	E. Fk. Little Delta	Hunter kill
1352	F	15	6/27/83	5/30/84	W. Fk. Little Delta	Hunter kill
1327	F	18	7/8/82	6/23/84	E. Fk. Little Delta	Capture mortality?
3UM	Unk	Cub	--	6/23/84	E. Fk. Little Delta	Unk, offspring of 1327
UM	Unk	Cub	--	6/84	Wood River	Unk, offspring of 1345
UM	Unk	2	--	8-9/84	Dry Creek	Unk, offspring of 1351
UM	F	Unk	--	9/2/84	Delta Creek	Hunter kill
1353	M	2	6/27/83	9/4/84	W. Fk. Little Delta	Hunter kill
UM	M	3	--	9/6/84	Dry Creek	Hunter kill
1344	M	3	5/24/83	9/7/84	Dry Creek	Hunter kill
1325	M	2	6/10/82	9/9/84	Gold King Creek	Defense of life and property kill
1335	F	3	7/13/82	9/14/84	E. Fk. Little Delta	Hunter kill
1309	M	10	5/25/82	9/15/84	Gold King	Hunter kill
UM	F	17[f]	--	10/7/84	W. Fk. Little Delta	Hunter kill
1360	F	11[f]	5/28/85	5/28/85	Snow Mtn. Gulch	Capture mortality
UM	Unk	1	--	5/12-6/10/85	Molybdenum Ridge	Unk, offspring of 1311
UM	Unk	Cub	--	5/23-6/5/85	Mystic Creek	Unk, offspring of 1303

Table 6. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of capture	Date of death	Location	Cause of death
UM	Unk	1	--	5/23-7/22/85	Upper Wood River	Unk, offspring of 1345
1364	M	Cub	--	6/14-24/85	Mystic Creek	Unk, offspring of 1303
UM	Unk	Cub	--	6/18-27/85	Buchanan Creek	Unk, offspring of 1326
3UM	Unk	Cub	--	6/24-7/22/85	Wood River	Unk, offspring of 1321
1317	F	6	6/8/82	9/85	Wood R./Yanert R.	Illegal kill?[g]
1355	M	5	6/30/83	9/13/85	Iowa Ridge	Hunter kill

[a] UM designates an unmarked bear.

[b] M, male; F, female; Unk, unknown sex.

[c] Age at death; Unk denotes unknown age.

[d] Hunter kills with location only listed as Wood River were counted in the study area.

[e] Killed outside study area.

[f] Estimate.

[g] Bear killed in September 1985, but not reported or sealed.

Table 7. Grizzly bear harvest[a] within the study area, 1961-85.

Year	Drainage of reported harvest				Total
	Delta Creek	Little Delta River	Dry Creek	Wood River[b]	
1961	0	2	2	3	7
1962	0	2	1	1	4
1963	0	1	1	5	7
1964	3	3	1	2	9
1965	0	0	1	1	2
1966	3	5	3	3	14
1967	0	1	0	0	1
1968	1	1	1	1	4
1969	0	1	0	1	2
1970	1	0	0	1	2
1971	0	1	0	1	2
1972	0	1	0	0	1
1973	1	1	1	5	8
1974	1	0	1	4	6
1975	1	0	0	1	2
1976	0	0	0	1	1
1977	1	1	2	1	5
1978	0	0	1	2	3
1979	1	3	0	6	10
1980	1	4	1	3	9
1981	0	5	1	7	13
1982	0	3[c]	2[c]	1	6
1983	1	2	0	2[d]	5
1984	1	6[e]	2[e]	1[e]	11
1985	0	1[f]	0	1[f]	2
Totals	16	44	21	55	136

[a] Includes hunter harvest, bears killed in defense of life or property, and bears killed illegally.

[b] The study area does not include the entire Wood River drainage. However, because many harvest records do not record specific portions of the drainage, all harvest records that designated Wood River as the location of kill are included.

[c] Single marked bears were killed by hunters in the Little Delta River and Dry Creek drainages.

[d] One marked bear was killed illegally in the Wood River drainage in 1983.

Table 7. Continued.

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[e] Seven marked bears (5 in the Little Delta River, 1 in Dry Creek, and 1 in Wood River drainages) were killed by hunters in the study area during 1984; 1 was killed in defense of life or property along Gold King Creek.

[f] Both bears killed in 1985 were marked; one may have been taken illegally, either on the upper Wood River or Yanert River drainages.

Table 8. Radio locations and home range sizes of radio-collared grizzly bears, northcentral Alaska Range, 1981-85.

Individual No.	Sex	Age in 1985[a] (yrs)	Radio locations n	Radio locations Period	Maximum distance between locations (km)	Home range size (km^2)	Comments
1302	F	7.5	4	5/9/81-3/29/82	13	36	Shed collar
1303	F	6.5	38	6/17/81-12/3/85	38	578	
1304	M	9.5	14	6/19/81-10/31/82	45	756	Shed collar
1305	F	25.5	15	6/19/81-9/15/82	16	124	Hunter kill 1982
1306[b]	M	4.5	10	5/24/82-5/20/84	12	52	Hunter kill 1984
1307[b]	M	5.5	17	5/24/82-6/24/85	40	733	
1308	F	9.5	29	5/25/82-12/3/85	29	228	
1309	M	10.5	14	5/25/82-9/15/84	52	992	Hunter kill 1984
1310	M	16.5	21	5/25/82-6/20/85	100	1430	
1311	F	15.5	28	5/26/82-12/3/85	27	142	
1314	M	6.5	7	5/27/82-9/15/82	67	762	Hunter kill 1982
1315	M	15.5	12	6/4/82-5/17/84	139	1726	Capture mortality 1984
1316	M	14.5	5	6/7/82-8/4/82	29	197	Shed collar
1317	F	6.5	21	6/8/82-7/22/85	49	259	Illegal kill 1985
1318	F	16.5	30	6/8/82-12/3/85	37	549	
1320	F	20.5	27	6/8/82-12/3/85	17	111	
1321	F	19.5	38	6/9/82-7/22/85	27	332	
1322	F	11.5	14	6/9/82-4/27/84	20	130	Collar nonfunctional
1323	F	14.5	23	6/10/82-10/17/84	27	306	Shed collar; possible illegal kill
1325[b]	M	2.5	7	4/27/84-9/9/84	24	134	Defense of life or property kill 1984
1326	F	7.5	22	6/18/82-12/3/85	39	660	
1327	F	18.5	15	7/8/82-8/14/84	9	30	Dead, capture mortality?
1329	F	14.5	7	7/9/82-5/15/83	20	101	Killed by 1315 M
1330[b]	M	4.5	9	3/15/83-9/23/84	21	210	No radio contact 1985
1331	F	7.5	11	7/10/82-10/14/83	12	39	Shed collar

Table 8. Continued.

Individual No.	Sex	Age in 1985[a] (yrs)	Radio locations n	Radio locations Period	Maximum distance between locations (km)	Home range size (km^2)	Comments
1332	F	6.5	6	7/12/82-5/15/83	7	16	Died in den
1333[b]	F	18.5	16	7/13/82-5/22/84	13	67	Hunter kill 1984
1334[b]	M	4.5	7	4/27/84-6/26/84	56	433	No radio contact 1985
1335[b]	F	3.5	7	4/27/84-9/14/84	10	18	Hunter kill 1984
1336[b]	F	4.5	20	4/27/84-12/3/85	20	142	
1337	M	22.5	8	5/18/83-6/4/84	80	1552	Shed collar
1339	M	8.5	10	5/20/83-8/14/84	38	269	Shed collar
1340	F	5.5	11	5/23/83-6/27/85	26	171	
1341[b]	F	12.5	16	5/23/83-12/3/85	27	174	
1343[b]	M	4.5	2	4/27/84-5/15/84	9	--	
1344[b]	M	3.5	4	4/27/84-9/7/84	50	205	Hunter kill 1984
1345	F	10.5	10	5/24/83-7/22/85	24	142	
1346	M	7.5	2	5/25/83-8/19/83	24	--	Shed collar
1348	F	14.5	12	5/31/83-8/14/84	19	186	No signal 1985
1349	M	20.5	2	6/2/83-10/15/83	57	--	Shed collar
1350	M	10.5	2	6/3/83-8/21/83	24	--	No signal 1984
1351	F	16.5	20	6/23/83-12/3/85	36	293	
1352	F	15.5	6	6/27/83-5/18/84	17	62	Hunter kill 1984
1355	M	5.5	10	6/30/83-9/13/85	35	300	Hunter kill 1985
1356[b]	M	3.5	5	6/30/83-4/27/84	89	--	Hunter kill 1984
1357[b]	M	3.5	8	5/12/85-12/3/85	73	741	
1358[b]	M	13.5	3	5/18/84-6/4/84	19	--	Shed collar
1359[b]	M	3.5	5	5/28/85-12/3/85	8	8	
1361[b]	F	3.5	9	5/12/85-12/3/85	36	228	
1362	F	8.5	4	6/5/85-10/12/85	16	44	
1363	M	3.5	5	5/28/85-10/12/85	19	24	
1365	M	5.5	2	6/19/85-7/22/85	20	--	
1366	M	8.5	3	7/22/85-12/3/85	31	290	

Table 8. Continued.

[a] Age in 1985 or last year bear was alive.

[b] Calculations for offspring begin during year of weaning.

[c] Estimated.

Table 9. Movement of young-age bears subsequent to weaning, Alaska Range 1983-85.

Bear No. and sex	Maternal female No.	Age when weaned	Age during movement	Movement pattern
1306 M	1305	2.5	2.5	Within maternal home range (MHR)
			3.5	Within MHR
			4.5	Killed by hunter 5/20/84 in MHR
1307 M	1305	2.5	2.5	Within MHR
			3.5	Within MHR
			4.5	Sighted once within 15 km of MHR
			5.5	Moved 12 km NW of MHR
1344 M	1321	3.5	3.5	Moved 44 km SE of MHR between 5/15-6/4/84, remained there through 6/23; killed in MHR by hunter 9/7/84
1336 F	1322	3.5	3.5	Within MHR
			4.5	Within MHR, bred
1325 M	1323	2.5	2.5	Within MHR; killed in defense of life and property 9/9/84
1330 M	1329	2.5[a]	2.5	Within MHR
			3.5	Moved outside MHR?; no radio contact
1334 M	1333	3.5	3.5	Moved 48 km to SE between 6/4 and 6/25/84
			4.5	No radio contact 1985
1335 F	1333	3.5	3.5	Killed by hunter 9/14/84 in MHR
1357 M	1351	3.5	3.5	Moved 44 km NW of MHR by 12/3/85
1361 F	1351	3.5	3.5	Within MHR
1353 M	1352	2.5[b]	2.5	Killed by hunter 9/4/84 in MHR
1359 M	1360	3.5[c]	3.5	Within MHR
1363 M	1360	3.5[c]	3.5	Within MHR

Table 9. Continued.

Bear No. and sex	Maternal female No.	Age when weaned	Age during movement	Movement pattern
1355 M	Unk	Unk	3.5	Within established home range
			4.5	Within established home range
			5.5	Killed by hunter 9/13/85 12 km N of home range
1356 M	Unk	Unk	3.5	Moved 74 km ESE of den area between 4/27 and 5/20/84 when killed by hunter

[a] Orphaned when 1329 was killed and eaten by No. 1315, adult male.

[b] Orphaned when 1352 killed by hunter 5/30/84.

[c] Orphaned when 1360 died during capture.

Appendix A. Physical attributes[a] of grizzly bears captured in the northcentral Alaska Range, 1981-85.

Bear No.	Date	Sex	Age (yrs)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1301	5/18/81	M	6.5	120	180	119	31	61	114	101	21.0	36.8	3.4	3.0
1302	5/19/81	F	3.5	75	165	102	26	55	100	90	16.7	30.5	3.0	2.7
1303	6/17/81	F	2.5	57	122	87	23	53	89	78	15.1	27.7	2.5	2.7
	6/27/83	F	4.5	82	159	97	26	55	91	79	18.4	32.3	3.0	2.9
	6/14/85	F	6.5	73	--	--	--	47	85	--	18.8	32.2	--	--
1304	6/19/81	M	5.5	136	196	121	30	63	108	109	20.0	36.0	3.9	3.5
1305	6/19/81	F	24.5	114	174	103	28	60	100	96	20.1	32.6	3.0b	3.3b
1306	5/24/82	M	2.5	44	131	85	26	44	73	76	15.1	29.6	2.7	2.8
1307	5/24/82	M	2.5	44	148	84	28	46	74	83	15.4	27.3	2.5	2.5
	6/17/85	M	5.5	114[e]	--	--	--	55	94	--	19.2	34.8	--	--
1308	5/25/82	F	6.5	111	186	103	32	63	100	101	20.2	33.1	3.0	2.2b
	6/20/84	F	8.5	120[e]	--	--	--	64	116	--	20.8	34.1	--	--
1309	5/25/82	M	8.5	318[e]	238	150	36	89	152	128	25.0	39.1	4.0	3.5
1310	5/25/82	M	13.5	250[e]	--	--	--	--	--	--	--	--	b	--
	6/20/84	M	15.5	255	--	--	--	74	129	--	24.6	39.3	--	--
1311	5/26/82	F	12.5	120	190	107	30	63	113	105	21.8	33.8	3.0	2.6
	6/21/84	F	14.5	116	--	--	--	59	100	--	20.0	34.2	--	--
1312	5/26/82	F	0.5	12	81	48	15	28	43	42	10.2	16.5	m	m
1313	5/26/82	F	0.5	12	76	50	15	30	48	45	11.1	16.8	m	m
1314	5/27/82	M	6.5	116	191	114	33	61	105	99	18.5	34.8	3.6	3.3
1315	6/4/82	M	13.5	272	197	126	36	96	154	122	26.4	38.2	3.5	3.3
	5/17/84	M	15.5	295	--	--	--	97	139	--	26.8	37.5	--	--
1316	6/7/82	M	11.5	236	211	133	33	81	133	135	24.0	40.7	3.8	3.7
1317	6/8/82	F	3.5	36	142	91	24	38	62	72	14.2	27.9	2.9	2.9
	5/16/84	F	5.5	55	--	--	--	45	89	--	16.2	29.7	--	--
	5/23/85	F	6.5	59	--	--	--	43	77	--	16.4	30.3	--	--
1318	6/8/82	F	13.5	104[e]	188	113	31	57		113	19.5	33.5	3.1	2.8
	6/22/84	F	15.5	118[e]	--	--	--	59	105	--	19.8	33.5	--	--
1319	6/8/82	M	0.5	12	85	52	14	26	34	44	10.8	17.2	d	d

Appendix A. Continued.

Bear No.	Date	Sex	Age (yrs)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1320	6/8/82	F	17.5	102	181	110	29	65	103	100	21.0	33.1	2.9w	2.7w
	6/25/84	F	19.5	139	--	--	--	62	106	--	21.0	33.0	--	--
1321	6/9/82	F	16.5	141	199	107	34	69	105	115	22.1	35.8	3.5	3.1
	5/17/83	F	17.5	127	178	91	30	69	109	112	21.9	36.0	2.4b	3.2
	7/22/85	F	19.5	218	--	--	--	63	121	--	22.1	35.6	--	--
1322	6/9/82	F	8.5	91	169	100	29	62	97	97	18.9	32.8	3.2	3.0
1323	6/10/82	F	11.5	95	171	106	32	57	98	93	20.0	33.5	3.2	2.9
	6/29/84	F	13.5	132	--	--	--	61	109	--	20.9	33.6	--	--
1324	6/10/82	F	0.5	12	77	49	16	29	47	39	10.6	17.5	m	m
1325	6/10/82	M	0.5	12	86	54	15	26	48	42	11.5	18.0	m	m
	5/15/84	M	2.5	67	--	--	--	46	80	--	16.5	30.1	--	--
1326	6/18/82	F	4.5	93	172	102	27	54	88	98	17.9	31.4	3.1	2.9
	6/21/84	F	6.5	109	--	--	--	58	92	--	18.9	32.8	--	--
	6/27/85	F	7.5	111	--	--	--	52	95	--	20.1	33.3	--	--
1327	7/8/82	F	16.5	127	175	106	29	62	100	117	20.9	32.9	2.3	2.8
	6/23/84	F	18.5	125	--	--	--	61	109	--	21.0	33.5	--	--
1328	7/8/82	F	1.5	43	122	83	26	41	75	68	14.5	25.7	2.0	1.7
1329	7/9/82	F	13.5	120	186	112	30	59	106	104	19.8	34.2	3.3	3.0
1330	7/9/82	M	1.5	48	130	83	27	45	75	67	14.4	26.2	1.4	1.8
	6/28/84	M	3.5	102	--	--	--	50	99	--	17.5	32.9	--	--
1331	7/10/82	F	4.5	77	161	102	28	50	96	98	17.0	30.5		
1332	7/12/82	F	5.5	104	173	100	32	54	92	97	18.0	33.4	3.1	2.9
1333	7/12/82	F	16.5	141	175	112	33	65	117	124	21.0	34.0	3.1	2.6
1334	7/13/82	M	1.5	49	129	86	26	42	87	72	14.4	24.9	1.3	1.6
	6/27/84	M	3.5	107	--	--	--	52	104	--	18.1	31.3	--	--
1335	7/13/82	F	1.5	38	127	77	24	40	76	73	13.5	24.0	1.6	1.8
	6/25/84	F	3.5	80	--	--	--	47	90	--	16.8	30.0	--	--
1336	5/16/83	F	2.5	47	141	86	27	56	90	86	14.9	28.2	2.6	2.4
	6/26/84	F	3.5	89	--	--	--	49	101	--	16.9	31.7	--	--
	6/17/85	F	4.5	102	--	--	--	61	102	--	18.3	33.3	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yrs)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1337	5/18/83	M	20.5	289	210	122	36	98	151	135	26.6	39.8	4.0b	b
1338	5/20/83	M	6.5	111	175	89	29	35	107	101	19.9	34.8	3.5	3.4
1339	5/20/83	M	6.5	120	174	103	29	37	109	100	19.7	34.4	3.6	3.1
	5/17/84	M	7.5	168	--	--	--	60	102	--	20.0	35.0	--	--
1340	5/23/83	F	3.5	71[e]	159	86	27	58	95	91	15.7	30.2	3.2	3.2
	5/19/84	F	4.5	91[e]	--	--	--	51	95	--	17.3	31.8	--	--
	6/27/85	F	5.5	100	--	--	--	54	94	--	18.5	33.6	--	--
1341	5/23/83	F	10.5	107	171	110	31	63	125	110	20.7	33.2	3.2	3.1
1347	5/31/83	M	6.5	189	188	119	23	71	144	114	22.0	37.5	3.7	3.4
1348	5/31/83	F	12.5	--	175	107	20	72	123	110	20.0	37.6	3.2	2.9
1349	6/2/83	M	18.5	264	217	124	33	93	145	125	25.6	35.5	4.0b	3.4
1350	6/2/83	M	8.5	202	201	119	30	77	118	118	22.5	--	3.7	3.1
1351	6/23/83	F	14.5	114	181	91	23	69	114	116	21.0	38.0	3.3	3.2
	6/10/85	F	16.5	111	--	--	--	56	98	--	21.3	35.5	--	--
1352	6/27/83	F	14.5	111	175	102	29	59	103	108	19.5	34.1	3.1	2.8
1353	6/27/83	M	1.5	27	107	75	20	34	54	56	12.4	21.9	r	r
1354	6/27/83	F	1.5	12	87	60	17	24	41	43	11.0	18.4	r	r
1355	6/30/83	M	3.5	60	138	98	27	45	77	77	15.2	27.5	--	--
	6/3/85	M	5.5	70	--	--	--	49	84	--	17.4	31.6	--	--
1356	6/30/83	M	2.5	50	--	--	24	46	69	--	14.9	25.2	--	--
1357	5/15/84	M	2.5	63	--	--	--	53	90	--	14.7	27.5	--	--
	6/24/85	M	3.5	93[e]	--	--	--	50	88	--	18.5	31.1	--	--
1358	5/18/84	M	12.5	205[e]	--	--	--	86	--	--	--	38.4	--	--
1359	5/28/85	M	3.5[e]	61	--	--	--	44	--	--	14.4	29.1	--	--
1360	5/28/85	F	11.5[e]	95	--	--	--	--	89	--	19.5	34.4	--	--
1361	5/28/85	F	3.5	63	--	--	--	44	81	--	17.3	30.0	--	--
1362	6/5/85	F	8.5	--	--	--	--	--	--	--	--	--	--	--
	6/24/85	F	8.5	114	--	--	--	55	98	--	19.2	33.1	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yrs)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1363	6/5/85	M	3.5	43	128	--	--	50	86	--	16.0	28.3	--	--
1364	6/14/85	M	0.5	7	69	--	--	20	37	--	9.8	15.6	--	--
1365	6/19/85	M	5.5	118	--	--	--	57	97	--	18.9	34.9	--	--
1366	7/22/85	M	8.5	234	--	--	--	83	130	--	23.2	36.3	--	--

[a] Weights in kg; measurements in cm.

[b] Age determined by cementum layering.

[c] Designations of tooth characteristics: b=broken; w=heavily worn; r=erupting; m=deciduous milk teeth.

[d] Measurement not taken.

[e] Estimate after close examination.

Appendix B. Grizzly bear captures, recaptures, and capture-related mortalities, Alaska Range, 1981-85.

Year	Bear No.		Total no. captured during year	Cumulative no. total captures	Capture mortalities		Percentage capture mortality	
					Yearly mortality			
	New captures	Recaptures			Total	Bear No.	Year	Cumulative
1981	1301-1305		5	5	1	1301	20	20
1982	1306-1335		31[a]	36[a]	1	UM yrlg[a]	3	6
1983	1336-1356	1303, 1321	23	59	2	1338, 1347	9	7
1984	1357, 1358	1308, 1310, 1311, 1315, 1317, 1318, 1320, 1323, 1325, 1326, 1327, 1330, 1334, 1335, 1336, 1339, 1340, 1344	20	79	2(5)	1315, 1327[b], 3UM[b]	10	8
1985	1359-1366	1303, 1307, 1317, 1321, 1326, 1336, 1340, 1341, 1345, 1351, 1355, 1357	20	99	1	1360	5	7

[a] One unmarked (UM) yearling of female No. 1327 was not located after it was darted during a capture attempt and was assumed to have died.

[b] No. 1327 was found dead at the capture site and may have been killed by another bear before she recovered from immobilization drugs. We assume that her 3 cubs died without her care.

Appendix C. Current status of marked bears in the northcentral Alaska Range, 1985.

Bear No.	Sex	Initial capture Age	Initial capture Date	Date last location	Current status
1301	M	6.5	5/18/81	5/18/81	Dead, capture mortality
1302	F	3.5	5/19/81	8/11/81	Unk, shed collar fall 1981
1303	F	2.5	6/17/81	7/22/85	Unk, shed collar or dead by 12/3/85
1304	M	5.5	6/19/81	9/23/82	Unk, shed collar between 9/23 and 10/31/82
1305	F	24.5	6/19/81	9/15/82	Dead, hunter kill
1306	M	2.5	5/24/82	5/20/84	Dead, hunter kill
1307	M	2.5	5/24/82	6/24/85	Alive?, 1985 den not located
1308	F	6.5	5/25/82	12/3/85	Alive, functional collar; w/2 2-yr
1309	M	8.5	5/25/82	9/15/84	Dead, hunter kill
1310	M	13.5	5/25/82	6/20/85	Alive?, 1985 den not located
1311	F	12.5	5/26/82	12/3/85	Alive, functional collar; w/1 2-yr
1312	F	0.5	5/26/82	8/5/82	Dead, disappeared between 8/5 and 8/27/82
1313	F	0.5	5/26/82	8/5/82	Dead, disappeared between 8/5 and 8/27/82
1314	M	6.5	5/27/82	9/15/82	Dead, hunter kill
1315	M	13.5	6/4/82	5/17/84	Dead, capture mortality
1316	M	11.5	6/7/82	7/12/82	Unk, shed collar between 7/12 and 8/4/82
1317	F	3.5	6/8/82	7/22/85	Probable illegal kill
1318	F	13.5	6/8/82	12/3/85	Alive, collar functional; w/2 yrlgs
1319	M	0.5	6/8/82	6/18/82	Dead, disappeared between 6/18 and 7/2/82
1320	F	17.5	6/8/82	12/3/85	Alive, collar functional; 3 yrlgs
1321	F	16.5	6/8/82	7/22/85	Alive?, lost cubs?, den not located
1322	F	8.5	6/9/82	4/27/84	Unk, probably alive, collar nonfunctional
1323	F	11.5	6/10/82	6/29/84	Unk, unbolted collar recovered
1324	F	0.5	6/10/82	5/16/84	Unk, never radio-collared before weaning
1325	M	0.5	6/10/82	9/9/84	Dead, killed in defense of life or property
1326	F	4.5	6/18/82	12/3/85	Alive, lost cub?, functional collar
1327	F	16.5	7/8/82	6/23/84	Dead, capture-related mortality
1328	F	1.5	7/8/82	8/27/82	Dead, disappeared between 8/27 and 9/23/82
1329	F	13.5	7/9/82	5/15/83	Dead, killed and eaten by 1315M
1330	M	1.5	7/9/82	8/14/84	Unk, probably emigrated
1331	F	4.5	7/10/82	6/30/83	Unk, shed collar between 6/30 and 8/19/83
1332	F	5.5	7/12/82	10/31/82	Dead, died in den, winter 82/83
1333	F	16.5	7/12/82	5/22/84	Dead, hunter kill
1334	M	1.5	7/13/82	6/27/84	Unk, probably emigrated
1335	F	1.5	7/13/82	9/14/84	Dead, hunter kill
1336	F	2.5	5/16/83	12/3/85	Alive, functional collar
1337	M	20.5	5/18/83	5/19/84	Unk, tore collar off between 5/19 and 6/4/84, probably dead?
1338	M	6.5	5/20/83	5/20/83	Dead, capture mortality
1339	M	6.5	5/20/83	6/4/84	Unk, shed collar between 6/4 and 9/10/84
1340	F	3.5	5/23/83	6/27/84	Alive, functional collar
1341	F	10.5	5/23/83	12/3/85	Alive, functional collar

Appendix C. Continued.

Bear No.	Sex	Initial capture Age	Initial capture Date	Date last location	Current status
1342	M	2.5	5/24/83	6/27/83	Dead, illegal kill, snared fall 1983
1343	M	2.5	5/24/83	5/15/84	Unk, collar nonfunctional?
1344	M	2.5	5/24/83	9/7/84	Dead, hunter kill
1345	F	8.5	5/24/83	7/22/85	Alive, functional collar
1346	M	5.5	5/25/83	8/19/83	Unk, shed collar? between 5/25 and 8/19/83
1347	M	6.5	5/31/83	5/31/83	Dead, capture mortality
1348	F	12.5	5/31/83	8/14/84	Unk, possible illegal kill
1349	M	18.5	6/2/83	10/15/84	Unk, shed collar between 6/2 and 10/15/84 sighting fall 1985?
1350	M	8.5	6/2/83	8/21/83	Unk, not heard since 8/21/83
1351	F	14.5	6/23/83	12/3/85	Alive, functional collar
1352	F	14.5	6/27/83	5/30/84	Dead, hunter kill
1353	M	1.5	6/27/83	9/4/84	Dead, hunter kill
1354	F	1.5	6/27/83	5/18/84	Unk, never radio-collared
1355	M	3.5	6/30/83	9/13/85	Dead, hunter kill
1356	M	2.5	6/30/83	5/20/84	Dead, hunter kill
1357	M	2.5	5/15/84	12/3/85	Unk, shed collar? or dead?
1358	M	12.5	5/18/84	6/4/84	Unk, tore off collar
1359	M	3.5	5/28/85	12/3/85	Alive, functional collar
1360	F	11.5[a]	5/28/85	5/28/85	Dead, capture mortality
1361	F	3.5	5/28/85	12/3/85	Alive, functional collar
1362	F	8.5	6/5/85	10/12/85	Alive, functional collar
1363	M	3.5	6/5/85	10/12/85	Alive, functional collar
1364	M	0.5	6/14/85	6/14/85	Dead, disappeared between 6/14 and 6/24/85
1365	M	5.5	6/19/85	7/22/85	Alive, functional collar
1366	M	8.5	7/22/85	12/3/85	Unk, shed collar? or dead?

[a] Estimate.