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Effects of Harvest on Grizzly Bear Population Dynamics in the Northcentral Alaska Range

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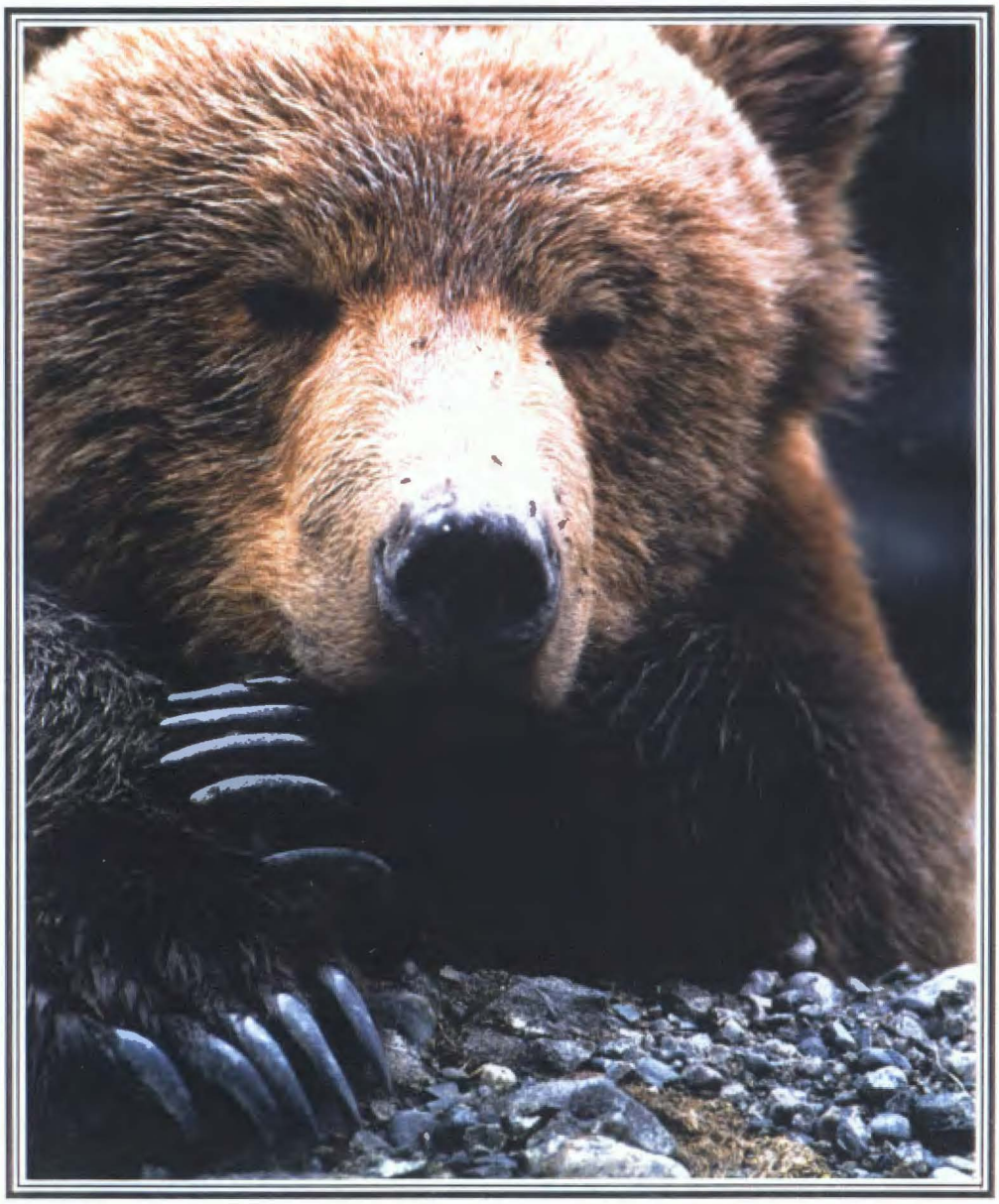

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RESEARCH FINAL REPORT

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STUDY TITLE: Effects of Harvest on Grizzly Bear Population Dynamics in the Northcentral Alaska Range

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SUMMARY

During 1996 the third phase in a long-term investigation of the effects of harvest on grizzly bear (*Ursus arctos horribilis*) population dynamics continued in a 3160-km^2 area of the northcentral Alaska Range. The total population size declined during the first 2 phases. Because they are productive and the most stable of any sex and age segment of the population, the change in numbers of adult females ($\geq$ 6 years of age) was selected as the most representative measure of population status and recovery. The mean size of the adult female segment of the population was stable at 22 (range = 21-23) from 1981 to 1988 but declined to 15 by 1992. During 1993-1996 human-caused mortality accounted for 9.5% of annual female populations; natural deaths accounted for 1.9%. Even so, the population recovered at an annual rate of 6.3% to 19 adult females by 1996; if this rate persists, recovery will be achieved by 1999. However, these rates should be viewed skeptically and not applied to management without further confirmation because the recovery was also accompanied by the highest measures of reproductive performance recorded during this 16-year study. Mean age at first parturition was 6.0 years during 1981-1996, initial litter size was 2.10 cubs, and litter size at weaning was 1.9. Mortality rates of offspring under maternal care was 28% for cubs, 13% for yearlings, and 4% for 2-year-olds.

Key words: grizzly bear, harvest rates, Interior Alaska, mortality, population dynamics, recovery, reproductive biology, *Ursus arctos*

CONTENTS

BACKGROUND

An understanding of the effects of different levels of hunter harvest on grizzly bear (*Ursus arctos horribilis*) population density, structure, and dynamics is necessary for effective management. In addition, rates of recovery and mechanisms of response to high levels of harvest must be included in analyses for management models to reflect real-life situations. Although recent studies have increased our knowledge on some of these aspects of population dynamics, additional information is necessary to clarify the extent and direction of population response to, and recovery from, high harvest levels. Further, as demands on grizzly bear habitat and populations increase, more intensive management will require models based on observed harvest and recovery rates of specific segments of the population.

To determine sustainable harvest levels for grizzly bears, it is crucial to be able to document responses in population numbers or density to various harvest rates (Miller et al. 1987; Reynolds et al. 1987; Miller 1990*a*,*b*,*c*, 1993; Miller et al. 1997). It is equally important to understand the mechanisms of population responses to harvest (such as compensatory production or survival) through long-term observation of individuals (Reynolds et al. 1987;

Schwartz and Franzmann 1991; Reynolds and Boudreau 1992). Use of harvest data alone is inadequate for timely determination of population trend or calculation of sustainable harvest rates (Harris and Metzgar 1987).

Documentation of population response to exploitation is necessary to fully realize the benefits from this long-term study. Measures of population production, survival, compensatory behavior, and emigration rates are essential to effectively assess this response. Because of characteristics of production and survival, grizzly bear populations respond very slowly to forces that may change population status. For instance, Alaska Range grizzly bears do not usually produce surviving young until they reach 7 years of age and the mean interval between litters can be as long as 4.1 years (Reynolds 1990; Reynolds and Boudreau 1990), so the effects of compensatory production or survival are difficult to document. In addition, stochastic factors such as annual variation in weather or food resources can complicate interpretation of responses to reduction in mortality influences from sport hunting. Measurements of these variables over periods long enough so that changes in trend can be separated from annual variation is crucial to effective management.

This study was initiated in 1981 as a 3-phase study. It has been conducted in a 3160-km^2 study area of representative northern Alaska Range habitat in Unit 20A. The study area is large enough to include the entire home ranges of 66% of females under observation for at least 5 years, and 17% of males (Reynolds 1993*a*).

Phase I was completed in 1985; it emphasized gathering of baseline information on population biology (Reynolds 1982; Reynolds and Hechtel 1983, 1984, 1985, 1986, 1988; Reynolds et al. 1987). Harvest level during the years 1965 through 1980 was generally moderate (i.e., 5.6% of the estimated population). Initially, study design called for low to moderate levels of harvest to occur during Phase I while baseline data were collected. This was to be followed by higher harvest levels during Phase II, while data were collected on individuals and on population response to increased harvest. However, grizzly bear harvest by hunters, supplemented in part by capture mortality, resulted in the 12% harvest level during Phase I. Even though this harvest was higher than indicated in the study design, this circumstance strengthened rather than detracted from the investigation. By 1985, at the end of Phase I, the population had already begun to decline. The early high harvest level allowed monitoring of reproductive responses over a longer period.

Phase II, which continued from 1986 through 1991, was designed to measure grizzly bear population response to human-caused mortality. Throughout this period, mean annual harvest rates continued at 11% (Reynolds 1989, 1990; Reynolds and Boudreau 1992). Alaska Department of Fish and Game (ADF&G) staff monitored changes in estimated population size and productivity. In 1986 a mark-recapture density estimate was conducted (Reynolds et al. 1987). Changes in reproductive performance of adult females and survival rates of young bears showed inconclusive evidence for compensatory production and survival.

Following completion of Phase II, a second mark-recapture density estimate was conducted in 1992 (Reynolds 1993*a*; Miller et al. 1997) for comparison with the 1986 estimate (Reynolds et al. 1987). No changes in density were detected between the 2 time periods because the

estimates displayed wide confidence intervals, primarily because of low density within the search areas. However, annual direct count estimates, based on intensive capture and presence of individual bears within home ranges in the area, indicated that by 1992 the population of bears ≥ 2 years of age declined by 36% since 1981 and adult females declined by 32%.

Patterns of movement or fidelity to maternal or established home ranges indicated that all females remained in the vicinity of their maternal home ranges and none emigrated from the study area. All males weaned or captured as 2- or 3-year-olds emigrated from their maternal or established home ranges within 2 years. Males ≥ 4 years of age apparently left their maternal home ranges to immigrate to the study area; none of these later emigrated from the study area although some had home ranges that extended beyond the study area boundaries (Reynolds 1992).

Several other intensive studies have documented declining populations (Craighead et al. 1974; Knight and Eberhardt 1984, 1985; McLellan 1989*a*,*b*,*c*). Harvest models that have been developed are complex and illustrate the difficulty of using harvest data to predict population changes (Tait 1983; Harris and Metzgar 1987; Miller and Miller 1990; Miller 1993). Miller (1990*a*) estimated a sustainable harvest rate of 8% in Unit 13 in Alaska but concluded a number of potential biases remained to be investigated. Other studies have addressed aspects of population biology or density of grizzly bears in Interior Alaska (Dean 1976; Murie 1981; Ballard et al. 1982; Miller and Ballard 1982; Miller 1984, 1987, 1990*a*,*b*, 1993).

Before effects of various harvest rates can be assessed, the following information should be available: 1) population density or size; 2) population structure; 3) movement patterns; 4) home range size; 5) mortality and survival rates; and 6) reproductive potential including age at first breeding, litter size, and interval between litters (Craighead et al. 1974, 1995; Reynolds 1974, 1976, 1978, 1980, 1993*a*; Bunnell and Tait 1980, 1981; McLellan 1989*a*; Miller 1990*c*; Miller and Miller 1990). The approach taken in this study is to monitor these characteristics annually so that harvest can be related to potential population responses.

OBJECTIVE

Following reductions in human-caused mortality rates, determine the rate and length of time necessary for recovery of the female segment of a grizzly bear population which had declined by 32% from 1981-1988 levels; specifically, determine the recovery responses in the dynamics of the population, including female population size, total population size, and production and survival of offspring.

STUDY AREA

The 3160-km^2 (1220-mi^2) study area is located in the mountains and foothills of the northcentral Alaska Range within Unit 20A. Study area boundaries did not include mountainous areas above 1800 m (6000 ft), glaciers, or heavily forested portions of the Tanana Flats where we did not attempt searches and where we made few observations. Boundaries are the Gold King Creek and Wood River drainages 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°07'N) to the north. The study area includes portions of 2 US Army reservations, Fort Wainwright and Fort Greely.

Elevation in the study area ranges from 500 to 3700 m (1500-12,000 ft). Most rivers flow northerly through U-shaped, glacially formed valleys and are fed by active glaciers. Tree line is at approximately 900 m (3000 ft). Dense patches of willow (*Salix* spp.) or alder (*Alnus crispa*), which bears use for cover, may be present up to an elevation of approximately 1200 m (4000 ft).

METHODS

Methods used to capture bears, monitor individual presence in the study area, and measure population variables have been described in previous reports and papers (Reynolds 1982, 1993*b*, 1994, 1995, 1996; Reynolds and Hechtel 1983, 1984, 1985, 1986, 1988; Reynolds et al. 1987; Taylor et al. 1989; Reynolds and Boudreau 1992; Miller et al. 1997). Standardized weight and measurement data were collected (Kingsley et al. 1988).

RESULTS AND DISCUSSION

The primary emphasis of work accomplished during 1993-1996 was to monitor all adult females living within the study area. As funding allowed, I also replaced radiocollars on adult females and those 2- to 5-year-old females that would enter adult cohorts if they survived. In addition, I monitored measures of reproductive status, reproductive performance, and possible compensatory changes in population dynamics.

Bears Captured and Radiocollared

During 1993-1996, 67 bears were captured a total of 104 times (Table 1). Captures included 42 females and 25 males: 22 (18 females, 4 males) were recaptured to replace radiocollars and 45 had not been captured previously, but 12 of the latter were also subsequently recaptured to replace radiocollars. Of those not previously captured, 30 were cubs, yearlings, or 2-year-olds of marked females; 7 were females captured on the extreme edges of the study area, 1 was a young female captured near the center of the area; and 7 were males, all but one of which were 4- to 5-year-olds.

For comparison, during the entire study period, 171 individual bears were captured from 1981 through 1996 (Table 1). In addition, we recaptured 260 (Appendix A), usually to replace radiocollars. From 1981 to 1983, initial captures were made of bears of all sex and age classes. Since 1983, most initial captures were of offspring of previously captured bears. Radiocollars have been placed on 143 bears; 53 on young-age males (≤ 5 years), 18 on adult males (≥ 6 years), 45 on young-age females, and 27 on adult females. Radiocollars were not placed on 28 bears because they were cubs or yearlings (22), 2-year-old males (1), capture-related mortalities (4), or captured outside the boundaries of the study area (1). By spring 1996, 39 bears were carrying radiocollars, 7 had shed collars and were assumed alive in the study area, 81 were known dead and 11 presumed dead, and 14 could not be located because of long-range movement or collar failure (Appendix B).

No capture mortalities occurred during 199 captures in the past 9 years (Appendix A). This is in part due to the use of Telazol® (tiletamine HCL and zolazepam HCL, Fort Dodge Lab, Fort Dodge, IA) as an immobilizing drug (Taylor et al. 1989) and in part to experience gained in avoiding other hazards related to immobilization (Reynolds 1992). Capture-related mortality rate during the entire study period was 2% (Appendix A); half of these were due to the use of etorphine during 1983-1985, when other immobilizing drugs were not easily available.

Movement Patterns and Fidelity to the Area

Analysis of movement patterns of grizzly bears in the study area and intensive aerial monitoring allowed me to account for the status of most individuals in the population (Reynolds and Boudreau 1992, Reynolds 1993*a*). Adult females were faithful for up to 16 years to the home ranges in which they were first observed and no emigration was observed. Following weaning, all female offspring remained within or adjacent to their maternal home ranges and all male offspring emigrated from the study area by the time they reached age 4. Home ranges of adult males (≥ 6 yr) were large, and most extended beyond the boundaries of the study area, but no emigration was documented. Immigrant males captured as 2- to 4-year-olds either passed through the study area or established home ranges that included it (Reynolds 1993*a*). These patterns resulted in stable occupancy of home ranges by bears in this population with the exception of young males.

Status and presence of individual bears in the study area were monitored annually (Appendix C). Because adult females rarely shed radiocollars and were faithful to their home range, their presence and status in the study were predictable. For those few adult females with collars that malfunctioned or those 2- to 5-year-olds with breakaway collars that fell off before they could be replaced, presence in the area was reliably predicted (Reynolds 1993*a*). Once telemetry contact was lost with a female, an intensive search of her home range was begun. Collared males in the area were especially monitored during the breeding season so that any consorting females could be recaptured. Of 21 instances in which radiocollars failed or broke away from females that had reached at least 5 years of age, 6 were recaptured within their home range after 1 year, 3 after 2 years, 5 after 3 years, 4 after 4 years, 1 after 5 years, and 1 after 6 years. One bear was not found after 6 years. Based on this pattern, females were assumed present in the study area for 6 years following collar failure and then were assumed dead. Based on data collected in a similar manner, 2- to 3-year-old males were assumed to have emigrated by the age of 4, and males ≥ 4 years old were assumed to have immigrated to the area at age 4 and remained alive and present until they were not located for 4 years (Reynolds 1993*a*).

POPULATION SIZE AND DENSITY

We estimated population size and density in the 3160-km^2 study area using the direct count method (Reynolds 1980, 1993*a*,*b*; Reynolds et al. 1987; McLellan 1989*a*); 2 mark-recapture estimates were also conducted in a portion of the area (Reynolds et al. 1987; Reynolds 1993*b*; Miller et al. 1997). Direct count estimates were made annually during spring after emergence from dens and before any harvest or other observed mortality occurred (Table 2). Although 3 measures of population size were calculated using this method, the estimate of number and density of bears ≥ 2 years of age, adjusted to account for population closure, was judged most useful for population analysis and management purposes (Reynolds 1993*a*). Using this measure, the 1996 estimated population size was 38 bears, or 12.0 bears/1000 km^2. This is a decline from the adjusted 1981 population size of 55 or 17.4 bears ≥ 2 years of age /1000 km^2, but represents a 23% recovery from the 1991 estimated population of 31 bears.

Two other measures of estimated population size and density were calculated annually using the direct count method: 1) minimum population of bears of all ages, unadjusted for population closure and 2) minimum population of bears of all ages, adjusted for population closure (Table 2). Minimum population estimates included all bears present in the study area regardless of age, or the portion of their home ranges within the study area; in other words, these estimates were not adjusted for population closure. This measure is the least useful of the 3 direct count estimates because it does not account for closure; it is included here for comparative purposes only.

The estimated minimum 1996 spring population in the study area, adjusted for closure, was 72 bears of all ages, a density of 22.8 bears/1000 km^2. This included 59 marked bears, adjusted from a total marked population of 71 bears whose home ranges included the study area; 13 unmarked offspring of marked females, adjusted from a total of 20; and zero unmarked bears killed by hunters, adjusted from a total of 1 bear. This total adjusted population size estimate is the same as that for 1981 and represents recovery from the low levels of 53 and 51 bears recorded for 1992 and 1993, respectively. In contrast, as described above, the adjusted estimated population of bears ≥ 2 years of age has not recovered; the greatest portion of this difference is in the high number of cubs, yearlings, and 2-year-olds present during 1996 (see section on litter and cohort size).

In 1986 and 1992, to apply more statistically rigorous analysis to density estimates, mark-recapture techniques that accounted for population closure were conducted in portions of the area (Reynolds et al. 1987; Reynolds and Boudreau 1990; Reynolds 1993*a*,*b*; Miller et al. 1997). During 1986 the estimate of density of bears ≥ 2 years of age in a 950-km^2 portion of the area was 11.2/1000 km^2 (95% CI = 8.4-25.4). In 1992 applying an improved analysis technique developed by Miller et al. (1997) and increasing the size of the portion of the area to 1496 km^2 allowed calculation of an estimate with a smaller confidence interval. This estimate, 11.2/1000 km^2 for bears ≥ 2 years of age (95% CI = 9.0-15.5), was more precise and close to the direct count estimate of 12.0/1000 km^2 calculated for the entire 3160-km^2 study area.

FEMALES PRESENT IN THE POPULATION

Adult females (≥ 6 years of age) compose the most productive and stable of any sex and age segment of the population (Reynolds 1993*a*). Adult females are characterized by the lowest natural mortality rates of any sex and age class (Craighead et al. 1995) and are much less affected by the wide annual variation in cohort size that is observed in cub to 2-year-old age classes (Reynolds 1993*a*). Once females attain maturity and are accompanied by offspring, they are less vulnerable to hunting than adult males because of regulations that prohibit the hunting of females with cubs or yearlings (Reynolds 1993*a*). Also, their behavior tends to reduce vulnerability to mortality associated with wide-ranging movement patterns (Bunnell and Tait 1980). For these reasons, Alaskan wildlife managers have recognized the value of basing management strategies on the take of females in sport hunting harvest (ADF&G files, October 1994). Similarly, use of density or mortality rates of adult female brown bears as benchmarks in population management has been proposed or utilized in other areas, including Yellowstone Park (Eberhardt et al. 1986; Craighead et al. 1995) and Sweden (Swenson et al. 1994).

During 1981-1989 the female segment of the population at the beginning of each spring remained stable at 21-23 bears ≥ 6 years of age (Table 3), despite a mean annual harvest rate of 6.3% (Reynolds 1993*a*). Natural mortality of all females ≥ 2 years of age during the same period was 2.5% (Reynolds 1993*a*). Following 1989-1992 mean harvest rates of 16.7% for adult females, including unreported wounding loss, the adult female population reached a low of 15 during 1992 and 1993 (Reynolds 1993*a,b*).

Adult females began to recover following a delay in the opening of the fall hunting season from 1 September to 10 September. Also, most bears in the area are taken incidentally to other hunts, and the caribou season in the area was closed beginning in September 1991. An educational effort was begun to make hunters aware of the conservation importance of reducing the take of females and to teach hunters to identify differences between males and females. By May 1996, 19 adult females ≥ 6 years of age, adjusted for closure, were assumed present in the population (22 if not adjusted for closure) (Table 3). The total number, not adjusted for closure, included 6 observed with cubs, 10 observed with yearlings, 4 observed with 2-year-olds, and 2 whose collars failed but were assumed alive. The latter 2 females met the criteria for inclusion in the estimated population as described in Reynolds (1994).

These increases could be due to a combination of factors including: 1) a decline in human-caused mortality; 2) the production of strong cohorts in 1988 and 1989; and 3) high survival rates in both young-aged and adult female segments of the population since 1993.

REPRODUCTIVE BIOLOGY

Age at First Production of Young

The mean age at first production of cubs was 6.0 years (n = 28). The mean age at which females first produced cubs that survived until fall was 6.6 years (n = 31). However, this is a minimum figure because it includes 2 bears that lost cubs at one age and bred again with an outcome that was undetermined but assumed to result in surviving cubs the next year (1 at age 7, the other at age 9). Although the mean age of first production of cubs was similar for

the 1981-1992 and 1993-1996 periods, differences were observed in the mean age at which first surviving young were produced. During 1981-1992 mean age at parturition of surviving offspring was 7.1 years (n = 15) (Reynolds 1993*a*), but since then, the mean age has been 6.1 years (n = 16). In the 1981-1992 period, only 3 of 11 5-year-old females were observed with cubs or showed evidence of suckling, although 7 had been observed with males the previous year (Reynolds 1993*a*). In comparison, during 1993-1996, 7 of 16 5-year-old females produced cubs. However, because the sample length differed and because the earlier period included 1983, a year in which cub production failed (Reynolds and Hechtel 1984), the differences in mean age may not be meaningful. The range of ages at which females first produced cubs in this area was from 5 to 7 years, but the age at parturition for females that produced cubs that were successfully reared was 5 to 10 years (Table 4).

Litter and Cohort Size

Mean litter size during 1981-1996 was 2.10 for 71 litters of cubs, 1.94 for 65 litters of yearlings, and 2.00 for 38 litters of 2-year-olds, and 1.78 for 9 litters of 3-year-olds (Table 5). For comparison in the Nelchina Basin on the south side of the Alaska Range, Miller (1987, 1990*a*, 1997) found the same mean cub litter size (2.1) but a mean yearling litter size of only 1.8.

In the northcentral Alaska Range, the number of females producing cubs varied from year to year, ranging from 1 female producing 1 cub in 1983 to 13 females producing 26 cubs in 1995 (Table 6). Initial cohort size was lowest during 1983 and 1992. The poor cub production observed in 1983 may have been due to failure of berry crops in 1982, as it was in the southcentral Alaska Range (Miller 1984), or to the weather patterns of winter 1982-1983, in which little snow fell and temperatures fluctuated widely. Low cub production was also observed in 1992. Only 3 females were known to have bred in 1991; 2 females each produced litters of a single cub. The third was radiotracked to a den site, but her radiocollar ceased functioning and she was not observed subsequently. This low production was related to a decline in adult females in the population and the fact that 12 other productive females, accompanied by cub or yearling offspring, were not available to breed.

Strong cohorts were produced during 1987, 1990, 1994, and 1995, when 18, 16, 17, and 26 cubs were produced, respectively (Table 6). The 1987 cohort included 10 offspring that survived until weaning; the 1990 cohort, 10; and the 1994 cohort, 10. Although the 1995 cohort had not reached weaning age by the time of den entry in fall 1996, the survival of 18 from emergence as cubs until that age (about 21 mo) is a good approximation of the number that will reach weaning age in 1997. Strong cohorts with high initial size and high subsequent survival play an important mitigating role in the recovery of the female segment of the population.

Although the difference in mean litter size between cubs and yearling is small, it is primarily due to the mortality of entire litters rather than an indication of uniformly high survival rates across litters. Similar patterns of litter mortality have been recorded in northwestern Alaska (H Reynolds, unpubl data).

The mean size of 38 litters that were observed until weaning as yearlings (n = 3), 2-year-olds (n = 25), or 3-year-olds (n = 10), was 1.9 (Table 4). The annual number of adult females in the population since 1982 has ranged from 14 to 23 (Table 4 and 5), and the observed annual numbers of litters produced within the study area ranged from 1 to 11 (Table 5). From 1982 to 1996 the observed annual number of weaned litters ranged from 1 to 5. These patterns also reflect mortality of entire litters, mostly in cub or yearling age classes.

Reproductive Interval

Reproductive interval, or reproductive cycle, was defined as the period between weaning of one litter by an adult female and the successful rearing and weaning of her subsequent litter (Reynolds and Hechtel 1983; Schwartz and Franzmann 1991). For females producing cubs for the first time, intervals began at the first breeding that resulted in offspring. Years in which a female bred but failed to conceive or lost her litter are included in this definition of 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, 1995; Reynolds 1974, 1976, 1978, 1980; Glenn et al. 1976; Reynolds and Hechtel 1982).

Offspring were observed weaned as yearlings (n = 3 litters), 2-year-olds (n = 24 litters), or 3-year-olds (n = 12 litters). Mean minimum reproductive interval, however, was 3.9 years (n = 79), based on those cycles that were observed plus those projected by assuming weaning of offspring as 2-year-olds (Table 7). Alternately, a projected minimum cycle length based upon observed proportions of those litters weaned as yearlings, 2- and 3-year-olds would result in an estimated mean reproductive interval of 4.0 years. All 21 intervals $\geq$ 5 years resulted from interruption of the breeding cycle due to mortality of litters or to breeding that did not produce cubs the following year.

MORTALITY

From 1981 through 1996 at least 191 bears died in the study area (Table 8 and 9). Hunters killed 84 bears, 63 offspring were missing from family groups and presumed dead, 9 died as a result of capture, 14 were killed illegally, 9 were killed in defense of life or property (DLP), 4 were presumed wounding losses (by hunters or DLP), and 8 were natural mortalities other than offspring that disappeared from the care of their mothers (Table 9; Appendix B).

The causes of mortality for cubs, yearlings, and 2-year-olds that 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; Reynolds and Hechtel 1982, 1984), Alaska Range (Dean et al. 1986), 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). During 1981-1992 simple pooled annual natural mortality rates (i.e., excluding human-caused deaths) for offspring under maternal care were 23% for cubs (n = 80), 6% for yearlings (n = 67), and 5% for 2-year-olds (n = 39) (Reynolds 1993*a*). Using similar data for the 1993-1996 period, calculated rates were 35% for cubs (n = 57), 26% for yearlings (n = 39), and 0% for 2-year-olds (n = 9). However,

using the pooled sample for the entire 1981-1996 period, natural mortality rates were 28% (n = 137) for cubs, 13% for yearlings (n = 106), and 4% for 2-year-olds (n = 48).

Harvest of grizzly bears by hunters in Unit 20A, which includes the study area, was primarily influenced by the length of caribou (*Rangifer tarandus*) and moose (*Alces alces*) seasons and secondarily by the length of bear seasons and weather (Reynolds and Boudreau 1992). Bear harvests during the 1960s declined after the fall season opening changed from 1 September to 15 September; it fell again following caribou and moose season reductions. Harvests climbed as moose seasons lengthened and caribou seasons reopened. Since 1984 grizzly bear seasons have been liberal, but harvest has been influenced more by changes in caribou seasons or caribou movement patterns and rain or inclement flying weather during September. Most grizzly bears were harvested by hunters during caribou or moose hunts and with little apparent selectivity for large adult males (Reynolds and Boudreau 1992).

Sport hunting is a major source of mortality in this population. Before 1981 the mean annual harvest ranged from 1 to 15 with a mean take of 5.0 (Table 10). If the population remained relatively stable during 1961-1980 and the pre-1981 adjusted minimum density was stable at the 1981 estimate of 22.8 bears/1000 km^2 (59.0/1000 mi^2), then the average annual harvest rate was approximately 5.6% of the population, with a range of 1.1% to 16.5%. By comparison, during 1981-1992 the mean harvest rate for the minimum population, adjusted for closure and including all human-caused mortalities, was 11% (Table 11). The same harvest rate of 11% was calculated when neither the population nor the harvest was adjusted for closure. Alternately, if harvest rates are calculated for only those bears ≥ 2 years of age, and adjusted to account for lack of population closure, then the mean mortality rate for 1981 through 1992 was 16% (Reynolds 1993*a*). In comparison, harvest rate for bears ≥ 2 years of age, adjusted to account for lack of closure, was 12% for the 1993-1996 period, or 14% if data were pooled for 1981-1996. Mean annual number harvested from the study area during 1981-1992 was 7.4 bears, but only 4.5 bears since then.

More than a simple calculation of harvest rate is necessary to evaluate the effect of harvest or to correlate harvest rates with population trend. Both Craighead et al. (1976, 1995) and Knight and Eberhardt (1984) 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. These data also indicate the importance of adult females to population dynamics. Between 1981 and 1988 observed harvest did not result in a decline in the number of adult females. The harvest rate of 6.3%, including all documented human-caused mortality but not natural mortality, apparently led to only minor fluctuations in the 21 to 23 females present in spring populations from 1981 to 1989 (Reynolds 1993*a*). During 1989-1992 harvest rates of 16.7%, including unreported wounding loss, resulted in an adult female population of only 15 during 1992 and 1993.

During 1993-1996 human-caused mortality rate of adult females decreased from that of 1989-1992 but was still higher than that observed during 1981-1988, based on monitoring 26 individual radiocollared females ≥ 6 years of age. Adult female mortality rate during 1993-1996 was 9.5% from human-related causes and 1.9% from natural causes based on telemetry contact from bears 6 to 48 months old (n = 650 mo). Observed mortalities included 2 hunter

kills, 2 DLP (1 of these was illegal, ruled not justifiable in court), 1 killed illegally, and 1 killed by another bear. This rate, under the environmental and population status during the period, allowed the adult female segment of the population to begin recovery toward previous levels. However, based on the stability of the adult female segment of the population during 1981-1988 under a 6.3% mortality rate, it is important to emphasize that factors *other* than hunter harvest must have allowed the female population to grow under a 9.5% human-caused mortality rate. The 9.5% rate should be viewed skeptically and not applied to sustained yield management of females until other factors involved in observed growth of the population can be identified and their relative contributions evaluated.

Alternately, if calculations are based on annual numbers of females present in the population and known mortalities, rather than calculated from radiotelemetry data, mortality rates are 7.3% for adult females during 1981-1988, 18.1% during 1989-1992, and 8.8% during 1993-1996.

Population Recovery

For the purposes of this study, recovery from population decline will be achieved when the adult female segment of the population reaches the mean level of 22 observed during 1981-1988 (range = 21-23). During that period, the mean annual population was very stable, but declined 32% to 15 by 1992. However, by 1996 the adult female population recovered to 19 bears, 86% of its former size. If the mean annual recovery rate of 6.1% observed during 1993-1996 persists, recovery based on numbers of adult females can be achieved by 1999. Under the environmental conditions present during the 1993-1996 period, 2 strong cohorts of cubs were produced and survival was good. By fall 1996 surviving members of the 1994 and 1995 cohorts included 8 2-year-olds and 18 yearlings. This resulted in higher numbers in cohorts ≥ 2 years of age during 1995 and 1996 than in any other years of the study (Table 3). If present rates of survival persist and the mean numbers of females killed by humans decline or at least do not increase, then those cohorts may provide adequate population growth for recovery.

However, the potential also exists for limiting factors to further retard recovery. In 1996 limited caribou seasons in the area were reopened and additional moose seasons were also established in areas heavily used by females. Because most human-caused mortality of grizzlies in the area has been related to incidental kill by moose and caribou hunters (Reynolds 1993*a*), there is a potential for increase in harvest rate. Further, there is evidence that environmental or population conditions have been more conducive to cub production and a younger age at first production of young since 1990 than during the 1981-1989 period. If such relationships exist, they could recur and impede population recovery.

CONCLUSIONS AND RECOMMENDATIONS

This is the final year of the third phase in a study to evaluate effects of harvest on grizzly bear population dynamics. The primary objective during this phase was to monitor the recovery or stabilization of the population and to document the accompanying changes in productive capacity. In a 3160-km^2 study area in the northcentral Alaska Range, major findings of grizzly bear research for the 1993-1996 report period included the following:

1 Using the direct count method and adjusting for area closure, in 1981 there were 55 bears ≥ 2 years of age in the study area, or 17.4 bears ≥ 2 years of age/1000 km^2. By 1992, following high levels of human-caused mortality, this segment of the population declined to 31 bears or 9.8/1000 km^2. By 1996, following a reduction in the fall hunting season and educational efforts designed to protect females, the number of bears recovered to 38 bears or 12.0 bears ≥ 2 years of age/1000 km^2, adjusted for closure.

2 Because they compose the most productive and stable of any sex and age segment of the population, the change in numbers of adult females ≥ 6 years of age was selected as the most representative measure of population status and recovery. Annual adult female numbers in the study area, adjusted for closure, remained stable at 21 to 23 bears during 1981-1989, declined to 15 during 1991 and 1992, and recovered to 19 by 1996.

3 The grizzly bear population in this area was a productive one: mean age at first production of young was 6.0 years; initial litter size was 2.10 cubs; litter size at weaning was 1.9 for yearlings, 2-year-olds, and 3-year-olds combined; and mean reproductive interval was 3.9 years. The cohort of 26 cubs produced in 1995 was the largest recorded during this study, the 1994 cohort of 17 cubs was the third largest, and those for 1993 and 1996 included 10 and 11 cubs, respectively, near the mean size of 11.5 for 1981-1996.

4 Survival rates for offspring under maternal care was 72% for cubs, 87% for yearlings, and 96% for 2-year-olds. During 1961-1980, prior to this study, the mean annual harvest rate was an estimated 5.6% of the population. During 1981-1992, human-caused mortality, including hunter kills, bears killed in defense of life or property, and capture mortalities, accounted for an average of 16% of the bears ≥ 2 years of age in the population when both harvest and population were adjusted for closure. During 1993-1996 mean annual human-caused mortality rate was 11% of the population, adjusted for closure.

5 Mean annual human-caused mortality rate for adult females was 6.3% during 1981-1988, 16.7% from spring 1989 through 1992, and 11.0% during 1993-1996. Natural mortality rates during 1981-1992 were 2.5% for females ≥ 2 years of age; in comparison, during 1993-1996, natural mortality for adult females was 1.9%.

6 Regaining former population size will require recovery of the adult female segment of the population. Numbers of adult females declined 32% from their 1981-1988 mean level of 22 bears to 15 bears by 1992. Following reductions in seasons and hunting pressure, adult females recovered to 86% of their former numbers by 1996. If human-caused mortality is reduced and productivity remains at present levels, the population could achieve recovery by 1999.

Continuation of this study should enable us to answer the following questions.

1 Will continued harvest at current or reduced levels result in a further decline in population size?

2 Can presently available population models be used to confirm observed patterns of population change that occurred in this study? If not, can they be modified or a better model be developed to more accurately predict changes in populations harvested at various rates?

3 If population recovery occurs in this study area, what mechanisms or changes in reproduction, survival, and harvest will be most responsible?

4 For grizzly bear populations a harvest rate of 4% to 6% is generally accepted as allowing maximum sustained yield. Using population modeling based on data gathered from this study, can higher rates be safely harvested if managed to minimize female mortality?

The answers to these questions should allow managers to better predict the effects of high levels of bear harvest, to better predict the length of time necessary for population recovery, and to assess the effects of various levels of harvest on grizzly populations.

Therefore, I recommend the mean harvest rates that began during the early 1980s be reduced to 3% of adult females and no more than 6% to 8% of bears ≥ 2 years of age until recovery is achieved. Concurrently, research effort should continue to monitor the dynamics of this population to document mechanisms of recovery. Emphasis should be directed toward determining the response by individual members of the population to high harvest levels and the ways individual responses affect the population. Further attention should be directed toward constructing and testing population dynamics models based on measurable productivity and harvest variables.

It will be especially important to continue to radiocollar and monitor the presence and status of all adult females in the study area. Female offspring of marked females should also be radiocollared to monitor their presence in the population and the rate at which they serve as recruits to the adult female cohort.

Hunter harvest should continue to be closely monitored and the hunting of females discouraged. ADF&G staff should continue to explore the effectiveness of other methods besides season and bag limit management in reducing harvest of females.

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Table 1 Capture and marking characteristics of 171 bears captured in the northcentral Alaska Range, 1981-1996

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1301 M	6	5/18/81	120 (265)	Buchanan Creek	1.8/1.2 H	373/374	G/G
1302 F	3	5/19/81	75 (165)	East Fork Delta	1.0/1.0 M	368/367	R/G
	8	6/12/86	114 (250)	East Fork Delta	2.2 TEL M	280/281	O/lB
	11	5/12/89	109 (241)	Buchanan Creek	4.5 TEL M	339/340	O/lB
1303 F	2	6/17/81	57 (125)	Mystic Mountain	1.4/1.4 M	524/523	R/R
	4	6/27/83	82 (180)	Hearst Creek	5.0 M99 M	3227/3214	R/R
	6	6/14/85	73 (160)	Upper Gold King	2.0/2.0 M	486/487	R/R
	12	5/31/91	95 (210)	Upper Moose Creek	1.0 TEL L	104/104	Y/W
1304 M	5	6/19/81	136 (300)	West Fork Delta	2.4/2.0 M	451/452	lB/R
	11	5/21/87	255 (560)	Threemile Creek	8.1 TEL M	430/431	W/mG
	13	6/7/89	245 (540)	Slate Creek	7.0 TEL M	778/--	W/--
	15	6/1/91	272 (600)	West Fork Delta	9.6 TEL M	136/137	W/mG
1305 F	24	6/19/81	114 (250)	Slate Creek	A M	453/454	O/R
1306 M	2	5/24/82	44 (97)	West Fork Delta	1.0/1.0 L	3151/3086	G/lB
1307 M	2	5/24/82	44 (98)	West Fork Delta	1.0/1.0 H	3087/3152	lB/G
	5	6/17/85	114 (250)[d]	Sheep Creek	2.4/2.6 L	3087/3152	lB/G
1308 F	6	5/25/82	111 (245)	Dry Creek	-[e]	3001/3154	O/Pp
	8	6/20/84	120 (265)	Dry Creek	5.0 M99 M	3001/471	O/Pp
	11	6/8/87	123 (270)	Dry Creek	3.3 TEL M	528/529	O/Pp
	15	5/6/91	125 (275)	Dry Creek	6.0 TEL M	150/149	W/R
	18	5/30/94	129 (285)	Dry Creek	6.0 TEL M	332/333	W/R
	19	6/6/95	129 (285)	Dry Creek	7.2 TEL M	332/333	W/R
1309 M	8	5/25/82	318 (700)[d]	Dry Creek	A L	3153/3101	dB/Bk
1310 M	13	5/25/82	250 (550)[d]	Buchanan Creek	2.0/2.0 M	No tags	
	15	6/20/84	241 (530)	Molybdenum Ridge	4.0/2.0 M	467/473	O/W
	18	5/21/87	264 (580)	Buchanan Creek	9.0 TEL M	414/413	Y/W
1311 F	12	5/26/82	120 (265)	Molybdenum Ridge	1.9/2.1 M	3106/3107	W/W
	14	6/21/84	116 (255)	Molybdenum Ridge	2.0/2.2 M	466/455	W/W
	17	6/8/87	123 (270)[d]	Molybdenum Ridge	3.4 TEL M	571/570	W/W
	21	6/3/91	125 (275)	Molybdenum Ridge	5.5 TEL M	139/140	W/W

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	22	5/10/92	121 (267)	Molybdenum Ridge	5.0 TEL M	249/250	W/W
	25	6/11/95	118 (260)	Molybdenum Ridge	7.0 TEL M		
1312 F	Cub	5/26/82	12 (26)	Molybdenum Ridge	0.1/0.1 M	3104/3155	O/W[f]
1313 F	Cub	5/26/82	12 (27)	Molybdenum Ridge	0.08/0.13 M	3156/3105	W/O[f]
1314 M	6	5/27/82	116 (255)	Iowa Ridge	2.1/1.9 H	3088/3002	dB/lB
1315 M	13	6/4/82	272 (600)	Buchanan Creek	1.9/2.1 L	3102/3157	Bk/O
	15	5/17/84	295 (650)	Hayes Creek	A H	3322/none	Bk/-
1316 M	11	6/7/82	236 (520)	West Fork Delta	3.8/0.0 H	3089/3090	O/lB
1317 F	3	6/8/82	36 (80)	Forgotten Creek	1.2/1.8 L	3091/3003	lB/O
	5	5/16/84	55 (122)	Upper West Fork	A L	3486/3239	lB/O
	6	5/23/85	59 (130)	Upper Wood River	7.0 M99 M	497/498	lB/O
1318 F	13	6/8/82	104(230)	Buchanan Creek	A L	3004/3103	W/G
	15	6/22/84	118 (260)[d]	Slate Creek	A M	458/472	W/G
	18	6/2/87	105 (230)[d]	Slate Creek	3.3 TEL M		
1319 M	Cub	6/8/82	12 (26)	Buchanan Creek	0.15/0 L	3005/3092	R/Y[f]
1320 F	17	6/8/82	102 (225)	Trident Glacier	A M	3158/3093	G/B
	19	6/25/84	139 (305)	East Hayes Creek	5.0 M99 M	463/461	G/B
	22	6/12/87	114 (250)	Hayes Glacier	4.0 TEL M	517/518	mG/dB
1321 F	16	6/9/82	141 (310)	Snow Mountain Gulch	2.1/1.9 M	3028/3108	G/W
	17	5/17/83	127 (280)	Dry Creek	1.8/2.2 M	3028/3427	G/W
	19	7/22/85	218 (480)	North VABM Wood	2.6/1.0 L	399/398	G/W
	23	6/6/89	170 (375)	Dry Creek	---- TEL M	788/789	lG/W
1322 F	8	6/9/82	91 (200)	Sheep Creek	1.9/2.1 M	3051/3159	W/lB
1323 F	11	6/10/82	95 (210)	Mystic Mountain	1.9/2.1 M	3160/3030	G/G
	13	6/29/84	132 (290)	VABM Wood	A M	579/582	G/G
1324 F	Cub	6/10/82	12 (26)	Mystic Mountain	0.12/0 M	3027/3162	R/W[f]
	6	5/26/88	111 (245)	Coal Creek	3.6 TEL L	159/160	Bk/W
	10	5/26/92	129 (285)	Dry Creek	5.5 TEL L	121/122	Bk/W
	12	5/27/94	125 (275)	Mystic Mountain	6.0 TEL M	121/122	Bk/W
	13	6/6/95		Wood River Bluffs	7.2 TEL M	121/122	Bk/W
1325 M	Cub	6/10/82	12 (27)	Mystic Mountain	0.10/0 M	3161/3031	W/R[f]

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	2	5/15/84	67 (148)	Mystic Creek	1.0 M99 M	3233/3394	R/W
1326 F	4	6/18/82	93 (205)	Buchanan Creek	2.2/1.8 M	3008/3163	W/R
	6	6/21/84	109 (240)	Buchanan Creek	1.8/2.2 M	468/462	W/R
	7	6/27/85	111 (245)	Slate Creek	2.4/1.6 L	426/427	W/W
1327 F	16	7/8/82	127 (280)	Whistler Creek	2.2/1.8 M	3134/3192	G/R
	18	6/23/84	125 (275)	Whistler Creek	A H	458/192	G/R
1328 F	1	7/8/82	43 (95)	Whistler Creek	0.9/1.1 M	3115/3014	dB/G
1329 F	13	7/9/82	120 (265)	Buchanan Creek	2.4/1.6 M	3026/3111	W/R
1330 M	1	7/9/82	48 (106)	Buchanan Creek	-- M		R/W
	3	6/28/84	102 (225)	East Fork Delta	2.6/3.0 M	597/598	R/W
1331 F	4	7/10/82	77 (170)	Trident Glacier	2.4/1.6 M	3120/3194	Bk/O
	9	5/20/87	114 (250)[d]	East Hayes Creek	3.0 TEL M	519/520	Bk/Y
	12	5/15/90	111 (245)	Trident Glacier	6.0 TEL H	196/197	Bk/Y
1332 F	5	7/12/82	104 (230)	Gillam Glacier	2.4/1.6 M	394/190	R/dB
1333 F	16	7/13/82	141 (310)	Buchanan Creek	A M	474/469	G/R
1334 M	1	7/13/82	49 (108)	Buchanan Creek	1.0/1.0 M	395/392	Y/G
	3	6/27/84	107 (235)	McGinnis Creek	A M	585/583	O/G
1335 F	1	7/13/82	38 (84)	Buchanan Creek	1.0/1.0 M	32/456	G/Y
	3	6/25/84	80 (175)	Gillam Glacier	1.5/3.0 M	465/464	dB/G
1336 F	2	5/16/83	48 (105)	Kansas Creek	1.0/1.0 M	3201/3204	Bk/mG
	3	6/26/84	89 (195)	Copper Creek	2.0/3.0 M	470/595	Bk/mG
	4	6/17/85	102 (224)	Wood River	A L	470/595	Bk/mG
	6	5/15/87	109 (240)	Rogers Creek	2.2/2.0 M	521/522	Bk/mG
	8	5/17/89	145 (320)	Upper Wood River	4.5 TEL M	330/329	Bk/mG
	11	5/7/92	116 (255)	Wood River	6.0 TEL M	330/329	Bk/mG
1337 M	20	5/18/83	293 (645)	Sheep Creek	3.5/3.5 L	3209/3205	R/O
	25	6/15/88	277 (610)	Sheep Creek	A TEL H	364/363	O/R
1338 M	6	5/20/83	111 (245)	Molybdenum Ridge	A M	3203/3202	O/Bk
1339 M	6	5/23/83	120 (265)	Trident Glacier	-- M	3286/3351	lB/W
	7	5/17/84	168 (370)	East Fork Delta	6.0 M99 H	3254/3398	lB/W
1340 F	3	5/23/83	71 (157)	Hayes Creek	1.2/0.8 H	3277/3208	G/O

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	4	5/19/84	91 (200)[d]	Molybdenum Ridge	4.0 M99 M	3277/3208	mG/O
	5	6/27/85	100 (220)	West Hayes Creek	2.4/1.6 L	590/596	mG/mG
1341 F	10	5/23/83	107 (235)	NE Portage	1.5/1.5 H	3210/3428	R/dB
	12	6/13/85	107 (235)[d]	East Fork Delta	2.0/2.0 M	442/none	O/-
	15	6/14/88	164 (360)	East Fork Delta	7.0 TEL M	356/355	dkB/
1342 M	2	5/24/83	49 (108)	Threemile Creek	0.6/1.2 M	3354/3207	W/dB
1343 M	2	5/24/83	43 (95)	Threemile Creek	0.6/1.2 M	3426/3285	R/B
1344 M	2	5/24/83	56 (123)	Threemile Creek	0.6/1.2 M	3361/3433	lB/Bk
	3	6/23/84	123 (270)	Hayes Creek	2.2/3.2 M	475/460	lB/Bk
1345 F	8	5/24/83		Upper West Fork	1.2/1.8 L	3206/3352	O/O
	10	5/23/85	105 (230)[d]	Upper West Fork	7.0 M99 M	499/500	O/O
	14	5/13/89	118 (260)	Upper Wood River	4.5 TEL M	445/446	O/O
1346 M	5	5/25/83	114 (250)	Hayes Glacier	A M	3359/3356	lB/lB
	12	5/14/90		Trident Glacier	10.5 TEL M	192/193	mG/mG
	13	6/1/91	249 (550)	Buchanan Creek	11.0 TEL M	192/193	mG/mG
	16	5/28/94	254 (560)	Delta Creek	7.6 TEL M	192/193	None
1347 M	6	5/31/83	189 (415)	Coal Creek	3.5 M99	None	Dead
1348 F	12	5/31/83	123 (270)[d]	Mystic Mountain	A M	3363/3372	W/O
	15	5/16/86	116 (255)	Wood River	2.4/1.6 M	235/236	W/O
	19	5/12/90	141 (310)	Gold King	6.0 TEL M	117/118	W/O
	20	5/9/91	120 (265)	SW Gold King	11.0 TEL H	117/118	W/O
	21	5/9/92	107 (235)	Wood River	5.5 TEL M	117/118	W/O
1349 M	18	6/2/83	264 (580)	O'Brien Creek	3.8/1.2 L	3364/3292	R/lB
1350 M	8	6/2/83	202 (445)	Ptarmigan Creek	3.0/2.0 L	3432/3430	dB/R
	11	6/12/86	205 (450)[d]	East Fork Delta	3.5 TEL L	273/272	dB/R
1351 F	14	6/23/83	114 (250)[d]	Dry Creek	4.0 M99 M	3217/3390	dB/W
	16	6/10/85	111 (245)	Little Delta River	2.0/2.0 M	477/436	dB/W
	18	5/19/87	130 (285)	Dry Creek	A M	503/504	dB/W
1352 F	14	6/27/83	111 (245)	West Fork Delta	--	3215/3316	O/W
1353 M	1	6/27/83	27 (60)	West Fork Delta	--	3310/none	O/-
1354 F	1	6/27/83	12 (27)	West Fork Delta	--	None/3314	-/O

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1355 M	3	6/30/83	60 (133)	East Fork Delta	4.0 M99 H	3232/3473	O/Bk
	5	6/3/85	70 (155)	Whistler Creek	2.2/1.8 H	586/587	O/Bk
1356 M	2	6/30/83	50 (110)	Little Delta River	2.0 M99 H	3234/3392	Bk/O
1357 M	2	5/15/84	63 (138)	Dry Creek	1.1 M99 M	3323/3235	W/Bk
	3	6/24/85	93 (205)	Dry Creek	1.5/1.5 M	447/448	W/Bk
1358 M	13	5/18/84	205 (450)	Hayes Creek	A L	3318/3447	lB/dB
	15	5/20/86	236 (520)	Trident Glacier	3.4/2.0 L	297/296	lB/dB
1359 M	3	5/28/85	61 (134)	Snow Mountain Gulch	4.0 M99 M	489/488	dB/O
1360 F	10	5/28/85	95 (210)	Snow Mountain Gulch	7.0 M99 H	None	None
1361 F	3	5/28/85	63 (138)	Dry Creek	4.0 M99 M	482/483	mG/R
	4	5/19/86	100 (220)	Rogers Creek	1.7/2.0 L	274/275	G/Bk
1362 F	6	6/5/85		Glacier Creek	2.0/2.0 L	None	None
	6	6/24/85	114 (250)	Threemile Creek	2.2/1.8 L	443/490	dB/dB
	9	5/15/88		Sheep Creek	5.0 TEL H	197/198	O/Y
	16	9/28/95	173 (380)	3-Mile Creek	7.5 TEL L	834/833	lB/lB
1363 M	3	6/5/85	55 (120)	Slide Creek	1.0/2.0 M	592/593	dB/lB
1364 M	Cub	6/14/85	7 (15)	Gold King Creek	0.7/- M	None	None
1365 M	5	6/19/85	118 (260)	Wood River	A M	476/441	lB/G
1366 M	8	7/22/85	234 (515)	Tatlanika River	3.2/1.0 M	390/391	mG/R
1367 M	2	5/19/86	61 (134)	Threemile Creek	1.4/2.0 M	400/241	lB/W
1368 F	2	5/19/86	48 (106)	Threemile Creek	1.4/2.0 M	257/256	lB/lB
1369 M	2	5/19/86	68 (150)	Threemile Creek	1.4/2.0 L	247/246	W/dB
1370 F	2	5/20/86	47 (103)	Buchanan Creek	1.4/2.0 H	253/252	dB/Bk
	3	5/20/87	69 (151)	Buchanan Creek	1.5/1.5		
1371 M	2	5/20/86	57 (126)	Buchanan Creek	1.4/2.0 M	269/268	Bk/dB
1372 M	2	5/20/86	72 (158)	Ptarmigan Creek	1.4/2.0 M	387/386	lB/O
	5	5/17/89	186 (410)	Chute Creek	7.0 TEL M	310/309	lB/O
1373 M	7	5/21/86	193 (425)	Delta Creek	4.0/2.0 M	295/294	lB/R
1374 F	6	5/21/86	106 (233)	Delta Creek	2.0/2.0 M	249/248	R/G
	9	6/9/89	147 (325)	Delta River	6.0 TEL M	320/319	lG/lB
1375 M	6	6/13/86	186 (410)	Sheep Creek	4.5 TEL L	276/277	Y/W

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	9	5/13/89	281 (620)	Mystic Creek	9.0 TEL L	439/440	O/W
	11	5/31/91	295 (650)	Threemile Creek	14.0 TEL H	146/440	O/W
1376 F	14	6/13/86	130 (285)	Hayes Creek	3.0 TEL M	279/278	G/O
1377 M	2	8/28/86	132 (290)	Iowa Ridge	4.0 TEL L	505/507	Bk/R
1378 F[g]	2	5/20/86	59 (130)[d]	Ptarmigan Creek		None	None
1379 F	2	5/15/87	67 (148)	Sheep Creek	2.2/2.0 L	334/335	W/W
	4	6/6/89	102 (225)	Dry Creek	3.5 TEL L	777/776	W/W
1380 M	2	5/18/87	65 (142)	West Fork Delta	2.2 TEL H	513/514	W/R
	3	5/17/88	109 (240)	Buchanan Creek	3.2 TEL	175/174	W/R
1381 M	2	5/21/87	73 (160)	Dry Creek	3.0 TEL M	481/480	lB/Bk
1382 F	3	5/15/88	68 (150)	West Fork Delta	3.2 TEL M	169/170	R/Y
	4	6/7/89	84 (185)	Buchanan Creek	4.0 TEL M	169/170	R/Y
1383 M	2[d]	6/12/87	77 (170)	Coal Creek	A M	389/390	mG/dB
1384 M	7[d]	5/15/88	191 (420)	Chute Creek	7.0 TEL M	960/959	W/Y
1385 F	2	5/15/88	68 (150)	Upper Wood River	2.2 TEL H	168/167	lB/Y
	3	5/13/89	82 (180)	Wood River	3.4 TEL M		lB/Y
	4	5/11/90	95 (210)	Upper Wood River	A TEL H		
	5	6/2/91	118 (260)	West Fork Delta	5.5 TEL M	108/107	lB/Y
	7	5/9/93	86 (190)	West Fork Delta	4.0 TEL M	108/107	lB/Y
	9	6/9/95	125 (275)	Upper Wood River	4.0 TEL M	258/259	lB/Y
	10	6/3/96	111 (245)	Big Grizzly Creek	7.0 TEL M	258/259	lB/Y
1386 M	2	5/15/88	73 (160)	Upper Wood River	2.2 TEL M	181/180	Bk/Y
	3	5/13/89	91 (200)	Upper Wood River	3.4 TEL M	181/180	Bk/Y
	4	6/7/90	120 (265)	Upper Wood River	7.0 TEL H[h]	790/791	Bk/Y
	5	5/31/91	156 (345)	West Fork Delta	6.0 TEL H[h]	790/791	Bk/Y
1387 F	2	5/23/88	55 (120)	Dry Creek	A TEL M	179/178	Y/R
	3	5/12/89	77 (170)	Rogers Creek	3.4 TEL M	337/338	Y/R
	4	5/15/90	84 (185)	Sheep Creek	A TEL M	190/191	
1388 M	2	5/25/88	68 (150)	Dry Creek	2.5 TEL M	153/154	Y/lB
1389 M	3	5/13/89	84 (185)	Mystic Creek	4.5 TEL H	343/344	W/dB
1390 F	3	5/13/89	77 (170)	Mystic Creek	3.4 TEL H	345/346	Y/Y

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1391 F	2	5/13/89	68 (150)	Dry Creek	2.8 TEL L	333/334	O/mG
	3	5/12/90	95 (210)	Dry Creek	3.8 TEL M	333/334	O/mG
	4	5/7/91	109 (240)	Forgotten Creek	5.5 TEL H	109/110	O/mG
	5	5/23/92	111 (245)	Dry Creek	5.0 TEL L	109/898	O/mG
	8	6/7/95	123 (270)	Slate Creek	7.0 TEL M	336/337	O/mG
1392 M	2	5/13/89	89 (195)	Dry Creek	2.8 TEL M	341/342	lG/O
	5	5/26/92	229 (505)	Dry Creek	13.0 TEL L	881/882	mG/R
1393 M	2	5/17/89	66 (145)	Molybdenum Ridge	3.5 TEL H	326/325	Bk/lB
	3	5/14/90	100 (220)	Trident Glacier	4.4 TEL M	326/325	Bk/lB
1394 F	2	5/17/89	59 (130)	Molybdenum Ridge	3.5 TEL -	331/332	lB/Bk
	6	5/10/93	94 (207)	Molybdenum Ridge	3.4 TEL M	165/166	lB/Bk
	7	5/28/94	125 (275)	Molybdenum Ridge	6.0 TEL M	165/166	lB/Bk
	9	6/2/96	142 (313)	Delta Creek	7.0 TEL M	126/166	lB/none
1395 M	2	5/17/89	86 (190)	Molybdenum Ridge	3.1 TEL M	302/301	dkB/W
1396 M	13[d]	5/18/89	295 (650)	Molybdenum Ridge	7.0 TEL M[h]	327/328	Y/O
1397 F	2	5/18/89	61 (135)	Delta Creek	3.2 TEL M	314/313	O/O
	5	5/25/92	116 (255)	East Fork Delta	5.5 TEL M	793/792	O/O
1398 F	8[d]	5/18/89	127 (280)	Delta Creek	4.5 TEL M	315/316	W/Y
	13	5/8/94	147 (325)	Trident Glacier	5.6 TEL L	-/316	-/Y
	15	6/2/96	127 (280)	Trident Glacier	6.4 TEL M	271/272	
1399 M	2	5/18/89	66 (145)	Delta Creek	3.2 TEL M	303/304	R/R
1400 M	8[d]	6/8/89	239 (525)	Trident Glacier	7.0 TEL M[h]	425/426	R/lB
1601 M	9	6/9/89	193 (425)	Whistler Creek	6.5 TEL M[h]	782/785	Gr/Y
	11	5/7/91	245 (540)	Slate Creek	13.0 TEL L	125/126	Gr/Y
	12	10/4/92	340 (750)[d]	Buchanan Creek	A TEL M	179/180	dB/W
1602 M	7	5/13/90	166 (365)	Molybdenum Ridge	A TEL M	122/121	lB/Gr
	9	5/25/92	200 (440)	East Fork Delta	7.0 TEL M	980/981	lB/Gr
	11	5/28/94	238 (525)	East Fork Delta	10.5 TEL L	338/339	lB/mG
1603 F	2	5/13/90	55 (120)	Hayes Creek	3.6 TEL H	141/142	lB/dB
	3	5/8/91	70 (155)	Whistler Creek	3.6 TEL M	128/127	lB/dB
	4	5/24/92	102 (225)	West Hayes Creek	6.0 TEL M	214/213	lB/dB

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	6	5/30/94	113 (250)	West Hayes Creek	5.6 TEL M	348/349	lB/dB
	8	6/4/96	111 (244)	East Hayes Glacier	7.0 TEL M	237/238	lB/dB
1604 F	2	5/13/90	48 (105)	Buchanan Creek	3.4 TEL M	119/120	lB/R
	3	5/7/91	59 (130)	Buchanan Creek	4.0 TEL H	101/120	lB/R
	4	5/25/92	95 (210)	West Fork Delta	6.0 TEL M	101/889	lB/R
	5	5/8/93	82 (180)	Buchanan Creek	5.0 TEL M	889/101	R/lB
	5	5/10/93		East Fork Delta	5.0 TEL M	889/101	R/lB
1605 F	2	5/13/90	59 (130)	Buchanan Creek	3.6 TEL M	213/150	mG/lB
	3	5/8/91	68 (150)	East Fork Delta	3.6 TEL M	213/293	mG/lB
	4	5/25/92	102 (225)	Buchanan Creek	4.0 TEL M	213/293	mG/lB
	5	5/10/93	102 (225)	East Fork Delta	3.2 TEL M	195/196	mG/lB
	7	5/3/95	98 (215)?	Gillam Glacier	6.0 TEL H	195/196	mG/lB
1606 M	2	5/13/90	50 (110)	Buchanan Creek	A TEL M	143/144	R/dB
	3	5/8/91	70 (155)	Gillam Glacier	3.6 TEL M	143/144	R/dB
	5	5/8/93	105 (230)	West Hayes Creek	5.4 TEL M	396/397	R/dB
1607 F	8	5/14/90	141 (310)	Glacier Creek	5.5 TEL M	188/189	W/lB
	13	6/7/95	143 (315)	Glacier Creek	7.2 TEL M	330/331	lG/W
1608 F	15	5/14/90	136 (300)	Trident Glacier	5.5 TEL M	184/-	lG/-
	19	5/30/94	127 (280)	Trident Glacier	5.6 TEL M	172/-	lG/-
	21	6/1/96	120 (265)	Trident Glacier	7.0 TEL M	172/-	lG/-
1609 F	2	5/14/90	61 (135)	Trident Glacier	3.2 TEL M	103/104	dB/mG
	3	5/7/91	77 (170)	Trident Glacier	4.0 TEL M	103/102	dB/mG
	4	5/25/92	93 (205)	Ptarmigan Creek	A TEL M	103/102	dB/mG
	5	6/29/93	107 (235)	E. Hayes Creek	6.2 TEL M	103/102	dB/mG
1610 F	2	5/6/91	70 (155)	Threemile Creek	3.4 TEL M	116/115	O/R
1611 M	2	5/6/91	91 (200)	Threemile Creek	3.4 TEL M	106/105	Gr/O
1612 F	2	5/6/91	73 (160)	Threemile Creek	3.4 TEL M	131/132	Y/mG
	6	5/3/95	125 (275)	Lower Sheep Creek	6.0 TEL M	16/22	R/lG
	6	6/8/95	127 (280)	Snow Mtn Gulch	7.2 TEL M	16/22	R/lG
	7	6/3/96	109 (240)	Threemile Creek	7.0 TEL M	16/22	R/lG
1613 M	7	6/2/91	177 (390)	Wood River	12.0 TEL M	131/130	R/O

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	11	5/29/95	211 (465)	West Fork Delta	12.9 TEL H	10/9	W/dB
	11	6/7/95		West Fork Delta	14.0 TEL M	10/9	W/dB
1614 M	4	6/1/91	109 (240)	Hayes Creek	12.0 TEL H	144/145	lG/lG
1615 M	4[d]	6/3/91	125 (275)	Hayes Creek	5.5 TEL H	112/111	R/W
1616 M	5	5/7/92	169 (370)	Mystic Creek	14.0 TEL H	239/240	Y/R
1617 F	2	5/7/92	54 (120)	Wood River	3.6 TEL M	847/848	R/lG
	3	5/9/93	43 (95)	Wood River	3.6 TEL M	848/847	lG/R
	4	5/27/94	84 (185)	Wood River	3.6 TEL M	848/847	lG/R
	5	6/9/95	105 (230)	Kansas Creek	7.0 TEL M	374/118	lG/R
	6	5/4/96	120 (265)	Kansas Creek	4.2 TEL M	374/118	lG/R
1618 F	2	5/7/92	54 (120)	Wood River	3.6 TEL M	209/210	lB/lG
	3	5/9/93	49 (107)	Virginia Creek	3.6 TEL M	209/210	lB/lG
1619 F	2	5/7/92	68 (150)	Bonnifield Creek	3.6 TEL L	201/202	R/R
1620 M	2	5/7/92	75 (165)	Bonnifield Creek	3.6 TEL M	229/230	lB/lB
1621 M	2	5/7/92	82 (180)	Bonnifield Creek	3.6 TEL L	147/148	mG/Y
1622 M	2[d]	5/9/92	100 (220)	Wood River	3.6 TEL M	143/236	Y/Y
1623 F	2[d]	5/9/92	95 (210)	Wood River	3.4 TEL M	127/126	O/dB
	3	5/9/93	93 (205)	Wood River	3.6 TEL M	191/192	O/dB
	5	6/6/95	107 (235)	VAMB Mystic	7.2 TEL M	191/192	O/dB
	6	6/3/96	111 (245)	Mystic Creek	7.0 TEL M	191/192	O/dB
1624 F	2	5/10/92	70 (155)	Molybdenum Ridge	3.6 TEL M	245/246	dB/lB
	3	5/8/93	57 (125)	Molybdenum Ridge	3.4 TEL M	245/246	dB/lB
	4	5/28/94	98 (215)	Molybdenum Ridge	6.0 TEL M	245/217	dB/lB
	6	6/2/96	110 (243)	S. Molybdenum Ridge	6.5 TEL M	123/217	
1625 M	2	5/10/92	84 (185)	Molybdenum Ridge	3.6 TEL M	243/244	R/Y
1626 F	16	5/23/92	109 (240)	Dry Creek	6.0 TEL L	150/233	W/lB
1627 F	3	5/7/93	73 (160)	Dry Creek	3.6 TEL M	997/998	Y/lB
	5	5/29/95	109 (240)	Slide Creek	6.0 TEL H	378/379	Y/lB
1628 F	2	5/7/93	45 (100)	Dry Creek	3.6 TEL M	173/174	lG/R
	3	5/8/94	64 (140)	West Fork Delta	3.6 TEL M	173/174	lG/R
	4	5/3/95	84 (185)	Buchanan Creek	4.5 TEL L	173/174	lG/R

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
	5	5/6/96	112 (247)	Forgotten Creek	5.8 TEL L	173/174	-/R
1629 F	2	5/7/93	41 (90)	Dry Creek	3.6 TEL M	230/231	R/mG
	3	5/8/94	59 (125)	West Fork Delta	3.6 TEL M	231/230	mG/R
1630 F	3[d]	5/7/93	59 (125)	Wood River	3.6 TEL M	168/167	dB/lG
1631 F	5[d]	5/9/93	89 (195)	Virginia Creek	5.6 TEL M	169/170	mG/O
	7[d]	6/10/95	127 (280)	Upper Wood River	7.2 TEL M	169/375	mG/O
1632 M	10[d]	5/10/93	277 (610)	Tatlanika Creek	12.2 TEL M	161/162	lG/mG
	11	5/30/94	281 (620)	Mystic Creek	13.4 TEL M	372/373	lG/mG
1633 M	3[d]	5/8/94	66 (145)	Trident Glacier	6.4 TEL H	238/239	Gy/lB
1634 F	Cub	5/27/94	8 (18)	Mystic Mountain	0.25 TEL L	-/988	
	1	6/6/95	52 (115)	Wood River Bluffs	4.7 TEL M	7/8	Bk/lB
	2	5/4/96	86 (190)	Mystic Mtn.	3.8 TEL M	7/8	
1635 F	Cub	5/27/94	6 (14)	Mystic Mountain	0.25 TEL L	157/-	
	1	6/6/95	52 (115)	Wood River Bluffs	4.7 TEL M	19/20	W/Y
1636 F	4[d]	5/27/94	129 (285)	Mystic Mountain	6.0 TEL M	382/383	dB/Y
	5[d]	6/5/95	111 (245)	Coal Creek	7.2 TEL M	383/382	Y/dB
1637 M	4[d]	5/27/94	188 (415)	Mystic Mountain	7.0 TEL M	992/993	mG/W
1638 M	1	5/28/94	54 (120)	Delta Creek	3.6 TEL M	358/359	Y/mG
1639 M	4[d]	5/29/94	220 (485)	East Fork Delta	10.5 TEL M	354/355	Bk/R
	6	6/1/96	262 (578)	Trident Glacier	13.0 TEL M	354/-	
1640 M	2	5/2/95	80 (175)	Dry Creek	4.5 TEL M	13/14	W/mG
	2	6/8/95	64 (140)	Dry Creek	6.0 TEL M	13/14	W/mG
1641 F	2	5/2/95	57 (125)	Dry Creek	4.5 TEL M	23/24	R/W
	2	6/7/95	61 (135)	Dry Creek	5.5 TEL M	23/24	R/W
1642 F	6[d]	5/2/95	125 (275)	Healy Creek	6.0 TEL M	4/3	lB/R
1643 M	Cub	6/6/95	13 (29)	VAMB Mystic	0.5 TEL H	17/-	
1644 M	Cub	6/6/95	11 (24)	VAMB Mystic	0.5 TEL ?	-/18	
1645 M	4[d]	6/7/95	120 (265)	Forgotten Creek	7.2 TEL ?	5/6	lB/W
1646 F	3	6/7/95	61 (135)	Upper West Fork	7.2 TEL M	328/329	O/R
	4	6/4/96	83 (185)	West Fork Little Delta	5.0 TEL M	328/329	O/R
1647 M	5[d]	6/9/95	270 (595)	Virginia Creek	13.2 TEL L	11/12	lB/W

Table 1 Continued

Bear no./sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1648 M	2	5/4/96	96 (212)	Chute Creek	A TEL M	113/114	mG/mG
1649 F	2	5/4/96	86 (190)	Chute Creek	3.8 TEL	171/172	W/lG
1650 M	5[d]	5/5/96	163 (359)	Trident Glacier	7.4 TEL M	293/294	lB/W
1651 F	7[d]	5/5/96	85 (187)	Trident Glacier	5.6 TEL M	267/268	lB/Y
1652 F	1	5/5/96	28 (62)	Trident Glacier	2.4 TEL M	119/120	lB/Gy
1653 M	1	5/5/96	28 (62)	Trident Glacier	2.4 TEL M	135/136	0/Y
1654 F	17[d]	5/5/96	128 (283)	Trident Glacier	5.8 TEL M	141/142	W/Bk
1655 M	1	5/5/96	57 (126)	Trident Glacier	4.0 TEL M	104/110	Gy/Y
1656 M	2	5/6/96		Molybdenum Ridge	4.2 TEL M	259/260	R/G
1657 F	2	5/6/96		Molybenum Ridge	4.0 TEL M	253/254	Y/W
1658 F	4[d]	5/6/96	89 (196)	O'Brien Creek	4.2 TEL M	149/150	dB/G
1659 M	4[d]	6/1/96	156 (345)	West Fork Little Delta River	9.0 TEL M	273/274	mG/lG
1660 M	2	6/1/96	88 (195)	Trident Glacier	4.6 TEL M	247/248	O/lG
1661 M	1	6/2/96	45 (100)	Molybdenum Ridge	3.0 TEL M	228/229	
1662 F	1	6/2/96	23 (50)	Molybdenum Ridge	3.0 TEL M	192/191	
1663 M	1	6/2/96	45 (100)	Molybdenum Ridge	3.0 TEL M	231/232	Y/R
1664 F	1	6/2/96	29 (65)	Molybdenum Ridge	3.0 TEL M	297/298	
1665 F	1	6/3/96	48 (105)	Glacier Creek	3.0 TEL M	289/290	lB/O
1666 M	1	6/3/96	50 (110)	Glacier Creek	3.0 TEL M	287/288	O/W
1667 F	1	6/3/96	45 (100)	Glacier Creek	3.0 TEL M	279/280	lG/lG
1668 M	1	6/3/96	29 (63)	Big Grizzly Creek	2.5 TEL M	277/278	lG/lB
1669 F	1	6/3/96	32 (70)	Big Grizzly Creek	2.0 TEL M	286/285	W/O
1770 F	1	6/4/96	44 (96)	East Hayes Creek	3.5 TEL M	296/295	R/dB
1771 M	1	6/4/96	43 (95)	East Hayes Creek	3.5 TEL M	102/101	lB/O

[a] Dosage in ml. No designation indicates use of phencyclidine hydrochloride/acepromazine maleate at 100 mg/ml concentration; use of M-99 is designated M99 at 1 mg/ml concentration; use of Telazol® at 200 mg/ml concentrations is designated TEL; 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.

Table 1 Continued

[c] Marking designations:

Colors: R, red; G, light green; mG, medium green; Gr, gray; 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.

[g] Bear no. 1378, an offspring of no. 1311, was darted but not immobilized on 20 May 1986. We left her with her mother to recover from the darting chase, but she was killed by hunters before we returned. We include her in this table for ease of data analysis.

[h] Dosages of Telazol® administered at a concentration of 300 mg/ml, instead of the usual 200 mg/ml.

Table 2 Estimates of the minimum spring grizzly bear population size in the northcentral Alaska Range, 1981-1996[a]

Year	Marked bears	Unmarked young with marked mothers	Unmarked bears killed by hunters	Minimum observed population
1981				
N	46	12	29	84
Adjusted	41	12	19	72
$N \geq 2$ yr	39	0	16	55
1982				
N	58	13	14	85
Adjusted	50	13	9	71
$N \geq 2$yr	39	0	8	47
1983				
N	64	7	10	81
Adjusted	54	7	7	68
$N \geq 2$yr	52	0	6	58
1984				
N	63	15	7	86
Adjusted	55	15	4	74
$N \geq 2$yr	54	1	3	58
1985				
N	50	20	6	76
Adjusted	41	20	3	54
$N \geq 2$yr	41	0	1	42
1986				
N	55	13	9	77
Adjusted	46	13	5	64
$N \geq 2$yr	46	0	4	50
1987				
N	50	26	8	84
Adjusted	40	24	5	69
$N \geq 2$yr	40	0	3	43
1988				
N	46	25	8	78
Adjusted	38	23	6	67
$N \geq 2$yr	38	0	2	40
1989				
N	54	14	8	76
Adjusted	44	14	6	64
$N \geq 2$yr	44	0	5	49

Table 2 Continued

Year	Marked bears	Unmarked young with marked mothers	Unmarked bears killed by hunters	Minimum observed population
1990				
N	45	20	3	68
Adjusted	36	19	3	58
$N \geq 2$yr	36	0	0	36
1991				
N	44	19	3	70
Adjusted	35	23	3	57
$N \geq 2$yr	32	0	3	35
1992				
N	47	14	4	65
Adjusted	39	13	2	53
$N \geq 2$yr	30	0	1	31
1993				
N	49	12	5	66
Adjusted	38	11	2	51
$N \geq 2$yr	38	0	2	40
1994				
N	50	10	4	64
Adjusted	45	10	2	57
$N \geq 2$yr	35	0	2	37
1995				
N	76	11	3	90
Adjusted	63	11	1	75
$N \geq 2$yr	34	0	1	35
1996				
N	71	13	1	85
Adjusted	59	13	0	72
$N \geq 2$yr	38	0	0	38

[a] Minimum populations are presented as: *N*, total number present; Adjusted, *N* adjusted to for those bears that range outside the study area; and $N \geq 2$yr, adjusted *N* including only those bears ≥ 2yr of age. To account for those bears whose home ranges extend beyond the study area boundaries, the proportion of each home range or estimated range outside the study area was estimated. These individual fractional home ranges were subtracted from appropriate population figures to more accurately reflect the numbers of bears present. Fractional figures were rounded to the nearest whole number.

[b] Numbers of bears alive during the spring of the year, *N*, includes bears that were later captured or killed by hunters but presumed to be present in preceding years to age 4 years for adult males and to birth for bears captured at age 2 or 3 years.

Table 3 Minimum number of female grizzly bears present in the study population in the northcentral Alaska Range, 1981-1996

	Minimum number of females in population, by age class								
		3 to 5 yr				≥ 6 yr			
Year	≤ 2 yr[a]	Gain	Loss	Net change	Minimum number	Gain	Loss	Net change	Minimum number
1981	-[b]	-[c]	4	-[c]	-[c]	-[c]	-[c]	-[c]	23[d]
1982	9-12	4	3	-[c]	12	1	1	0	23
1983	6-8	1	3	-2	10	0	2	-2	21
1984	9-12	3	5	-2	8	3	2	+1	22
1985	8-11[e]	3	4	-1	7	3	4	-1	21
1986	7-8[e]	0	2	-2	5	2	2	0	21
1987	12-14[e]	1	2	-1	4	2	1	+1	22
1988	13-15[e]	2	4	-2	2	2	1	-1	23
1989	10-12[e]	2	0	+2	4	0	0	0	23
1990	12-14[e]	4	1	+3	7	0	5	-5	18
1991	10-12[e]	5	3	+2	9	1	2	-1	17
1992	10-11[e]	2	1	+1	10	1	3	-2	15
1993	10-11[e]	8	6	+2	12	3	3	0	15
1994	8-13[e]	2	4	-2	10	4	0	+4	18
1995	16-21[e]	2	2	0	10	2	4	-4	16
1996	14-22[e]	1	7	-6	4	6	3	+3	19

[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] Calculation of the number of adult females was based on those bears killed by hunters or captured during the study; therefore, figures for 1981 are likely underestimates because natural mortality could not be addressed. The probable number of adult females present during 1980-1981 was more likely 21-24.

[e] These are minimum figures because not all marked and reproductively active females were observed every year due to radiocollar loss or failure. I assumed that these females remained in the study area and continued to produce offspring. There were 2 reproductively mature females that were not observed in 1985, 1991, and 1993-1996, 4 in 1986-1989, 7 in 1990, and 3 in 1992. Because the number and age of offspring were not known, their estimated numbers are not included here.

Table 4 Reproductive status and litter sizes of potentially mature females (≥ 5 years of age) in the northcentral Alaska Range, 1981-1996

Bear no./Age[a]	Offspring no.	Reproductive status[b]																Reproductive history[b]
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	
1302/14	1604, 1605, 1606, 1UM	NB	UN	UN	UN	UN	B	B	3c	3yl	3 2y/B	1c	1yl/D					No offsp prior 1986; killed by 1601 9/30/92
1303/17	1364, 1UM, 2UM	NB	NB	B?	B	2c/B	UN	UN	UN	UN	UN/B	2c	1yl	1 2yr/B	UN	UN	UN	No offsp prior 1981; lost 2 c 1985, lost 1 c 1991; lives mostly outside area
1305/25	1306, 1307	2yl	2 2y /B/D															Hunter kill fall 1982
1308/20	2UM, 1391, 1392, 1UM, 1640, 1641	UN	?/B	B	2c	2yl	1 2y/B	2c	2yl	2 2y/B	3c	2yl	2 2y/B	3c	2yl	2 2y/B	2c	Offsp 1982 or before; lost 1 yl 1985; lost 1 c 1990; lost 1 c 1993
1311/26	1312, 1313, 1372, 1378, 1UM, 1395, 1624, 1625, 1656, 1657	UN/B	2c	B	2c	2yl	2 2y/B	2c	2yl	2 2y/B	2c	2yl	2 2y/B	?c/B	3c	2yl	2 2yr/B	Lost 2 c Aug 1982; lost UM 2yr? spring 1989; lost 1 c 1994
1317/6			NB	NB?	NB	NB/D												Illegal kill 1985
1318/20	1319, 1380, 1382, 2UM	UN/B	1c/B	B	B	2c	2yl	2 2y	2 3y/B	2c/D								Lost 1 c 1982; dead Aug 1990
1320/24	1UM, 3UM, 2UM		?/B	1c/B?	B	3c	B	2c	1yl	B/D								Weaned or lost offsp 1982; lost 1 c 1983; lost 3 c 1985; lost 1 c 1987; lost 1 yl 1988; dead, fall 1989
1321/23	1342, 1343, 1344, 1UM, 1379c, 1381c, 3UM	UN/3+c	3yl	3 2y	2 3y/B	3c	3yl	2 2y/B	3c	B/D								1342 killed illegally fall 1983; lost 1 yl 1983; lost 3 c 1988
1322/17	1336	UN/1+c	1yl	1 2y	1 3y/B	UN	UN	UN	UN	UN	UN	B?/D						Hunter kill fall 1991
1323/18	1324, 1325, 2UM	UN/B	2c	2yl	2 2y/B	UN	UN/B	2+c	2+yl	2 2y/D								DLP kill[b] fall 1989
1324/14	1389, 1390, 1622, 1623, 3UM, 1634, 1635		NB	NB	NB	UN/NB ?	UN/B	2+c	2yl	2 2y/B	2c	2yl	2 2y/B	3c/B	2c	2yl	2 2yr /B/D	Lost 3 c 1993; DLP 1996
1326/8	1UM		NB	B	B	1c	B/D											No offsp prior 1982; lost 1 c 1985; hunter kill 1986
1327/18	1328, 1UM, 3UM	UN/2+c	2yl	B	3c/D													1UM yl capture mortality; lost 1328 in 1982; 1327 capture mortality? 1984
1329/14	1330	UN/1+c	1yl	1 2y/D														Killed by male May 1983
1331/12	1UM, (1603)?		NB	B	UN	UN/B	1+c	1yl/B	1+c	1yl	1 2y/ B/D							No offsp prior 1982; lost yl 1987

Table 4 Continued

Bear no./Age[a]	Offspring no.	Reproductive status[b] 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Reproductive history[b]
1332/6			NB?	D														No offsp prior 1982; died in den 1983
1333/18	1334, 1335	UN/2+c	2yl	2 2y	2 3y/ B/D													Hunter kill 1984
1336/11	2UM, 1UM, 1617, 1618			NB	NB	B	B	2c	2yl	B	3c	2yl	2 2y/D					No offsp prior 1983; lost 2 yl 1988; lost 1 c 1990
1340/11				NB	NB	B	UN	UN	UN	UN	UN	UN						No offsp prior 1983
1341/16	1UM, 1370, 1371, 2UM, 2UM	UN	UN/1+c	1yl/B	2c	2yl	2 2y/B	B	2c/B	2c/D								Lost yl 1983; lost 2 c 1988; dead fall 1989
1345/20	2UM, 1385, 1386, 3UM	UN	UN	B	2c	1yl/B	2c	2yl	2 2y	2 3y/B	3c	3yl	UN	UN	UN/D?			Lost 1 c 1984; lost 1yl 1985; probable hunter kill, 1994
1348/24	1367, 1368, 1369, 2UM, 1UM, 1619, 1620, 1621	UN	UN	?/B	3c	3yl	3 2y/B	2c	2yl/B	1 c/B	3c	3yl	3 2y	1 3yr/B	?c/B	2c/D?		Probably weaned or lost offsp 1983; lost 2 yl 1988; lost 1 c 1989; probable dead 1995; intensive searches of known home range in 1995-97 = no sighting
1351/18	1357, 1361, 1UM, 3UM	UN/B	3+c	3yl	3 2y	2 3yr/B	3+c	3yl/D										Lost 1UM offsp 1984; hunter kill 1987, 3UM yl orphaned?
1352/15	1353, 1354	UN/B	2+c	2yl	2 2y/D													Hunter kill 1984; 1353 hunter kill 1984
1360/10	1359, 1363	UN/B	2+c	2+yl	2+ 2y	2 3y/D												Capture mortality 1985
1361/9	1UM				NB	NB	NB	UN	UN/B	1+c	1+yl	1 2y/D						No offsp prior 1985; both 1361 and 2 yr hunter kills 1991
1362/17	1387, 1388, 1648, 1649				UN	B	2c	2yl	2 2y/B	B	UN	UN	UN	UN/B	2+c	2+yl	2 2yr	No offsp prior 1985
1374/14	2UM, 2UM, 3UM				UN/B	2+c	2yl	?/B	2+c	2yl	2 2y/B	3c	UN/B	3c	3yl/B/D			1374 and 3 yl illegally killed (claimed defense of life) 1994; lived outside study area
1376/18	1393, 1394	UN	UN	UN	UN	UN	?/B	2c	2yl	2 2y	2 3y/D							Offsp prior 1986; dead spring 1990
1379/7									NB	B	UN	UN	D					Dropped collar spring 1990; hunter kill 1992
1385/10	1668, 1669										NB	B	1c	1yl/B	c?/B	2c	2yl	Lost 1 yl 1993?
1391/8	2UM										NB	B	1c	1yl	B	2c/D		Lost 2c, 1995; hunter kill 1995
1394/9	1638, 1661, 1662												B	1+c	1yl/B	2c	2yl/D	Weaned 1 yl and bred 1994; illegal kill, 1996
1397/8												UN	B	B	UN	UN	UN	
1398/15	1397, 1399, 2UM, 3UM						?/B	2+c	2+yl	2 2y/B	UN/B	2c	2yl	UN?/B	2c	1yl/B	3c/D	Lost 1 c 1994; weaned 1yl 1995; lost 3c, hunter kill 1996
1603/8	1670, 1671										NB	B	B	B	B	2c	2yl	

Table 4 Continued

Bear no./Age[a]	Offspring no.	Reproductive status[b] 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Reproductive history[b]
1608/21	1609?, 1UM, 1633?, 1660?	UN	UN	UN	UN	UN	UN	UN/B?	1+c?	1+yl?	1+ 2y?/B	2c	2yl	2 2yr/B	2c	2yl	2 2y/B	Assumed 1609 was offsp from strong circumstantial evidence
1609/8	1677										NB	NB	NB	B	B	B	1c	
1612/7	1UM, 2UM											NB	UN	B	1+c	1yl/B	2c	Lost 1 yl and bred 1995
1617/6												NB	NB	NB	NB	B	c?/B	
1623/6	1643, 1644												NB	NB	B	2c	2yl	
1624/6	1663, 1664												NB	NB	B	2c	2yl	
1626/16	1628, 1629	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN/B	2+c	2yl/D					Killed by hunter in defense of life
1627/6	1674, 1675												NB	NB	B	2c	2yl	
1628/5														NB	NB	NB	B	
1629/5														NB	NB	NB	B	
1631/8	1UM, 2UM													B	B	1c/B	2c/B	Lost 1 c 1995 (capture ?); lost 2c 1996
1636/6	1672, 1673, 1UM														B	3c	3yl	Lost 1 yl, 1996
1642/7?	2UM													B	2+c	2yl	2 2y/B	
1651/7	1652, 1653														B	2+c	2yl	
1654/17	1655				UN	UN	UN	UN	UN	UN	UN	UN	UN	UN	B	1+c	1yl	Lost or weaned 1 yl, 1996; lives outside study area
1658/5																	B	No prior offsp

[a] Age in 1996 or last year in which bear was alive.

[b] Designations: B, in breeding condition; NB, observed in nonbreeding condition; c, cub of year; yl, yearling; 2y, 2-year-old; D, dead; DLP, killed in defense of life or property; UM, unmarked; UN, not observed in that year; ?, status unknown; +, not observed in that year but offspring first observed in subsequent year; therefore, litter size may have been larger; offsp, offspring.

[c] Siblings 1379 and 1381 were captured separately after weaning within 1321's home range and were sighted together once during the summer. I assume the siblings were those recently weaned by 1321.

Table 5 Observed litter size and number of offspring in cub, yearling, 2-year-old, and 3-year-old age classes, northcentral Alaska Range, 1982-1996

Age class	Observed no. of litters															Total		$\bar{x}$
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	No. of litters	No. of offspring	litter size
Cub																		
litter size 1	1	1	0	1	0	0	0	1	0	1	2	1	0	2	1	11	11	
litter size 2	2	0	4	2	2	7	1	2	2	3	0	0	5	9	3	42	84	
litter size 3	0	0	2	2	0	0	2	0	4	1	0	3	1	2	1	18	54	
Total	3	1	6	5	2	7	3	3	6	5	2	4	6	13	5	71	149	2.10
Yearling																		
litter size 1	2	1	0	1	0	1	1	1	0	0	2	2	1	2	1	15	15	
litter size 2	2	2	0	3	2	2	5	1	0	4	3	0	1	6	7	39[a]	78[a]	
litter size 3	1	1	0	1	1	1	0	1	1	2	0	0	0	0	2	11	33	
Total	5	4	0	5	3	4	6	3	1	6	5	2	2	8	10	65[a]	126[a]	1.94[a]
2-year-old																		
litter size 1	0	2	0	0	1	0	0	0	1	0	0	1	1	0	0	6	6	
litter size 2	1	1	2	0	2	2	2	5	1	0	4	0	0	1	5	26	52	
litter size 3	0	1	1	0	1	0	0	0	1	1	1[b]	0	0	0	0	6	18	
Total	1	4	3	0	4	2	2	5	3	1	5	1	1	1	5	38	76	2.00
3-year-old																		
litter size 1	0	0	1	0	0	0	0	0	0	0	0	1[b]	0	0	0	2	2	
litter size 2	0	0	2	1	0	0	1	1	1	0	0	0	0	0	0	7	14	
litter size 3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	0	3	2	0	0	1	1	1	0	0	1	0	0	0	9	16	1.78

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

[b] Two 2-year-old offspring of bear no. 1348 were legally killed by hunters while they still accompanied their mother in fall 1992.

Table 6 Annual number of breeding females, cubs produced, cub survival to weaning, and subsequent presence of offspring in the northcentral Alaska Range, May 1981-1996 (+ indicates minimum figures)

	Number during given year															
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Females bred previous year[a]	5+	7+	3+	9+	5+	5+	11+	5+	6+	8+	4+	5+	6+	10+	13+	6
Minimum litters produced	5	7	1	6	5	4	9	5	5	6	5	2	4	9	11	6
Cubs produced	9+	13+	1	14+	11	8+	18+	10+	9+	16	9	2	10	17+	26	11
Cubs survived to age 1	9	10	0	10	7	8	17	7	4	14	8	2	6	14	21	5
Survived from age 1 to age 2	7	9	0	8	4[d]	4	12	7	4	11[d]	3[d]	1	2	10	18[d]	
Cubs survived to weaning	7[b,c]	8[c]	0	8[b]	4	4[b]	10[c]	7	3	10+	2+	1	2	10		
Still in area as 3-year-olds	6	5	0	3	3	3	4-10	5	3	9+	0+	0+	1+			
Still in area as 5-year-olds	1	1	0	2	0-1	2-4	3-4	2+	0+	4+	3+	0+				
Offspring weaned during year		2+	1[c]	9[c]	4	9	2	4	12[c]	7	3	4+	3+	1+	2+	8+

[a] If the reproductive status of females could not be established for the year subsequent to breeding, they were not included here.

[b] In 3 instances mortality of offspring was human-caused. During 1981 an unmarked yearling of female no. 1327 was not observed after a capture attempt and was assumed dead. During 1984 no. 1327 died from capture-related causes or was killed by another bear while recovering from immobilization; her 3 cubs were assumed dead as well. During September 1986 a hunter killed bear no. 1351; subsequent survival of her 3 yearlings is unlikely. In addition, female no. 1352 was killed by a hunter during May 1984 before it was determined whether she had weaned her offspring. One was killed during September while it still traveled with its sibling. The remaining 2-year-old was a runt, weighing only 12 kg the previous year, and presumably died during fall-winter 1984.

[c] The survival of 2 litters of 2-year-olds to weaning age was assumed because most offspring are weaned at that age. In 1983, female no. 1329 was killed by an adult male prior to the time her 2-year-old, no. 1330, would normally have been weaned. Bear no. 1323 was shot in self-defense by a hunter in August 1989; her 2 accompanying offspring would have been weaned as 3-year-olds.

[d] In 1985 the 2 yearling offspring of female 1374 were not observed after June, so survival was not included here and the litter was not included in survival calculations. Similarly, the radiocollars of female 1345 failed in 1990, and of female 1398 in 1991, so the fate of 1345's 3 yearlings and 1398's 2, was not determined or used in calculations of survival. In 1996 female 1654 weaned her offspring 1655, who was not radiocollared; therefore, his survival is not included in calculations.

Table 7 Observed and projected minimum reproductive intervals for adult female grizzly bears in the northcentral Alaska Range, 1981-1996 (projected status underlined)

Bear no./ Age[b]	Annual reproductive status by year of interval observation[a]																	Minimum interval length
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1302/7	B?	B	B	C	Y	2B	C	YD	2B									5,3
1303/5	B	CB	B	C	Y	2B	?	?	C	Y	2B							5,5
1305/22	WB	C	Y	2BD														3
1308/6	C?B	B	C	Y	2B	C	Y	2B	C	Y	2B	C	Y	2B	C	Y	2B	5,3,3,3,3
1311/10	WB	C	B	C	Y	2B	C	Y	2B	C	Y	2B	CB	C	Y	2B		5,3,3,4
1318/12	WB	CB	B	B	C	Y	2	3B	CD	Y	2B							7,3
1320/17	WB	CB?	B	C	B	C	YB?	BD	C	Y	2B							10
1321/14	WB	C	Y	2	3B	C	Y	2B	C	BD	C	Y	2B					4,3,5
1322/6	B	C	Y	3B														4
1323/11	WB	C	Y	2B	?	?B	C	Y	2D	3B								3,6
1324/5	B	C	Y	2B	C	Y	2B	CB	C	Y	2BD							3,3,4
1326/6	B	CB?	BD	C	Y	2B												5
1329/11	WB	C	Y	2D														3
1331/7	B	C	YB	C	Y	2BD												5
1333/14	WB	C	Y	2	3BD													4
1336/5	B	C	Y	B	C	Y	2B											7
1341/10	WB	C	YB	C	Y	2B	B	CB	CD	Y	2B							5,5
1345/8	B	C	YB	C	Y	2	3B	C	Y	2B								6,3
1348/12	WB	C	Y	2B	C	YB	CB	C	Y	2	3B	C?B	CD	Y	2B			3,7,4
1351/12	WB	C	Y	2	3B	C	YD	2B										4,3
1352/13	WB	C	Y	2D														3
1360/6	WB	C	Y	2	3D													4
1361/6	B	C	Y	2D	3B													4
1362/6	B	C	Y	2B	B	C	Y	2B	B	C	Y	2/B	?B	C	Y	2	3B	3,4,4,5
1374/4	B	C	Y	2B	C	Y	2B	C	Y	2B	C	B	C	YBD				3,3,3,4
1376/14	WB	C	Y	2	3?D													4
1385/5	B	C	YB	C?B	C	Y	2B											6
1391/4	B	C	Y	2B	CBD	C	Y	2B										3,4
1394/5	B	C	YB	C	YD	2B												2,3
1398/5	B	C	Y	2B	?/B	C	Y	2B	C	YB	C	Y	2B					3,4,5
1603/6	B	C	Y	2B														3
1605/5	B	C	YD	2B														3
1607/6	B	C	Y	2B	?	?	?B	C	Y	2B								3,-[c],3
1608/?	2?B	C	Y	2B	C	Y	2B	C	Y	2B								3,3,3
1609/7	B	C	Y	2B														3
1612/4	B	C	YB	C	Y	2B												5
1623/4	B	C	Y	2B														3
1624/4	B	C	Y	2B														3

Table 7 Continued

Bear no./ Age[b]	Annual reproductive status by year of interval observation[a]																	Minimum interval length
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1626/17	?B	C	YD	2B														3
1627/4	B	C	Y	2B														3
1631/6	B	CB	CB	C	Y	2B												5
1636/4	B	C	Y	2B														3
1642/4	B	C	Y	2B														3
1651/5	B	C	Y	2B														3
1654/15	?B	C	YB	B	C	Y	2B											2,4

[a] Age when interval began.

[b] Reproductive intervals are defined as the periods between the weaning (raising surviving offspring to the age that maternal bonds were severed) of 1 litter and the weaning of the next. For females in their first productive cycle, intervals were defined as beginning at the first breeding that resulted in observed cub production the following year. Many reproductive intervals were minimum values because they were partially based on projections prior to or after years when direct observations were made. In addition all projected calculations assume weaning of young as 2-year-olds; however, in weanings that were observed, 10 of 42 weaned litters of offspring were composed of 3-year-olds.

Underlining indicated reproductive status that was projected to allow minimum cycle length calculation; status that was observed is not underlined. Designations are: B, bred; WB, weaned offspring, then bred; CB, lost cubs, then bred; YB, lost yearling, then bred; C, with cubs; C?, evidence that female had cubs was not confirmed; Y, with yearlings; 2, with 2-year-olds; 3, with 3-year-olds; D, died or was killed. Thus CBD indicates a year in which a female had cubs, lost them, bred, and then died.

[c] Female 1607 was not observed for 2 years following breeding and was not observed in the third year until after she could have weaned offspring; because of this uncertainty this period of unknown status was not included in calculations.

Table 8 Mortality of grizzly bears in the northcentral Alaska Range, 1981-1996

Bear no.[a]	Sex[b]	Age[c]	Date of initial 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	West Fork Little Delta	Hunter kill
UM	M	2		9/4/81	Wood River	Hunter kill
UM	F	2		9/6/81	Iowa Ridge	Hunter kill
UM	M	12		9/7/81	Wood River[d]	Hunter kill
UM	M	2		9/12/81	West Fork Little Delta	Hunter kill
UM	F	3		9/28/81	Wood River[d]	Hunter kill
UM	M	7		10/2/81	East Fork Little Delta	Hunter kill
UM	M	Unk		10/8/81	Wood River	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	West Fork Little Delta	Unk, offspring of 1318
UM	Unk	1	7/8/82	7/8/82	East Fork 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	East Fork Little Delta	Unk, offspring of 1327
UM	F	5		9/15/82	West Fork 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	East Fork 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
1338	M	6	5/20/83	5/20/83	Molybdenum Ridge	Capture mortality
UM	F	5		5/24/83	West Fork 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

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
UM	F	14		9/16/83	Kansas Creek	Hunter kill
UM	M	7		9/19/83	Little Delta River/	Hunter kill Tenmile Creek
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	West Fork Little Delta	Hunter kill
1356[e]	M	3	6/30/83	5/20/84	Gerstle River	Hunter kill
1333	F	18	7/12/82	5/22/84	East Fork Little Delta	Hunter kill
1352	F	15	6/27/83	5/30/84	West Fork Little Delta	Hunter kill
1327	F	18	7/8/82	6/23/84	East Fork Little Delta	Natural or capture-related mortality
UM	Unk	Cub		6/23/84	East Fork Little Delta	Unk, offspring of 1327
UM	Unk	Cub		6/23/84	East Fork Little Delta	Unk, offspring of 1327
UM	Unk	Cub		6/23/84	East Fork 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	West Fork 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 or property kill
1335	F	3	7/13/82	9/14/84	East Fork Little Delta	Hunter kill
1309	M	10	5/25/82	9/15/84	Gold King	Hunter kill
1354	F	2	6/27/83	Fall 1984	West Fork Little Delta	Assumed dead, offspring of 1352
UM	F	17		10/7/84	West Fork Little Delta	Hunter kill
UM	Unk	Cub		5/85	Hayes Glacier	Unk, offspring of 1320
UM	Unk	Cub		5/85	Hayes Glacier	Unk, offspring of 1320
UM	Unk	Cub		5/85	Hayes Glacier	Unk, offspring of 1320
UM	Unk	1		5/12/85-5/15/86	Dry Creek	Unk, offspring of 1308
1360	F	10	5/28/85	5/28/85	Snow Mountain Gulch	Capture mortality
UM	Unk	Cub		5/23-6/5/85	Mystic Creek	Unk, offspring of 1303
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
1317	F	6	6/8/82	9/85	Wood River/Yanert River	Illegal kill?, not sealed
1355	M	5	6/30/83	9/13/85	Iowa Ridge	Hunter kill

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
1378	F	2		5/25/86	Delta Creek	Hunter kill, offspring of 1311
1326	F	8	6/18/82	5/27/86	O'Brien Creek	Hunter kill
1358	M	15	5/18/84	5/31/86	Delta Creek	Hunter kill
1368	F	2	5/19/86	5/31/86	Bonnifield Creek	Defense of life or property kill, offspring of 1348
1367	M	2	5/19/86	6/28/86	Bonnifield Creek	Defense of life or property kill, offspring of 1348
UM	M	3[f]		9/2/86	Wood River	Hunter kill
1373[e]	M	7	5/20/86	9/2/86	McGinnis Creek	Hunter kill
UM	M	2[f]		9/3/86	West Fork Little Delta	Hunter kill, offspring of 1308?
1371	M	2	5/20/86	9/7/86	Little Delta River	Hunter kill, offspring of 1341
1357[e]	M	4	5/15/84	9/23/86	Tatlanika River	Hunter kill, offspring of 1351
UM	Unk	1		fall 1986	Dry Creek	Unk, offspring of 1321
UM	Unk	1		5/20/87-7/3/87	East Hayes Creek	Unk, offspring of 1331
UM	Unk	Cub		7/3/87-8/30/87	Hayes Glacier	Unk, offspring of 1320
UM	M	3[f]		5/9/87	Slate Creek	Hunter kill, offspring of 1308?
1370	F	3	5/20/86	5/20/87	Buchanan Creek	Capture mortality, offspring of 1341
1349[e]	M	22	6/2/83	5/22/87	Coal Creek (Healy)	Hunter kill
1369[e]	M	3	5/19/86	6/26/87	Lignite	Defense of life or property kill, offspring of 1348
UM	F	2		9/2/87	Delta Creek	Hunter kill, offspring of 1374?
UM	M	2		9/2/87	Wood River	Hunter kill
UM	M	8		9/2/87	Wood River	Hunter kill
UM	M	17		9/7/87	Virginia Creek	Hunter kill
1381	M	2	5/21/87	9/8/87	Dry Creek	Hunter kill
1351	F	18	6/23/83	9/11/87	Slide Creek	Hunter kill
1334[e]	M	7	7/13/82	4/14/88	Tangle Lakes	Hunter kill
UM	Unk	1		Spring 1988	Hayes Glacier	Unk, offspring of 1320
UM	Unk	Cub		Spring 1988	Sheep Creek	Unk, offspring of 1321
UM	Unk	Cub		Spring 1988	East Fork Delta River	Unk, offspring of 1345
UM	Unk	Cub		Spring 1988	East Fork Delta River	Unk, offspring of 1345
UM	Unk	Cub		June 1988	Wood River	Unk, offspring of 1348
UM	Unk	Cub		June 1988	Wood River	Unk, offspring of 1348
UM	M	3		9/7/88	South of Gold King	Hunter kill
1350	M	13	6/2/83	9/14/88	Dry Creek	Hunter kill
UM	Unk	Cub/ylg		8/30/88-5/12/89	Glacier Creek	Unk, offspring of 1321
UM	Unk	Cub/ylg		8/30/88-5/12/89	Glacier Creek	Unk, offspring of 1321

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
UM	Unk	Cub/ylg		8/30/88-5/10/89	Upper Wood River	Unk, offspring of 1336
UM	Unk	Cub/ylg		8/30/88-5/10/89	Upper Wood River	Unk, offspring of 1336
1384	M	7	5/15/88	4/23/89	Wood River	Hunter kill
UM	Unk	Cub		5/18 to 6/7/89	Wood River	Unk, offspring of 1348
M[g]	Unk	Unk		7/89	St George Creek	Illegal kill
UM	Unk	2[f]		7/89	St George Creek	Illegal kill
UM	M	3[f]		8/16/89	Gillam Glacier	Defense of life or property kill
1318	F	20	6/18/82	5/13-8/10/89	West Fork Little Delta	Unk, wounding loss?
UM	Unk	Cub		5/13-8/10/89	West Fork Little Delta	Unk, offspring of 1318
UM	Unk	Cub		5/13-8/10/89	West Fork Little Delta	Unk, offspring of 1318
1323	F	18	6/10/82	8/18/89	Gold King Creek	Defense of life or property kill
1321	F	23	6/9/82	9/1/89	Dry Creek	Hunter kill
1310[e]	M	20	5/25/82	9/1/89	Tangle Lakes, Unit 13	Hunter kill
UM	M	2[f]		9/1/89	West Fork Little Delta	Hunter kill
UM	M	3[f]		9/1/89	West Fork Little Delta	Hunter kill
1382	F	4	5/15/88	9/9/89	West Fork Little Delta	Hunter kill
1395[e]	M	2	5/17/89	9/9/89	Jumbo Dome	Hunter kill
1399[e]	M	2	5/18/89	9/9/89	Ruby Creek/Delta River	Hunter kill
UM	M	3[f]		9/15/89	Trident Glacier	Hunter kill
1337	M	26	5/18/83	9/16/89	Blair Lakes	Hunter kill
UM	M	4[f]		9/19/89	Coal Creek	Hunter kill
1320	F	24	6/8/82	8/10-30/89	Hayes Creek	Unk, wounding loss?
1341	F	16	5/23/83	6/9-8/30/89	Little Delta River	Unk, wounding loss?
UM	Unk	Cub		6/9-8/30/89	Little Delta River	Unk, offspring of 1341
UM	Unk	Cub		6/9-8/30/89	Little Delta River	Unk, offspring of 1341
1380[e]	M	5	5/18/87	4/22/90	Nenana Glacier	Hunter kill
1376	F	18	6/13/86	5/5-15/90	Moly Ridge	Unk, scavenged by bear
1390	F	4	5/13/89	5/18/90	Kansas Creek	Hunter kill
UM	Unk	Cub		6/6-8/30/90	Wood River	Unk, offspring of 1336
1331	F	13	7/10/82	Fall 1990	West Hayes Glacier	Unk, wounding loss
1387	F	4	5/23/88	Sep 1990	Rogers Creek	Assumed illegal kill
UM	Unk	Unk		6/6/90-5/6/91	Dry Creek	Unk, died as cub/ylg of 1308
1611	M	2	5/6/91	5/27/91	Gold King Airstrip	Hunter kill at residence
UM	Unk	Cub		6/19-8/29/91	Moose Creek	Unk, offspring of 1303

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
UM	M	3		9/3/91	East Hayes Glacier	Hunter kill
1322	F	17	6/9/82	9/4/91	West Fork Little Delta	Hunter kill
1377[e]	M	7	8/28/86	9/6/91	June Creek, Nenana River	Hunter kill at residence
1361	F	9	5/28/85	9/7/91	East Fork Little Delta	Hunter kill
UM	M	2		9/7/91	East Fork Little Delta	Hunter kill; offspring of 1361
1386[e]	M	6	5/15/88	4/20/92	West Fork Susitna River	Hunter kill
1400	M	11[f]	6/8/89	5/11/92	Trident Glacier	Hunter kill
UM	M	2[f]		9/4/92	Gillam Glacier	Hunter kill
UM	F	4[f]		9/9/92	Iowa Ridge	Hunter kill
1626	F	17[f]	5/23/92	9/11/92	Dry Creek	Defense of life kill
UM	M	3[f]		9/15/92	Newman Creek	Hunter kill
1379	F	7	5/15/87	9/16/92	Slide creek	Hunter kill, shot at cabin
1619	F	2	5/7/92	9/18/92	Gold King Airstrip	Hunter kill; with mother 1348
1614[e]	M	4[f]	6/1/91	9/23/92	Black Rapids Glacier	Hunter kill
1302	F	14	6/17/81	9/30/92	Buchanan Creek	Killed and eaten by 1601
UM	Unk	1		9/30/92	Buchanan Creek	Offspring of 1302, assumed killed by 1601
1336	F	11	5/16/83	9-10/92	Wood River/Cody Creek	Illegal kill
1621	M	2	5/7/92	10/3/92	Gold King Creek	Hunter kill, shot at cabin; w/mother 1348
UM	Unk	1		5/9-8/26/93	Upper Wood River	Unknown, offspring of 1385
UM	Unk	Cub		5/9/93-4/29/94	Gold King Benches	Unknown, offspring of 1324
UM	F	3[f]		5/18/93	Dry Creek	Hunter kill
UM	Unk	Cub		6/29-8/26/93	Dry Creek	Unknown, offspring of 1308
UM	M	Unk		9/1/93	Cody/Canyon Creek	Hunter kill
UM	M	3[f]		9/2/93	West Fork Little Delta	Hunter kill
1604	F	5	5/13/90	9/20/93	O'Brien Creek	Hunter kill
1615	M	6[f]	6/3/91	9/20/93	O'Brien Creek	Hunter kill
1630[e]	F	3	5/7/93	10/93	Dean Creek	Hunter kill; tattoo not confirmed; outside area
UM	Unk	Cub		5/8-5/28/94	Molybdenum Ridge	Unknown, offspring of 1311
UM	Unk	1		5/8-5/28/94	Molybdenum Ridge	Unknown, offspring of 1394
UM	Unk	Cub		5/8-8/30/94	Delta Creek	Unknown, offspring of 1398
UM	M	3[f]		5/24/94	Delta Creek	Hunter kill; likely outside area
UM[e]	M	1		6/19/94	Delta/Tanana River	Illegal defense of life or property
UM[e]	M	1		6/19/94	Delta/Tanana River	Illegal defense of life or property
UM[e]	F	1		6/19/94	Delta/Tanana River	Illegal defense of life or property

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
1374[e]	F	14	5/21/86	6/20/94	Delta/Tanana River	Illegal defense of life or property
UM[e]	M	7[f]		6/20/94	Delta/Tanana River	Illegal defense of life or property
UM	F	3[f]		9/10/94	Delta/100-mile Creek	Hunter kill; edge of study area
UM	M	3[f]		9/17/94	Slide Creek	Hunter kill
1605	F	7	5/13/90	5/3-5/23/95	East Fork Little Delta	Killed by other bear
UM	Unk	1		5/3-5/23/95	East Fork Little Delta	Unknown, offspring of 1605
UM	Unk	1		5/3-5/23/95	East Fork Little Delta	Unknown, offspring of 1605
UM	Unk	1		5/3-5/23/95	Sheep Creek	Unknown, offspring of 1612
1633	M	4	5/8/94	5/10-5/23/95	Newman Creek	Killed by other bear
UM	M	5[f]		5/12/95	Little Delta River	Hunter kill
UM	Unk	1		6/4-8/21/95	Delta Creek	Unknown, offspring of 1398
UM	F	2[f]		6/9/95	Upper Wood River	Defense of life or property
UM	Unk	Cub		6/9-7/10/95	Slate Creek	Unknown, offspring of 1391
UM	Unk	Cub		6/9-7/10/95	Slate Creek	Unknown, offspring of 1391
UM	Unk	Cub		6/10-7/10/95	Upper Wood River	Unknown, offspring of 1631
1348	F	24	5/31/83	after 6/95	St George Creek	Unknown, assumed dead
UM	Unk	Cub		after 6/95	St George Creek	Unknown, offspring of 1348
UM	Unk	Cub		after 6/95	St George Creek	Unknown, offspring of 1348
1620[e]	M	5	5/7/92	9/10/95	Tanana River	Hunter kill; outside area
UM	M	5[f]		9/15/95	East Fork Little Delta	Hunter kill
1345[e]	F	21	5/24/83	9/17/95	Yanert R/Moose Creek	Hunter kill; 1345 assumed; outside area
1391	F	8	5/13/89	9/23/95	Dry Creek	Hunter kill
UM	Unk	Cub		6 to 8/96	Delta Cr/Delta River	Unknown, offspring of 1398
UM	Unk	Cub		6 to 8/96	Delta Cr/Delta River	Unknown, offspring of 1398
UM	Unk	Cub		6 to 8/96	Delta Cr/Delta River	Unknown, offspring of 1398
UM	Unk	Cub		6/96	Upper Wood River	Unknown, offspring of 1631
UM	Unk	Cub		6/96	Upper Wood River	Unknown, offspring of 1631
UM	Unk	1		6 to 8/96	Mystic Creek	Unknown, offspring of 1636
1324	F	14	6/10/82	7/15/96	Gold King cabins	Mortal wounds, DLP
1394	F	9	5/17/89	8 or 9/96	Molybdenum Ridge	Illegal kill
1661	M	1	6/2/96	8 or 9/96	Molybdenum Ridge	Assumed illegal kill; offspring of 1394
1662	F	1	6/2/96	8 or 9/96	Molybdenum Ridge	Assumed illegal kill; offspring of 1394
UM	M	7		9/12/96	N of Japan Hills	Hunter kill; edge of study area
1398	F	15	5/18/89	9/13/96	McGinnis Cr/Delta River	Hunter kill

Table 8 Continued

Bear no.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
1646	F	4	6/7/95	9/16/96	W Fork Little Delta	Hunter kill

[a] UM designates an unmarked bear; M, a marked bear whose number was unknown.
[b] M, male; F, female; Unk, unknown.
[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] A reliable source observed a marked bear that was killed illegally but buried by mining equipment and not recovered; therefore, number of the marked bear is unknown.

Table 9 Causes of annual known mortality[a] of grizzly bears, northcentral Alaska Range study area, 1981-1996

Year	Hunting (outside study[b])	Wounding loss[c]	Illegal	Defense of life[d]	Capture related	Natural mortality	Offspring loss	Annual total
1981	13	--[a]	--[a]	0	1	--[a]	--[a]	14[a]
1982	6	0	0	0	1	1	4	12
1983	4	0	1	0	2	1	2	10
1984	10 (1)	0	0	1	2	0	6	19
1985	1	0	1	0	1	0	8	11
1986	6 (2)	0	1	2	1	0	1	11
1987	7 (1)	0	0	0 (1)	1	0	2	10
1988	2 (1)	0	0	0	0	0	10	12
1989	9 (2)	3	2	2	0	0	5	21
1990	1 (1)	1	1	0	0	1	2	6
1991	5 (1)	0	0	0	0	0	1	6
1992	7 (2)	0	0	2	0	2	0	11
1993	5 (1)	0	0	0	0	0	3	8
1994	2	0	5	0	0	0	3	10
1995	3(2)	0	0	1	0	3	10	17
1996	3	0	3	1	0	0	6	13
Totals	84 (14)	4	14	9 (1)	9	8	63	191

[a] When the study began, a much smaller proportion of the population was radiocollared or marked. Therefore, prior to 1985, the ability to collect data on offspring loss, and mortality due to wounding loss, illegal take, and natural mortality was compromised and figures presented here are minimums and likely biased low. This is especially true of 1981, when known status was available for only 7 bears.

[b] Those mortalities within parentheses were marked but killed outside the boundaries of the study area and, therefore, not included in any totals.

[c] Mortalities listed as wounding losses were based upon circumstantial evidence, including proximity to hunting camps, observed physical condition, and status prior to death.

[d] Regulations allow bears to be killed without possession of a hunting license under "Defense of life or property" under special provisions.

Table 10 Grizzly bear harvest[a] within the northcentral Alaska Range, 1961-1996

	Drainage of reported harvest				
Year	Delta Creek	Little Delta River	Dry Creek	Wood River[b]	Total
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	2	1	6
1983	2	2	0	2	6
1984	1	6	2	1	11
1985	0	1	0	1	2
1986	2	3	0	3	8
1987	1	1	2	3	7
1988	0	0	1	1	2
1989	1	7	2	5	15
1990	1	0	0	2	3
1991	1	3	0	1	5
1992	1	2	4	3	10
1993	0	3	1	0	4
1994	0	0	1	0	1
1995	0	2	1	1	4
1996	4	1	0	2	7
Totals	28	66	33	75	202

[a] Includes hunter harvest, bears killed in defense of life or property, assumed wounding deaths, and bears killed illegally by hunters. Marked bears that were included in the harvest within the study area are listed below, by year:

1982: single, marked bears were killed by hunters in the Little Delta River and Dry Creek drainages.

Table 10 Continued

1983: 1 marked bear was killed illegally in the Wood River drainage.

1984: 5 marked bears were killed by hunters in drainages of the Little Delta River, 1 in Dry Creek, and 1 in Wood River. One was killed in defense of life or property along Gold King Creek.

1985: both bears killed were marked; the 1 killed on Wood River was taken illegally, either on the upper Wood River or Yanert River drainages.

1986: 4 marked bears were taken by hunters (2 in Delta Creek and 2 in the Little Delta River) and 2 were taken in defense of life or property in the Wood River drainage.

1987: 2 marked bears were killed by hunters in Dry Creek.

1988: 1 marked bear was killed by a hunter in Dry Creek.

1989: 4 marked bears were killed by hunters (1 each in Wood River, Dry Creek, Little Delta River, and Blair Lake drainages); 1 was killed on Gold King Creek in defense of life and 1 was killed illegally on St George Creek. Strong circumstantial evidence indicated 3 of these marked bears died after being wounded.

1990: 2 marked bears were killed in the Wood River drainage; 1 by a hunter and 1 was very probably killed illegally. Another marked bear probably died after being wounded.

1991: 2 marked bears were killed in the Little Delta River and 1 at Gold King airstrip. In addition, 1 of the unmarked bears killed was probably the 2-year-old offspring of no. 1361, 1 of the marked bears killed.

1992: 2 marked bears were killed in the Gold King Creek drainage and 1 near Slide Creek. A female killed as she mauled a hunter was reportedly not marked; however, strong circumstantial evidence at the site indicates that the female was no. 1626. Another hunter reported that a radiocollared bear was killed near Gold King Creek, but the bear was not sealed and its identity not confirmed.

1993: 2 marked bears were killed in the O'Brien Creek drainage.

1994: no marked bears were killed in the study area; however, female no. 1374, her 3 yearlings, and a breeding male were all illegally killed north of the study area.

1995: 1 marked bear was killed by a hunter in the Dry Creek drainage.

1996: single marked bears were killed by hunters in the Little Delta River and McGinnis Creek drainages and 1 was mortally wounded in Defense of Life or Property near Gold King airstrip. Female no. 1394 was killed illegally near Molybdenum Ridge; her 2 yearlings, nos. 1661 and 1662, were likely either killed at the same time or died subsequently without the presence of their mother.

[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.

Table 11 Human-caused mortality[a] and mortality rates for a grizzly bear population[b] in the northcentral Alaska Range, 1981-1996

		Minimum population of all age classes		Minimum population ≥ 2 yr of age		Adult females ≥ 6 yr of age		
Year	Human caused mortalities	n	Mortality rate (%)	n	Mortality rate (%)	n	All deaths[c]	Mortality rate (%)
1981	11	72	15	55	20	23	0	0
1982	5	71	7	47	10	23	2	9
1983	6	68	9	58	10	21	3	14
1984	12[d]	74	16	58	21	22	4	18
1985	3	64	5	42	7	21	2	10
1986	8	64	13	50	16	21	1	5
1987	7	69	10	43	16	23	1	5
1988	2	67	3	40	5	23	0	0
1989	15[d]	65	23	49	31	22	5	23
1990	4	58	7	36	11	18	2	11
1991	5	57	9	35	14	17	2	12
1992	10	54	19	31	20	15	4	27
1993	5	51	10	40	13	15	0	0
1994	1	57	2	37	3	18	0	0
1995	5	75	7	35	14	16	3	19
1996	7	72	10	38	18	19	3	14
$\bar{x}$	6	66	10	43	14	20	2	10

[a] Human-caused mortality includes deaths from hunter harvest, defense of life or property, capture-related causes, and illegal take.

[b] All population and mortality figures were adjusted to account for lack of population closure. Population size was defined as those bears present during spring at emergence from winter dens.

To account for those bears whose home ranges extend beyond the study area boundaries, the proportion of each home range or estimated home range outside the study area was estimated. These individual fractional home ranges were subtracted from appropriate mortality and population figures to more accurately reflect the numbers of bears included in each category. Fractional figures were rounded to the nearest whole number.

[c] Mortality of adult females from all causes, due to both human and natural causes, is included here to provide perspective with changes in mortality rates and minimum population size. Two cases of natural mortality of adult females were observed in 1983 and 1 in 1992. These cases are included in calculations of adult female mortality rates but not in human-caused mortality rates.

[d] Did not include those cubs that probably accompanied adult females.

APPENDIX A Grizzly bear captures, recaptures, and capture-related mortalities, northcentral Alaska Range, 1981 -1996

Year	New captures	Recaptures	Total no. captured during year	Cumulative no. total captures	Capture mortalities			
					Yearly total	Bear no.	Percentage	
							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
1986	1367-1378	1302, 1348, 1350, 1358, 1361	16	115	0		0	6
1987	1379-1383	1304, 1308, 1310, 1311, 1318, 1320, 1331, 1336, 1351	13	128	1	1370	8	6
1988	1382, 1384-1388	1324, 1337, 1341, 1362, 1380	11	139	0		0	6
1989	1389-1400,	1302, 1304,	26	165	0		0	5

APPENDIX A Continued

Year	New captures	Recaptures	Total no. captured during year	Cumulative no. total captures	Capture mortalities			
					Yearly total	Bear no.	Percentage	
							Year	Cumulative
	1601	1321, 1336, 1345, 1372, 1374, 1375, 1379, 1382, 1385, 1386, 1387						
1990	1602-1609	1331, 1346, 1348, 1385, 1386, 1387, 1391, 1393	16	181	0		0	4
1991	1610-1615	1303, 1304, 1308, 1311, 1346, 1348, 1375, 1385, 1386, 1391, 1601, 1603, 1604, 1605, 1606, 1609	22	203	0		0	4
1992	1616-1626	1311, 1324, 1336, 1348, 1391, 1392, 1397, 1601, 1602, 1603, 1604, 1605, 1609	24	227	0		0	4
1993	1627-1632	1385, 1394 1603, 1604 1605, 1606 1609, 1617 1618, 1623 1624	17	244	0		0	3
1994	1633-1639	1308, 1324 1346, 1394	20	264	0		0	3

APPENDIX A Continued

Year	New captures	Recaptures	Total no. captured during year	Cumulative no. total captures	Capture mortalities			
					Yearly total	Bear no.	Percentage	
							Year	Cumulative
		1398, 1602						
		1603, 1608						
		1617, 1624						
		1628, 1629						
		1632						
1995	1640-1647	1308, 1311	30	294	0		0	3
		1324, 1362						
		1385, 1391						
		1605, 1607						
		1612, 1612						
		1613, 1613						
		1617, 1623						
		1627, 1628						
		1631, 1634						
		1635, 1636						
		1640, 1641						
1996	1648-1671	1385, 1394	37	431	0		0	2
		1398, 1603						
		1608, 1612						
		1617, 1623						
		1624, 1628						
		1634, 1639						
		1646						

[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. Her 3 cubs probably died without her care.

APPENDIX B Status summary of marked bears in the northcentral Alaska Range, spring 1996

			Alive: 1996 1996 capture or active collar		Shed or nonfunctional collar, unknown, but predicted status		
	Dead				Alive in the area?	Dead?	Dispersed?
1301	1351	1620	1308	1653	1303	1316	1307
1302	1352	1621	1311	1654	1304	1339	1330
1305	1353	1626	1324	1655	1397	1340	1343
1306	1355	1630	1346	1656	1601	1354	1359
1309	1356	1633	1362	1657	1602	1363	1366[a]
1310	1357		1385	1658	1618	1365	1372
1312	1358		1392	1659	1632	1375	1383
1313	1360		1394	1660		1387	1388
1314	1361		1398	1661		1389	1393
1315	1364		1603	1662		1396	1606
1317	1367		1607	1663		1616	1622
1318	1368		1608	1664			1625
1319	1369		1609	1665			1637[b]
1320	1370		1612	1666			1638
1321	1371		1613	1667			
1322	1373		1617	1668			
1323	1374[a]		1623	1669			
1325	1376		1624	1670			
1326	1377		1627	1671			
1327	1378		1628				
1328	1379		1629				
1329	1380		1631				
1331	1381		1634				
1332	1382		1635				
1333	1384		1636				
1334	1386		1639				
1335	1390		1640				
1336	1391		1641				
1337	1395		1642[a]				
1338	1399		1643[b]				
1341	1400		1644[b]				
1342	1604		1645				
1344	1605		1646				
1345	1610		1647				
1347	1611		1648				
1348	1614		1649				
1349	1615		1650				
1350	1619		1651				
			1652				

[a] Home range is situated outside but adjacent to the study area.

[b] Alive but with nonfunctional collars.

APPENDIX C Status of marked bears in the northcentral Alaska Range, 1996

Bear		Initial capture		Date last	
no.	Sex	Age	Date	location	Status 1996
1301	M	6	5/18/81	5/18/81	Dead, capture mortality
1302	F	3	5/19/81	9/30/92	Killed/eaten by bear 1601, 9/30/92
1303	F	2	6/17/81	8/26/93	Unknown nonfunctional collar
1304	M	5	6/19/81	9/30/92	Unknown nonfunctional collar
1305	F	24	6/19/81	9/15/82	Dead, hunter kill
1306	M	2	5/24/82	5/20/84	Dead, hunter kill
1307	M	2	5/24/82	6/13/86	Unknown, probably emigrated, shed collar?
1308	F	6	5/25/82	10/4/96	Alive, functional collar, with 2 cubs
1309	M	8	5/25/82	9/15/84	Dead, hunter kill
1310	M	13	5/25/82	9/1/89	Dead, hunter kill
1311	F	12	5/26/82	10/4/96	Alive, functional collar
1312	F	Cub	5/26/82	8/5/82	Dead, disappeared between 8/5 and 8/27/82
1313	F	Cub	5/26/82	8/5/82	Dead, disappeared between 8/5 and 8/27/82
1314	M	6	5/27/82	9/15/82	Dead, hunter kill
1315	M	13	6/4/82	5/17/84	Dead, capture mortality
1316	M	11	6/7/82	7/12/82	Unknown, shed collar between 7/12 and 8/4/82
1317	F	3	6/8/82	7/22/85	Probable illegal kill
1318	F	13	6/8/82	5/13/89	Dead, unknown cause
1319	M	Cub	6/8/82	6/18/82	Dead, disappeared between 6/18 and 7/2/82
1320	F	17	6/8/82	8/30/89	Dead, unknown cause between 8/10 and 8/30/89
1321	F	16	6/9/82	9/1/89	Dead, hunter kill
1322	F	8	6/9/82	4/27/84	Dead, hunter kill
1323	F	11	6/10/82	8/18/89	Dead, killed in defense of life or property
1324	F	Cub	6/10/82	7/15/96	Dead, killed in defense of life or property
1325	M	Cub	6/10/82	9/9/84	Dead, killed in defense of life or property
1326	F	4	6/18/82	5/27/86	Dead, hunter kill
1327	F	16	7/8/82	6/23/84	Dead, capture-related mortality
1328	F	1	7/8/82	8/27/82	Dead, disappeared between 8/27 and 9/23/82
1329	F	13	7/9/82	5/15/83	Dead, killed and eaten by bear 1315
1330	M	1	7/9/82	8/14/84	Unknown, probably emigrated
1331	F	4	7/10/82	5/15/90	Dead, wounding loss? 1990
1332	F	5	7/12/82	10/31/82	Dead, died in den winter 1982-83
1333	F	16	7/13/82	5/22/84	Dead, hunter kill
1334	M	1	7/13/82	4/14/88	Dead, hunter kill
1335	F	1	7/13/82	9/14/84	Dead, hunter kill
1336	F	2	5/16/83	5/7/92	Dead, illegal kill
1337	M	20	5/18/83	9/1/89	Dead, hunter kill
1338	M	6	5/20/83	5/20/83	Dead, capture mortality
1339	M	6	5/20/83	6/4/84	Unknown, shed collar between 6/4 and 9/10/84
1340	F	3	5/23/83	6/27/85	Unknown, shed collar between 6/27/85 and 4/28/86
1341	F	10	5/23/83	8/30/89	Dead, wounding loss? fall 1989

APPENDIX C Continued

Bear no.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1996
1342	M	2	5/24/83	6/27/83	Dead, illegal kill, snared fall 1983
1343	M	2	5/24/83	5/15/84	Unknown, collar nonfunctional or emigrated?
1344	M	2	5/24/83	9/7/84	Dead, hunter kill
1345	F	8	5/24/83	9/17/95	Probable hunter kill, unconfirmed
1346	M	5	5/25/83	6/2/96	Alive, shed collar, 6/2/96
1347	M	6	5/31/83	5/31/83	Dead, capture mortality
1348	F	12	5/31/83	6/5/95	Probable dead, not found after intensive searches
1349	M	18	6/2/83	5/22/87	Dead, hunter kill
1350	M	8	6/2/83	9/14/88	Dead, hunter kill
1351	F	14	6/23/83	9/11/87	Dead, hunter kill
1352	F	14	6/27/83	5/30/84	Dead, hunter kill
1353	M	1	6/27/83	9/4/84	Dead, hunter kill
1354	F	1	6/27/83	5/18/84	Unknown, never radiocollared, assumed dead
1355	M	3	6/30/83	9/13/85	Dead, hunter kill
1356	M	2	6/30/83	5/20/84	Dead, hunter kill
1357	M	2	5/15/84	9/23/86	Dead, hunter kill
1358	M	12	5/18/84	5/31/86	Dead, hunter kill
1359	M	3	5/28/85	11/6/86	Unknown, shed collar between 4/28/86 and 11/6/86
1360	F	10	5/28/85	5/28/85	Dead, capture mortality
1361	F	3	5/28/85	9/7/91	Dead, hunter kill
1362	F	6	6/5/85	10/4/96	Alive, functional collar, with 2 2-yr-olds, 1648, 1649
1363	M	3	6/5/85	4/28/86	Unknown, shed collar between 4/28/86 and 5/16/86
1364	M	Cub	6/14/85	6/14/85	Dead, disappeared between 6/14/85 and 6/24/85
1365	M	5	6/19/85	7/28/86	Unknown, shed collar found 65 km south
1366	M	8	7/22/85	12/3/85	Unknown, shed collar
1367	M	2	5/19/86	6/28/86	Dead, killed in defense of life or property
1368	F	2	5/19/86	5/31/86	Dead, killed in defense of life or property
1369	M	2	5/19/86	6/26/87	Dead, killed in defense of life or property
1370	F	2	5/20/86	5/20/87	Dead, capture mortality
1371	M	2	5/20/86	9/7/86	Dead, hunter kill
1372	M	2	5/20/86	6/8/89	Unknown, shed collar 1989
1373	M	7	5/21/86	9/2/86	Dead, hunter kill
1374	F	6	5/21/86	6/20/94	Dead, killed in defense of life or property
1375	M	6	6/13/86	6/2/91	Unknown, shed collar between 6/2/91 and 8/29/91
1376	F	14	6/13/86	5/5/90	Died between 5/5/90 and 5/15/90
1377	M	2	8/28/86	3/25/87	Dead, hunter kill
1378	F	2	6/20/86	6/20/86	Dead, hunter kill
1379	F	2	5/15/87	9/16/92	Dead, hunter kill
1380	M	2	5/18/87	4/22/90	Dead, hunter kill
1381	M	2	5/21/87	9/8/87	Dead, hunter kill
1382	F	3	5/15/88	9/9/89	Dead, hunter kill
1383	M	2[a]	6/12/87	9/19/87	Unknown, shed collar between 9/19/87 and 4/18/88

APPENDIX C Continued

Bear no.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1996
1384	M	7[a]	5/15/88	4/23/89	Dead, hunter kill
1385	F	2	5/15/88	10/4/96	Alive, functional collar, with 2 yearlings
1386	M	2	5/15/88	4/20/92	Dead, hunter kill
1387	F	2	5/23/88	8/30/90	Unknown, illegal kill?
1388	M	2	5/25/88	8/30/88	Unknown, shed collar
1389	M	3	5/13/89	7/89	Unknown, shed collar
1390	F	3	5/13/89	8/30/89	Dead, hunter kill 5/18/90
1391	F	2	5/13/89	9/23/95	Dead, hunter kill, lost 2 cubs prior to death
1392	M	2	5/13/89	9/30/92	Unknown, shed collar by 4/28/93
1393	M	2	5/17/89	5/13/90	Unknown, heard 5/6/94
1394	F	2	5/17/89	7/25/96	Dead, illegal kill with 2 yearlings, 1661 and 1662
1395	M	2	5/17/89	9/9/89	Dead, hunter kill
1396	M	13[a]	5/18/89	8/30/89	Unknown, shed collar, assumed dead
1397	F	2	5/18/89	8/30/94	Unknown, nonfunctional collar
1398	F	8[a]	5/18/89	9/13/96	Dead, hunter kill; lost 3 cubs
1399	M	2	5/18/89	9/9/89	Dead, hunter kill
1400	M	8[a]	6/8/89	5/11/92	Dead, hunter kill
1601	M	7[a]	6/9/89	10/4/92	Unknown, shed collar by 8/26/93
1602	M	7[a]	5/13/90	5/25/92	Unknown, shed collar by 9/9/92
1603	F	2	5/13/90	10/6/96	Alive, functional collar, with 2 yearlings, 1670, 1671
1604	F	2	5/13/90	9/30/92	Dead, hunter kill
1605	F	2	5/13/90	5/3/95	Dead, killed by bear 5/3-5/23/95, lost 2 yearlings
1606	M	2	5/13/90	4/29/94	Unknown, shed collar by 8/30/94
1607	F	8	5/14/90	10/6/95	Alive, functional collar, with 3 yearlings
1608	F	15	5/14/90	10/6/96	Alive, functional collar
1609	F	2[a]	5/14/90	6/2/96	Alive, 1 cub; collar failed, 6/96
1610	F	2	5/6/91	10/12/91	Dead
1611	M	2	5/6/91	5/27/91	Dead, hunter kill
1612	F	2	5/6/91	10/4/96	Alive, functional collar, with 2 cubs
1613	M	7	6/2/91	6/7/95	Unknown, nonfunctional collar, assumed alive
1614	M	4	6/1/91	8/29/91	Dead, hunter kill 9/23/92
1615	M	4[a]	6/3/91	6/3/91	Dead, hunter kill
1616	M	5	5/7/92	6/29/93	Unknown, shed collar
1617	F	2	5/7/92	10/4/96	Alive, functional collar
1618	F	2	5/7/92	8/26/93	Unknown, nonfunctional collar
1619	F	2	5/7/92	9/18/92	Dead, hunter kill
1620	M	2	5/7/92	9/10/95	Dead, hunter kill
1621	M	2	5/7/92	10/3/92	Dead, hunter kill
1622	M	2[a]	5/9/92	5/9/92	Unknown, nonfunctional collar
1623	F	2[a]	5/9/92	10/4/96	Alive, functional collar, with 2 yearlings
1624	F	2	5/10/92	10/4/96	Alive, functional collar, with 2 yearlings
1625	M	2	5/10/92	4/28/93	Unknown, shed collar

APPENDIX C Continued

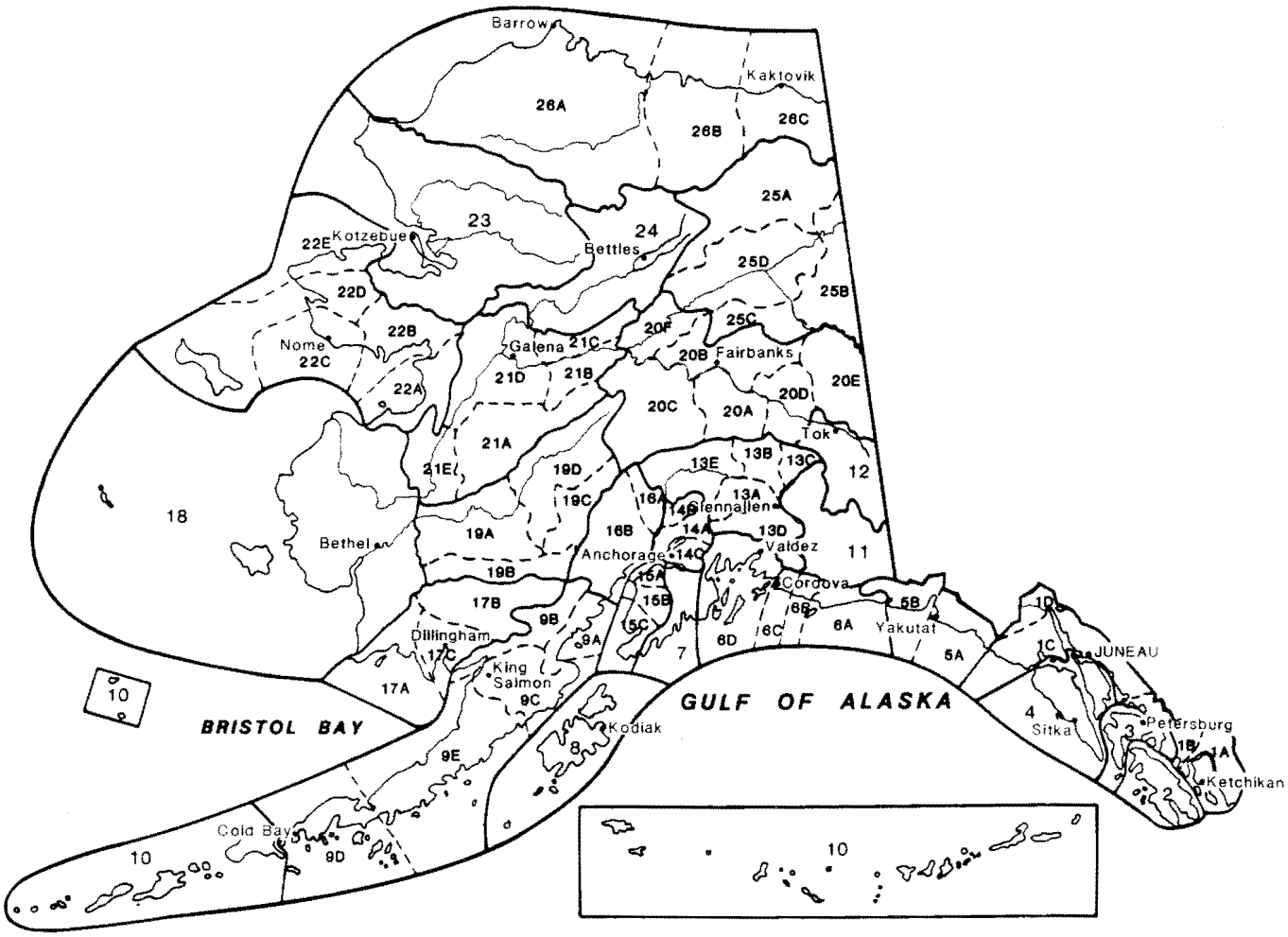
Bear no.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1996
1626	F	16	5/23/92	9/30/92	Dead killed in defense of life or property 9/92
1627	F	3	5/7/93	10/4/96	Alive, functional collar, with 2 yearlings
1628	F	2	5/7/93	10/6/96	Alive, functional collar
1629	F	2	5/7/93	6/4/95	Unknown, shed collar 6/10-7/10/95
1630	F	3	5/7/93	10/93	Assumed hunter kill, unconfirmed
1631	F	5	5/9/93	10/6/96	Alive, functional collar
1632	M	10	5/10/93	5/30/94	Unknown, shed collar, no locations recorded
1633	M	3	5/8/94	5/23/95	Dead, killed by other bear 5/10-5/23/95
1634	F	Cub	5/27/94	10/4/69	Alive, functional collar,
1635	F	Cub	5/27/94	10/4/96	Alive, functional collar
1636	F	4	5/27/94	10/6/96	Alive, functional collar, with yearlings 1643 and 1644
1637	M	4	5/27/94	5/27/94	Unknown, never collared
1638	M	1	5/28/94	5/28/94	Unknown, shed collar, never located
1639	M	4	5/28/94	6/2/96	Alive, ear tag transmitter
1640	M	2	5/2/95	10/6/95	Unknown, assumed emigrated
1641	F	2	5/2/95	10/6/96	Alive, functional collar
1642	F	6[a]	5/2/95	10/4/96	Alive, functional collar
1643	M	Cub	6/6/95	10/4/96	Alive, no collar, with 1644 and mother 1623
1644	F	Cub	6/6/95	10/4/96	Alive, no collar, with 1643 and mother 1623
1645	M	4[a]	6/7/95	9/25/95	Alive, functional collar
1646	F	2[a]	6/7/95	9/16/96	Dead, hunter kill
1647	M	5[a]	6/9/95	6/9/95	Unknown, shed collar 6/10-7/10/95
1648	M	2	5/4/96	10/4/96	Not collared, with 1649, mother 1362
1649	F	2	5/4/96	10/4/96	Alive, functional collar, with 1648, mother 1362
1650	M	5	5/5/96	6/2/96	Alive, functional collar
1651	F	7	5/5/96	10/4/96	Alive, functional collar, with yearlings 1652, 1653
1652	F	1	5/5/96	10/4/96	Alive, not collared; with mother 1651
1653	M	1	5/5/96	10/4/96	Alive, not collared; with mother 1651
1654	F	17	5/5/96	10/6/96	Alive, functional collar
1655	M	1	5/5/96	5/31/96	Alive, not collared; with mother 1654
1656	M	2	5/6/96	7/25/96	Alive, functional collar
1657	F	2	5/6/96	10/6/96	Alive, functional collar
1658	F	4	5/6/96	10/4/96	Alive, functional collar
1659	M	4	6/1/96	6/3/96	Alive, functional collar
1660	M	2	6/1/96	7/25/96	Alive, functional collar
1661	M	1	6/2/96	8/96	Dead, with mother 1394, illegal kill
1662	F	1	6/2/96	8/96	Dead, with mother 1394, illegal kill
1663	M	1	6/2/96	10/4/96	Alive, not collared; with mother 1624
1664	F	1	6/2/96	10/4/96	Alive, not collared; with mother 1624
1665	F	1	6/3/96	10/4/96	Alive, not collared; with mother 1607
1666	M	1	6/3/96	10/4/96	Alive, not collared; with mother 1607
1667	F	1	6/3/96	10/4/96	Alive, not collared; with mother 1607

APPENDIX C Continued

Bear no.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1996
1668	M	1	6/3/96	10/4/96	Alive, not collared; with mother 1385
1669	F	1	6/3/96	10/4/96	Alive, not collared; with mother 1385
1670	F	1	6/4/96	10/6/96	Alive, not collared; with mother 1603
1671	M	1	6/4/96	10/6/96	Alive, not collared; with mother 1603

[a] Estimate.

Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

Ken Whitten