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

by

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SUMMARY

Mark-recapture methods were used to calculate grizzly bear population density estimates in two portions of a 3,160-km^2 study area in the northcentral Alaska Range during 1992, for comparison with similar estimates calculated in the same area during 1986. Three different analytical techniques to estimate density from mark-recapture data were employed. No differences in bear density could be confirmed between the two time periods because the estimates displayed wide confidence intervals. A direct count estimate, based on intensive capture and presence of individual bears within home ranges in the area, indicated that by 1992 the population of bears $\geq$2 years of age had declined by 44% since 1981 and 38% since 1986. Application of mark-recapture estimates in areas of low bear density like the northcentral Alaska Range may be improved by increasing sightability through increased search intensity and increasing the total size of the search area. Population dynamics data have been collected annually since 1981 to monitor the effects of harvest on the population. The number of productive adult females in the population at den emergence fluctuated between 21 and 23 during 1981-89 with an average annual harvest rate of 6.3%, but will include only 14 by spring 1993 following a human-caused mortality rate of 16.7% during 1989-92. Population numbers and productivity were affected by environmental conditions resulting in the failure of the 1983 cub cohort. Females produced their first litters at mean age 6.2 years and their first surviving litters at mean age 7.1 years. Mean litter size for cubs of the year was 2.09 (n = 43) and 2.0 for offspring weaned as 2- or 3-year-olds (n = 20). In 86% of observations, females that bred in one year produced cubs the next. The mean interval between production of weaned offspring was 4.0 years. Although there were differences in some measures of population productivity between 1981-86 and 1987-92, they could not be ascribed to compensatory production or survival; these differences may have been influenced by the same environmental factors that resulted in the failure of the 1983 cub cohort. 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 that 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 $\geq$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. Recovery of the bear population to former levels will probably require reductions in harvest and more intensive management of females, since compensatory production or survival, if present, has not been enough to maintain adult female numbers.

Key Words: density estimates, emigration, grizzly bear, harvest rates, immigration, Interior Alaska, mark-recapture analysis, movement patterns, population dynamics, reproductive biology, *Ursus arctos*.

CONTENTS

BACKGROUND

An understanding of the effects of hunter harvest on grizzly bear (*Ursus arctos*) population dynamics is necessary for effective management. To accomplish this, we need to determine (1) how differing levels of harvest affect population status, (2) how populations respond to hunter-caused mortality, and (3) whether hunting harvest constitutes additive or compensatory mortality in grizzly bear populations.

During 1981, this study was begun to address these information needs (Reynolds 1982). The background and rationale for this long-term study have been described in previous reports (Reynolds and Hechtel 1983, 1984*a*, 1985, 1986, 1988; Reynolds et al. 1987; Reynolds 1989, 1990; Reynolds and Boudreau 1990, 1992). Initially, this long-term study was composed of two phases, the first in which baseline population status and reproductive biology were established and the second in which the population was subjected to higher hunting pressure and the responses identified and measured. At the conclusion of Phase 2 in 1991, the estimated population of bears that was adjusted for closure and $\geq$2 years of age declined by 39% since 1981 following a mean human-caused mortality rate of 16%. However, because variance or confidence intervals cannot be measured for the direct count method, a statistically based mark-recapture estimate was conducted during 1992, so that it could be compared with both the mark-recapture estimate conducted in 1986 and the annual direct counts. 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 1990*a*,*b*).

Currently, management decisions are usually based on the number, sex, and age of bears killed by hunters in a given area. These parameters may provide a general assessment of the status of grizzly bear populations under certain conditions, but few data are available to use as a basis for estimating rates of harvest (Harris and Metzgar 1987, Miller 1990*c*).

Before the 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, Reynolds 1976, Bunnell and Tait 1980, 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.

OBJECTIVES

The study objectives were to quantitatively relate changes in the harvest rate of grizzly bears to their population dynamics, especially population size, structure, productivity, survival, emigration, and immigration. The aspect of this project emphasized in this reporting period was estimation of population density using mark-recapture techniques.

STUDY AREA

The 3,160-km^2 (1,220-mi^2) study area is located in the mountains and foothills of the northcentral Alaska Range within Game Management Subunit 20A. The study area boundaries did not include mountainous areas above 1,800 m (6,000 ft), glaciers, or heavily forested portions of the Tanana Flats where searches were not attempted and where few observations were made. The 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. It includes portions of two U.S. Army reservations, Fort Wainwright and Fort Greely.

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

Within the central portion of the study area 20 contiguous quadrats of 1,496 km^2 (578 mi^2) total area were selected for estimation of population density during 1992. This search area was representative of the habitat types and terrain found in the study area. It included portions of the Dry Creek, East and West Forks of the Little Delta River, and Delta Creek drainages. Elevations in the search area ranged from 550 to 1,830 m (1,800-6,000 ft).

METHODS

The methods used to capture bears and measure population variables have been described in previous reports (Reynolds 1982; Reynolds and Hechtel 1983, 1984*a*, 1985, 1986, 1988; Reynolds et al. 1987, Taylor et al. 1989, Reynolds and Boudreau 1992). Standardized weight and measurement data were collected (Kingsley et al. 1988; Appendix A).

Mark-Recapture Estimates

During early June 1986, a modified capture-recapture method (Miller et al. 1987) was used to estimate the density of bears in a 950-km^2 portion of the northcentral Alaska Range study area (Reynolds et al. 1987). Miller et al. (1987) modified this method for use in southcentral Alaska in 1985, and then applied it subsequently in various parts of the state (Miller 1990*b*, Miller and Sellers 1992).

During 1992, this mark-recapture method (Miller et al. 1987) was used to estimate grizzly bear density in 1,496 km^2 of representative habitat in the central portion of the 3,160-km^2 study area. The 1986 estimate yielded wide confidence intervals, due partly to the low numbers of bears observed. Therefore, the density of bears present in the search area had some influence on the precision of the technique (Reynolds et al. 1987). To reduce the effects of low numbers of available marked bears, a larger area was selected for density estimation in 1992, so that the area would presumably include a larger number of marked and unmarked bears. The larger area searched in 1992 included the 950-km^2 area in which density was estimated during 1986, so that the two estimates would be more directly comparable. Boundaries of the 13 quadrats searched in 1986 (no. A - M) were contiguous with the 7 additional quadrats added in 1992 (no. P - Q) (Appendix B); sizes selected reflected easily identifiable topographic landmarks and ranged from 49 to 121 km^2.

Quadrats were searched with light aircraft each day for 5 consecutive days during 22-26 May 1992. Each of four light aircraft (Piper Super Cub, PA-18) included a pilot and an observer; the search team in a fifth aircraft (Bellanca Scout) determined presence or absence of bears in both the 1,496-km^2 search area and the same block of quadrats searched during 1986 (950-km^2 search area).

All pilots used during searches were highly experienced in finding bears and had radio-tracking experience as well. Four of the six pilots had previously participated in mark-recapture density estimates in this or other parts of the state. Five of the six observers had previous experience in aerial searches for bears. The pilot-observer search teams remained the same for the entire survey with one exception. On 22 May one search team was composed of a pilot and observer each from separate regular teams because their respective partners were not available.

The sampling protocol dictated that each quadrat be searched on each of the 5 days. This protocol was observed, with the exception that quadrats H, I, and J were not searched on 20 and 26 May because military jets were conducting gunnery exercises on the eastern boundaries of these quadrats. To compensate, two replicate searches were conducted by separate search teams on 23 and 25 May in these quadrats.

Three analyses of the same mark-recapture results were used to estimate population size or density. The method described by Miller et al. (1987) and subsequently used by Miller (1990*b*) and Miller and Sellers (1992) calculates density based on "bear-days." Eberhardt's (1990) approach calculates daily bias correction factors to apply to Lincoln-Peterson (L-P) estimates and confidence intervals. White and Garrott (1990:260-267) suggested that the joint hypergeometric maximum likelihood estimator (MLE) is preferred over five other L-P approaches based on the median of separate estimates, weighted or unweighted arithmetic means, or weighted or unweighted geometric means. The program used to calculate the MLE estimator was developed by White (S. Miller, pers. commun.) and will be more fully discussed in a monograph in preparation by S. Miller, G. White, and others. Calculation of all three estimators utilized the same data set that was collected during 22-26 May 1992. Each replicate data set included (1) the number of marked bears (with functional radiocollars) determined to be present within the boundaries of both the 1,496-km^2 and 950-km^2 search areas, (2) the number of marked bears seen by aircraft in these quadrats, and (3) the number of unmarked bears seen during the same searches.

Direct Count Estimates

Population size and density were also estimated by a direct count using the same methods that have been applied annually in previous years (Reynolds and Boudreau

1992). Direct count estimates of annual minimum population size included the sum of: (1) marked or radio-collared bears that were known or assumed to be alive and present in the area, (2) unmarked offspring of radio-collared females, (3) bears captured in the study area that would have been resident in past years (e.g., a 14-year-old female captured in 1986 was assumed to be a resident of the study area during 1981-85, but a 2-year-old male captured in 1986 was only counted as a member of the population from 1984 to 1986; those known to have emigrated were not included); and (4) unmarked bears killed within the study area, but which would have been resident in past years.

Based on observed patterns of immigration and fidelity to maternal and established home ranges, I assumed that all captured females were present in the study area from the time of their birth and that none emigrated from the area nor immigrated to it. Similarly, using observed patterns, I assumed that all males captured at ≥ 4 years of age immigrated to their established home range (of which at least a portion was included in the study area) as 4-year-olds. And, I assumed that all 2- or 3-year-old males captured in the area during May and June were born in the area but emigrated within 2 years after capture, regardless of whether or not their maternal lineage and home range were known (see section on Movement Patterns for supporting data).

When radio-collared bears could not be located during a season of aerial telemetry flights, I assumed that either they were present in the population, but with a shed or failed collar, or that they were no longer a part of the population due to emigration or death. Based on patterns of radiocollar loss and subsequent recapture or known death of specific bears, I also assumed that females remained present in the population for 6 years after they were last observed, males ≥ 4 years of age for 4 years, and 2- or 3-year-old males for 2 years (see section on Movement Patterns for supporting data).

By 1986, I had enough baseline data on home range size and movement of Alaska Range grizzly bears to "adjust" my estimates to more accurately account for lack of population closure (Reynolds et al. 1987). Not all bears captured, killed, or observed within the boundaries of the study area maintain home ranges entirely within the study area; this results in an overestimation of population size. Bears living near the center of the study area are far more likely to remain entirely within the area than those living near the boundaries. To account for this bias, the approximate proportion of each home range lying outside the study area was estimated. The fractional home ranges were subtracted from total population estimates to more accurately reflect numbers of bears in the study area and resulted in "adjusted" population estimates (Reynolds 1980). For bears killed by hunters, home range size and proportional inclusion in the study area were assumed to be similar to those of radio-collared grizzly bears of similar sex and age living in the same area. For example, if an unmarked 5-year-old female was killed near the Wood River at Mystic Creek, I would assume that 20% of her home range would lie outside the study area, since 20% of the home range of bear No. 1336, another 5-year-old female living along the Wood River, also lies outside the study area.

I believe that by 1992 almost all of the bears present in the area had been captured and that I can account for most of the bears using the study area. This assumption is justified because capture takes place during the breeding season when any unmarked bear consorting with a radio-collared bear can be captured. Over time, as adult females wean their offspring and breed, they can be captured so that all or almost all of the adult females present in the study area can be radio-collared. The same pattern is true of adult males, although they may have home ranges that extend beyond the study area. In the unlikely event that some adults do not breed, there is an increased likelihood that they could avoid capture; however, if present, they could still be captured because most of the study area is systematically and intensively searched annually. Most 2- to 3-year-old offspring of radio-collared females are also captured before they are weaned so they can be accounted for as well. The sex and age class most likely to be underrepresented in the captured sample is that of 2- to 4-year-old immigrant, nonbreeding males. However, if the number of these young males moving into the study area approximately equals the number moving out, this effect would be minimized and further mitigated by capture of such bears during routine searches. Also likely to be underrepresented in the sample are those bears living at the edges of the study area whose home ranges only include a small portion within the study area. By adjusting population estimates to account for closure, the bias resulting from such edge effect is minimized.

One measure of the validity of using the direct count method to estimate population size is the presence of unmarked bears in the study area. This is indicated by the proportion of unmarked bears that are captured or are killed by hunters. During 1986-92, only 16 of 70 bears captured in the study area were previously unmarked bears that were not offspring of marked bears. Of the 16, 7 were adult males captured on the edge of the study area, 1 was a young adult male captured in the core of the area, 3 were 2- or 3-year-old males prone to emigrate, 3 were adult females living on the edge of the study area, and 2 were adult females living in the core of the study area. Similarly, of 50 bears killed in the study area by humans during 1986-92 (not including 1 capture mortality), only 20 were not previously marked, 2 were offspring of marked females, 3 were likely the 2- or 3-year-old offspring of marked bears, 12 were 2- or 3-year-old males that were probably fall immigrants, and 3 were taken at the edges of the study area. It must be emphasized that the completeness of the sample improved as the study progressed. By 1991 and 1992, of 46 grizzly bears captured, only 5 were not previously marked or offspring of previously marked females. Four of these were young males living on the edge of the study area, and only one was an adult female living in the core of the area. Similarly, of 16 bears killed by hunters or in defense of life or property during 1991-92, only 3 2- or 3-year-old males taken on the edge of the study area were not marked or with a marked female.

RESULTS AND DISCUSSION

The primary emphasis of the work accomplished during 1992 was to produce a statistically based estimate of the density of grizzlies in the study area. The estimate provided a basis for comparison with a similar mark-recapture density estimate calculated for the population in 1986 (Reynolds et al. 1987), allowed testing of whether a population decline occurred, and allowed evaluation of the utility of annual direct count density estimates. In addition, measures of reproductive status, reproductive performance, and possible compensatory changes in population dynamics were analyzed.

Bears Captured and Radio-collared

One hundred and twenty-six individual bears were captured in the study area during 1981-92 (Table 1). In addition, 102 bears were recaptured to replace radiocollars. During 1981-83, initial captures were made of bears of all sex and age classes. Since 1983, most initial captures were of offspring of previously captured bears (Appendix C). Radiocollars have been placed on 114 bears; 41 on young-age males ($\leq$5 years), 19 on adult males ($\geq$6 years), 30 on young-age females, and 24 on adult females. By fall 1992, 37 bears carried functioning radiocollars; 16 bears had shed collars; 58 bears were dead; 1 was presumed dead; and 10 bears could not be located, presumably because of long-range movements or collar failure (Appendices D, E).

Movement Patterns

Use of direct counts to estimate population size and density in the study area was dependent on stability of home ranges and movement patterns of individual bears. Because estimates based on direct counts were compared with those calculated from mark-recapture methods, updated results and discussion presented on the rationale for direct counts from a previous report (Reynolds and Boudreau 1992) are included here.

A knowledge of movement patterns by grizzly bears of all sex and ages is crucial to understanding how emigration, immigration, and fidelity to home range affect population dynamics. Analyses of size, density, and demography of grizzly bear populations usually assume population closure or attempt to account for it. In this study, determining movement patterns was especially important because annual presence or absence in the study area affected some calculations of population size, density, and dynamics. Approximately 20-30 radiocollars were functional on bears during any one season. Although some bears were tracked by radiocollars for up to 11 years, contact with others was lost due to radiocollar loss or failure or due to movement beyond areas where we conducted aerial radio-tracking flights (emigration). Many of these bears were recaptured or killed within the study area or killed by hunters outside it. Patterns of movement by sex and age classes provided a basis for assignment of presence or absence in the population to individuals for which radio contact was lost.

No movement from the vicinity of their home range or area of initial capture was documented for 23 females captured in the study area as adults ($\geq$6 years), or for 21 females captured either as offspring (2- or 3-year-olds) of marked adults (Appendix F) or as young females (2- to 5-year-olds) with unknown family background. Of the females initially captured as 2- to 5-year-olds, 11 shed their radiocollars and were not subsequently observed for 1 to 6 years (Table 2). Six of these were later recaptured or killed by hunters in the study area after periods of 2, 2, 3, 4, 4, and 5 years; the three that have not been recaptured have been missing for 1, 2, and 6 years. Based on these patterns, I assumed that no young females emigrated from the area or immigrated to it. Similarly, of females initially captured as adults, six had collars that malfunctioned or were shed so that they were not relocated for 1, 1, 1, 2, 4, and 5 years. All were subsequently recaptured or killed within their established home ranges. In addition, one adult has not been located for 2 years. On this basis, I assumed that no females left their maternal or established home ranges in the study area and that all females present were born in, or immediately adjacent to, the study area. I further assumed that females remained alive in the area for 6 years following their last observation.

Utilizing the same approach, I found that most 2- to 3-year-old males captured either emigrated from their home ranges in the study area, could not be located, or were killed by hunters within 2 years after weaning (Table 2; Appendix F). Exceptions to this pattern included two bears that were killed in the study area within 3 years of initial capture and two others that emigrated from their maternal home ranges but remained in the study area. Twenty-four male offspring were weaned as 2- or 3-year-olds and their maternal home ranges were known; 6 were captured at the same age but their maternal home ranges were unknown. During the year in which these bears were weaned or captured, 20 remained in the area, 7 were killed by hunters within the study area, 2 were killed outside the study area, and 1 emigrated (Table 2). Of the 19 observed during the year following capture or weaning, 10 were observed in the study area, 2 were killed outside the area, 1 emigrated, and 6 could not be located. During the second year, none remained in the area for the entire year, two were killed in the area during spring, two were killed outside the area, one emigrated, and five could not be located. No males born in the area remained there as 4-year-olds except for two that emigrated from their maternal home ranges but not from the study area. Of the 11 that could not be located 1 or 2 years following capture or weaning, 3 were later killed by hunters outside the study area, 2 were later located in the study area but outside their maternal home ranges, and the status of 6 remains unknown. Based on these patterns, I assumed that, for this exploited population, all 2- or 3-year-old males emigrated from their maternal home ranges by spring of the year that they reached age 4. I further assumed that the six 2- or 3-year-olds of unknown maternal lineage that were captured in the area were either born in the area or, if they were immigrants, that others of the same age emigrated at the same rate.

Twenty males, initially captured at $\geq$4 years of age, maintained home ranges that included the study area. Radio contact with 13 of these was lost; 6 were later located within the study area after lapses of 1, 1, 1, 2, 4, and 6 years. Another was killed outside the study area but within a distance that could reasonably include the study area in his home range. One of the adult males that maintained a presence in the study area was observed from May to September every year from 1982 to 1989, but we were never able to locate his den; he was killed outside the study area by a hunter, presumably during movement to his denning area. The six bears for which present status is not known have been missing for 1, 2, 2, 5, 7, and 9 years. Based on these patterns, I assumed that all males $\geq$4 years of age were present in the study area unless they had not been observed for 4 years. In addition, based on these observed patterns and those of 2- to 3-year-old males, I assumed that all adults had been present in the study area since they were 4 years of age.

The effect of biases on the annual population estimates resulting from acceptance of these assumptions should be minimal. Based on the previous record of recaptures of females whose collars were shed or nonfunctional, it appears unlikely that females either died or emigrated from the study area. Presently, only the status of female No. 1340 has been unknown for more than 2 years. The fact that no young males of known status, initially captured as 2- or 3-year-olds, remained in the study area 2 years after capture or weaning is a sound argument against the possibility that any of the six with which radio contact was lost actually remain in the study area. The assumption that all of the six young males of unknown maternal lineage were born in the study area is not as strong. However, the productive status of four females was unknown during the period when these bears were captured and could have accounted for their presence in the population. Further, because it is reasonable to assume that rates of emigration and immigration are equal for this area, the total effects of any biases should also be near zero. The result of accepting assumptions that are not true are less straightforward for adult males. It is usually difficult to maintain telemetry contact with large males because they readily shed or damage their radiocollars and they have wide-ranging movement patterns and large home ranges. Some adult males moved outside the study area and returned after traveling as far as 40 km (25 mi) out of the study area, but their movement was confined to their apparent home ranges. However, once their radiocollars have been shed or have malfunctioned, they can be recaptured after they are observed accompanying radio-collared females in breeding condition. Accepting the assumption that a male is lost to the population after not being observed for 4 years would have resulted in counting three males as present in the population that had been missing for 1 or 2 years. It would have excluded three others missing for 5, 7, and 9 years as well as one that lived in the study area but was not recaptured for 6 years. In addition, a positive bias may result from accepting the assumption that males immigrate to, and establish residency in, an area when they are 4 years of age.

Population Size and Density

Categories Used in Estimates of Population Density:

Density estimates were conducted in the study area to document the degree of population change that has occurred since 1981 so that the effect of hunting pressure on population dynamics could be assessed. Direct count estimates for the entire area have been conducted annually since 1981. A mark-recapture density estimate was conducted in a 950-km^2 portion of the 3,160-km^2 study area during 1986. During 1992, mark-recapture estimates were conducted in two areas: for comparative purposes, the first was in the same 950-km^2 area searched in 1986; the second was in a 1,496-km^2 area that included the 950-km^2 area in addition to seven additional quadrats contiguous to it. The larger size of the 1,496-km^2 area was selected to reduce the effects of low mark-recapture sample size.

Population size and density were estimated using four methods, three of which were modifications of the L-P mark-recapture methods and one of which utilized a direct count (Table 3). The first three described statistical bounds on population size or density estimates within the 1,496-km^2 or 950-km^2 portions of the study area. These were the "bear-days" estimator (Miller et al. 1987, Miller and Sellers 1992), the mean L-P estimate that incorporated a bias correction factor (Eberhardt 1990), and the MLE (White and Garrott 1990). In the fourth or direct count method, variance or confidence intervals could not be calculated because population size was estimated based on annual direct counts of the portions of home ranges of individual bears.

Density estimates based on mark-recapture techniques were calculated for three segments of the population within two portions of a 1,496-km^2 search area during 1992. Estimates were made of the total number of bears present in the area, the number of bears that were at least 2 years of age, and the number of bears that were independent of maternal care. These estimate categories were selected to isolate different types of estimation bias, for ease of use in managing sport hunting of grizzly bear populations, and for comparison with other populations in Alaska for which similar estimates have been made. The total number of bears was calculated by assuming that dependent offspring that accompany marked females were of the same marked or unmarked status as their mothers, regardless of whether they actually carried radiocollars. Although estimates of total population size may be useful for some analyses, categorizing offspring in the same marked or unmarked status as their mothers violates the critical assumption that the $\underline{n}_2$ or recapture sample is independent (Seber 1973:59, Reynolds et al. 1987, Miller 1990*a*). Such bias can result in a tendency to overestimate population size and underestimate variance (Reynolds et al. 1987, Miller 1990*a*). The value of this measure is also compromised by the influence of cub production, which may show wide annual variation (Reynolds and Boudreau 1992) and can therefore mask changes in both the population's more stable older-aged cohorts and its long-term productive capacity.

Estimates of the number and density of bears that include only those bears $\geq$2 years of age reduce bias related to violation of L-P independence assumptions because observations of dependent cubs or yearlings are not included. However, because 2-year-olds and even 3-year-olds may remain with their mothers an additional year, some bias remains. For population analysis, this estimate has the advantages that it does not include cub and yearling cohorts that can be prone to high mortality and it is more useful for managers because it describes the portion of the population that can be legally hunted.

Estimates of the number or density of bears that were independent of maternal care (independent bears) reduces even further bias related to violation of independence assumptions. This is the least-biased estimate; however, some bias in the use of mark-recapture estimates may be unavoidable because of the presence of breeding or recently weaned sibling groups in samples. Although this estimate contains the least bias, sample size used in the estimate is smaller because cubs, yearlings, and some 2-year-olds and 3-year-olds are not included. Especially in an area like the northcentral Alaska Range, where population density is low and sightability is moderate, such small mark-recapture sample sizes will result in estimates with wide confidence intervals. Because of the age and familial status of bears in the 950-km^2 area samples, there were no differences between the estimates of bears >2 years of age and bears independent of maternal groups using any of the mark-recapture estimators (Table 3).

Of the three mark-recapture methods used to estimate density, Eberhardt's (1990) use of mean L-P estimators with bias adjustments resulted in estimates that were slightly higher than those using Miller et al.'s (1987) bear-days estimator or White and Garrott's (1990) MLE estimator (Table 3). Based on simulations conducted by White and Garrott (1990:267), the MLE method produced more accurate population estimates with smaller confidence intervals than those based on mean or median L-P calculations. The MLE estimator applied to this study likewise showed less spread in confidence intervals than did other methods; therefore, discussion of L-P estimators will primarily focus on the MLE estimator. Mark-recapture data that were used in L-P calculations of density during 1986 and 1992 are included in Appendices G, H, and I. Calculations of grizzly bear density estimates in the two search areas applying each of three L-P estimators are presented in Appendices J, K, L, M, N, O, and P.

During 1992, using the MLE estimator (White and Garrott 1990) for bears $\geq$2 years of age, the estimated density in the 1,496-km^2 search area was 11.2 bears/1,000 km^2 (Table 3). Comparison of categories between years does not show changes in density that can be statistically verified. Using the same MLE method to estimate the density of bears $\geq$2 years of age in the 950-km^2 portion of the search area, an estimated 10.2 bears/1,000 km^2 were present during 1992 compared with 11.4 bears/1,000 km^2 estimated in the same area during 1986; however, confidence intervals are large. Examination of the bear-days estimator (Miller and Sellers 1992) and Eberhardt's (1990) L-P adaptation show similar patterns among the estimates in relation to search area size and search year (Table 3). Even though the MLE estimator shows a slight decline in point estimates for bears $\geq$2 years of age or independent bears in the 950-km^2 area from 1986 to 1992, no changes in density are indicated because the differences are well within confidence limits for either year.

Density estimates for the 950-km^2 area were smaller and had relatively wider confidence intervals than those for the 1,496-km^2 area (Table 3). This may be due in part to biases related to inclusion of offspring in the same marked category as their marked mothers (Reynolds et al. 1987, Miller 1990*a*) and in part to the increased sample size that was available in a larger search area (Appendices G, H). The lower the size and density of the population, the greater the variation in estimates and confidence intervals is likely to be; small sample sizes should allow slight differences in the sighting of either marked or unmarked animals to result in larger differences in the size of the estimate and the variability around it. Using the MLE method (White and Garrott 1990), calculated population density of the category including bears of all ages was lower than that of independent bears or bears $\geq$2 years of age in the 950-km^2 area during 1992 and 1986. This anomaly was probably the result of small sample sizes and the composition of the sample.

Direct Count Estimates Based on Population Closure:

Using direct count methods, estimated population density of bears $\geq$2 years of age within the 950-km^2 search area was 10.8 bears/1,000 km^2, compared with 10.4 bears/1,000 km^2 in the 1,496-km^2 search area (Table 3) and 9.8 bears/1,000 km^2 for the entire 3,160-km^2 study area. The differences among these estimates are due to the number and distribution of home ranges of individual bears present in various portions of the study area. Similarly, the slight differences among direct count and mark-recapture estimates are most likely due to the same factors. However, to manage conservatively and avoid possibilities of further overharvest, the lower areal density estimate of the direct count approach should be applied in the northcentral Alaska Range. Further, the estimate for the entire study area should be used in management applications because fewer movement-related biases are likely to occur in the larger area; this may be an especially important consideration when density or sightability is low.

For the 3,160-km^2 study area, annual estimates were calculated for minimum population size in the study area, for minimum population size adjusted for population closure, and for minimum population $\geq$2 years of age that was adjusted for population closure (Table 4). All estimates represented size and density of the population in the spring after emergence from dens and before any harvest occurred. The minimum population estimates included all bears present in the study area regardless of how much of their estimated home ranges were included in the area; in other words, not adjusted for population closure. Estimated minimum population size for 1992 was 65, compared with 84 for 1981. Estimated minimum population density was 20.6 bears/1,000 km^2 (53.3 bears/1,000 mi^2) during 1992 compared with 26.6 bears/1,000 km^2 (68.9 bears/1,000 mi^2) during 1981.

The estimated minimum 1992 spring population, adjusted for closure, was 53 grizzly bears, a density of 16.7 bears/1,000 km^2 (43.4 bears/1,000 mi^2). This included 34 marked bears, adjusted from a total marked population of 42 bears whose home ranges included the study area; 16 unmarked offspring of marked females, adjusted from a total of 20 bears; and 2 unmarked bears killed by hunters, adjusted from a total of 2 bears. This compares with an estimated minimum adjusted population of 72 bears in 1981, a density of 22.8 bears/1,000 km^2 (59.0 bears/1,000 mi^2).

The most useful measure of population size or density includes those members of the population $\geq$2 years of age, for two reasons. First, cub and yearling cohorts constitute a relatively high percentage of the population--a mean of 28% in the 1982-92 adjusted population estimates. These proportions can fluctuate widely and point estimates may not be representative of the population trend or reproductive potential. Second, because regulations do not allow legal harvest of cubs or yearlings, calculation of harvest rates is more accurate and useful if the population base only includes those bears $\geq$2 years of age.

The adjusted population estimate of grizzly bears $\geq$2 years of age in the study area in 1992 was 31 bears, or 9.8 bears/1,000 km^2 (25.4 bears/1,000 mi^2). This represents a decline from the adjusted 1981 population estimate of 55 or 17.4 bears/1,000 km^2 (45.1 bears/1,000 mi^2) for bears $\geq$2 years old.

Changes in Population Density, 1981-92

Use of the direct count method to estimate bear numbers in the 3,160-km^2 study area indicated a 38% decline occurred from 50 bears in 1986 to 31 in 1992 (Table 3); however, in the 950-km^2 portion of the area, only an 8% decline was observed

(Table 3). Similarly, the mark-recapture MLE estimator (White and Garrott 1990) in the same 950-km^2 area indicated only an 11% decline that could not be substantiated because of the wide confidence intervals of the estimates (Table 3). Further reduction of confidence intervals might have been accomplished with inclusion of additional mark-recapture replications and by increasing sample sizes either through increasing the size of the search area or by conducting more time intensive searches so that sightability of the bears present is improved. These improvements would increase the cost of conducting density estimates. The utility of the 1992 estimates is limited under present conditions; in the 1,496-km^2 estimate area, the size of the confidence interval dictates that the population of bears $\geq$2 years of age in the area would have to decline by 20% or increase by 38% before significant differences in density could be shown.

These results suggest that the use of the mark-recapture technique in areas of low bear density should be considered carefully. The technique provides the only useful means of estimating density that has been widely applied in Alaska; it includes measures of statistical significance that are necessary for application as trend indicators. The mark-recapture technique has been useful in other areas of the state where density is higher or sightability is better than in the northcentral Alaska Range.

Population Structure

The sex and age structure of the population in 1992 was more heavily weighted toward females than males. There were more females (21%, n = 13) than males (14%, n = 9) present in adult age classes ($\geq$6 years) and approximately equal numbers of males (17%, n = 11) and females (23%, n = 15) in the subadult age classes (2-5 years) (8%, n = 5 were 2-year-olds of unknown sex). The proportions of males and females in the cub and yearling age classes (16%, n = 10 total) were unknown because offspring were not captured until they were 2-year-olds. The unequal sizes of the cub, yearling, and 2-year-old cohorts are related to a higher number of females producing cubs during 1990 and lower numbers during 1989 and 1992 rather than variations in litter sizes. Low representation in the structure of the 1983 cohort (8-year-olds in 1991) was due to a cub production failure, probably related to a berry crop failure during 1982. Low representation from other cohorts are mostly due to hunting pressure, or a combination of hunting pressure and lower survival rates.

For comparison, in 1982 the structure was also more heavily weighted toward females for bears $\geq$3 years of age (Reynolds and Boudreau 1992). Such a population structure should be expected, since males are more heavily harvested in the study area than females. The sex ratio of the bear harvest since 1979 is 79 males:40 females. Of 102 bears for which ages were determined during this period, the harvest included 47 males and 18 females in the 1- to 5-year-old age class and 26 males and 19 females for age classes $\geq$6 years old. Males have larger home ranges and travel more widely than females (see Movement Patterns section) and thus are more likely to encounter hunters (Bunnell and Tait 1980, 1981). In addition, because regulations prohibit the taking of cubs (including yearlings) or females accompanied by cubs, productive females are less vulnerable to hunters. During 1981-86, for those adult females whose reproductive status was known (29), only 22% were vulnerable to hunters during spring hunting seasons and 46% were vulnerable during fall; all adult males were vulnerable during both seasons.

Offspring observed as cubs had an approximately even sex ratio, 20 males:23 females:3 unknown sex. Capture of cubs was rarely attempted, so sample size was low. The sex ratios observed in older juvenile age classes tend to be male dominant, but none are significantly different from the male:female ratio observed for cubs. Yearlings had a sex ratio of 25 males:24 females:3 unknown sex; 2-year-olds, 27 males:24 females:2

unknown sex; and 3-year-olds, 8 males:5 females. Of those 2- and 3-year-olds that were observed at weaning, 30 (55%) were males, 25 (45%) were females, and 1 was of unknown sex. Of 22 litters, 5 were composed of all males, 3 were composed of all females, 18 were composed of mixed-sex litters, and 3 were composed of a male or a female with an unknown-sex litter mate. Similar sex ratios have been recorded in Yellowstone National Park. Craighead et al. (1969, 1976) found 57% of 74 cubs captured during 1959-70 were males, and Knight and Eberhardt (1985) reported that 67% of 24 cubs captured during 1974-82 were males.

Reproductive Biology

Age at First Production of Young:

During 1992, two young females produced first litters composed of a single cub: No. 1386 as a 6-year-old and No. 1391 as a 5-year-old. However, it was not determined whether either litter survived through the summer and fall seasons. Two other young females that were captured exhibited breeding behavior: as a 5-year-old, No. 1397 showed no evidence of previous cub production during 1992; No. 1603 bred as a 3-year-old during 1991 but was not observed with cubs and bred again during 1992.

The mean age at first production of cubs was 6.2 years (n = 12), but the mean age at which females produced cubs that survived was 7.1 years (n = 15). The range of age at which females first produced cubs in this area was from 5 to 7 years, but the age at which females produced cubs that were successfully reared was 5-10 years (Table 5). Only 3 of 11 5-year-old females were observed with cubs or showed evidence of suckling, although 7 had been observed consorting with males the previous year. Of 11 6-year-old females, 3 produced cubs that survived until fall, 2 had cubs that did not survive, 4 bred and produced cubs as 7-year-olds, 1 was not observed as a 6- or 7-year-old but produced surviving offspring at age 8 years, and 1 did not breed.

Reproductive Interval:

During 1992, female Nos. 1311 and 1324 both weaned their offspring as 2-year-olds; two others, Nos. 1308 and 1348, did not wean their 2-year-old offspring. It was not determined whether No. 1336 weaned her 2-year-olds.

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; Reynolds 1974, 1976, 1978, 1980; Glenn et al. 1976; Reynolds and Hechtel 1982). This definition differs from that used by others. Craighead et al. (1976) defined a cycle as the interval from pregnancy to pregnancy, and Alt (1989) defined it as the interval between births.

Offspring were weaned as 2-year-olds (n = 21 litters) or 3-year-olds (n = 12 litters). Mean minimum reproductive interval, however, was 4.0 years (n = 51), based on those cycles that were observed plus those that were projected by assuming weaning of offspring as 2-year-olds (Table 6). Alternately, a projected minimum cycle length based upon observed proportions of those litters weaned as 2- and 3-year-olds would result in an estimated mean reproductive interval of 4.1 years. All 15 intervals greater than 4 years resulted from interruption of the breeding cycle due to mortality of litters or to breeding that did not produce cubs the following year.

Factors that result in females weaning their young as 2-year-olds or keeping them another year to wean as 3-year-olds have not been identified. Weight or nutritional status in mid- to late May at weaning or at the onset of estrus may be important, but no patterns were detected with our small samples. Nevertheless, conditions present in summer 1982 or winter 1982-83 appear to have prolonged reproductive intervals. Not only were no surviving cubs produced during 1983, but females that were accompanied by 2-year-olds during 1983 tended not to wean those offspring until they were 3 years of age. Of three females accompanied by 2-year-olds in 1983, all weaned their litters as 3-year-olds. Similarly, of three females with yearlings in 1983, one weaned her litter as 2-year-olds but the other two weaned their litters as 3-year-olds. In contrast, of six litters produced in 1984 or 1985, five were weaned as 2-year-olds, and only one litter of 3-year-olds was weaned. Models of the effects of harvest on population dynamics should account for such stochastic events.

Production Success:

Reproductive success, or the proportion of breeding activity by adult females that results in the production of cubs, was 86%. This rate was based on the outcome of 56 observations of breeding activity by 26 individual females $\geq$6 years of age during 1982-92; only 1 female $\geq$6 years of age was observed consorting with a male during 1991 but she was not located during 1992. In addition, of 10 observations of females that bred at ages 4 and 5 years, 7 produced cubs and 3 did not. Successful reproduction is probably dependent upon an individual female reaching a critical weight or body condition, rather than a critical age, prior to ovulation or implantation (Rogers 1976, Schwartz and Franzmann 1991). Weight gain and maintenance, in turn, must depend on weather conditions, food availability, or other unknown factors either in the year that breeding occurs or during the winter/spring following breeding. Reproductive failure occurred in the study area population during 1983; only one cub was observed and it died shortly after it emerged from its den. Only one of three adult females observed breeding in 1982 produced cubs in 1983. In addition, at least three other females that were later either captured or killed in the study area may have bred in 1982 but were not accompanied by surviving offspring in spring 1983. There was little difference between 83% reproductive success (n = 24) observed during 1981-85 and 88% observed (n = 24) during 1986-91.

Litter Size:

Mean litter size was 2.09 for 43 litters first observed as cubs, 1.88 for 17 litters first observed as yearlings, and 2.00 for 38 litters observed as yearlings regardless of when they were first observed (Table 7). For comparison, in the Nelchina Basin on the south side of the Alaska Range, Miller (1987, 1990*a*) found the same mean cub litter size (2.1) but a mean yearling litter size of only 1.7. 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 11 females producing 18 cubs in 1987 (Table 8). Annual cub production was lowest during 1983 and 1986. 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 1982-83, in which little snow fell and temperatures fluctuated widely. Low production was also observed during 1986, when only eight cubs were produced by the five adult females that bred the previous year, but the cause of low production was not known. Low cub production was also observed during 1992, when only two litters of a single cub each were observed.

This was related to a decline in the number of adult females in the population and to the fact that only three females were known to have bred in 1991; 12 other productive females were accompanied by cub or yearling offspring and were not available to breed. The third female known to have bred during 1991 was radio-tracked to an apparent den site, but her radiocollar ceased functioning and she was not observed subsequently.

Although the difference in mean litter size between cubs and yearlings 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 20 litters weaned as 2- or 3-year-olds was 2.0. The annual number of adult females in the population since 1982 has ranged from 14 to 23 (Tables 5, 9), and the observed annual numbers of litters ranged from 1 to 9. From 1982 to 1992, the observed annual number of weaned litters ranged from 1 to 5. This pattern also reflects mortality of entire litters, mostly in cub or yearling age classes.

Recruitment:

Population recruitment is dependent upon cub production, survival of offspring to productive age, and movement patterns, including emigration and immigration. Although recruitment has been adequate to maintain 20-22 productive females in the early spring population during 1982-89, human-caused mortality of 11 adult females during 1989-92 was largely responsible for the decline to 14 by the end of 1992 (Table 9). Whether this trend will continue will depend on recruitment, survival, and harvest levels. The number of female offspring available to serve as replacements has fluctuated between 2 and 12 (Table 9). The decline in the 3- to 5-year-old age classes during 1986-88 was influenced by the cub cohort failure that occurred during 1983 and exacerbated by human-caused deaths of females since. This will likely result in a future decline in the number of productive females unless the production or survival of young-aged females improves. The number of cubs produced that survived and remained in this area after 5 years illustrates the response of this harvested population to low survival rates: of a minimum of 56 cubs produced during 1981-86, 31 survived until weaning, but only 6 (2 males, 4 females) remained in the area as 5-year-olds (Table 8). Whether this pattern will persist is unclear; a strong cohort in 1987 resulted in 10 weaned offspring and the 1990 cohort may produce 14 weaned 2- and 3-year-olds by 1993. If hunting pressure declines or young-aged female survival increases, then recruitment may allow the adult female segment of the population to recover. The effect of emigration or immigration on recruitment of 2- to 5-year-old females were found to be negligible. Males emigrated from their maternal home ranges within 2 years of weaning, but this loss to recruitment may have been compensated for by the gain from young males immigrating to the area (Table 10) (see Movement Patterns section).

The number of adult males in the population annually has fluctuated from 15 in 1981 to 9 in 1992, with a mean of 12 (Table 10). The number of 4- to 5-year-old males, assumed to be immigrants, has also fluctuated from a low of two in 1982 to a high of eight in 1981 and 1985, with a mean of four. The loss of the 1983 cub cohort probably affected the decline in the number of 4- and 5-year-old males during 1987-88 and adult male age classes during 1989-92 in the same manner as it did the female segment of the population.

Mortality

From 1981 through 1992 at least 128 bears died in the study area: 14 in 1981, 11 in 1982, 11 in 1983, 18 in 1984, 11 in 1985, 9 in 1986, 10 in 1987, 12 in 1988, 20 in 1989, 6 in 1990, 6 in 1991, and 12 in 1992. Sixty-nine bears were killed by hunters, 42 offspring were missing from family groups and presumed dead, 8 died as a result of capture, 5 were killed illegally, 8 were killed in defense of life or property (DLP), 4 were presumed wounding losses (by hunters or DLP), and 4 were natural mortalities for which carcasses were found (Table 11; Appendix D).

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*b*), 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). Natural mortality rates (i.e., excluding those caused by humans) for offspring under maternal care were 23% for cubs (n = 80), 6% for yearlings (n = 67), and 5% for 2-year-olds (n = 39).

The mortality rate for 45 radio-collared females aged 2 to 25 years, monitored for 163 bear-years, was 10.4% from human-related causes and 2.5% from natural causes. Human-caused deaths included 10 killed by sport hunters, 4 that died after probably being wounded by humans, and 2 that died from capture-related causes. Only four of the deaths were not human-caused: two females were killed and eaten by adult males, presumably as a result of defense of offspring, one had been accompanied by 3-year-old offspring and was found dead and eaten prior to the time she would have weaned her young, and the other was found dead in her collapsed den.

Harvest of grizzly bears by hunters in Game Management Subunit 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 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.

Sport hunting is a major source of mortality in this population. Prior to 1981, the mean annual harvest ranged from 1 to 14 with a mean take of 5.0 (Table 12). If the population remained relatively stable during 1961-80 and the pre-1981 adjusted minimum density was stable at the 1981 estimate of 22.8 bears/1,000 km^2 (59.0/1,000 mi^2), then the average annual harvest rate was approximately 5.6% of the population, with a range of 1.1-16.5%. By comparison, during 1981-92, the mean harvest rate for the minimum population, adjusted for closure and including all human-caused mortalities, was 11% (Table 13). 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 $\geq$2 years of age, and adjusted to account for lack of population closure, then the mean mortality rate for the years 1981 through 1992 was 16%.

During 1981-91, hunter harvest, including those bears killed in defense of life or property, accounted for the deaths of 30 males and 16 females 2 to 5 years of age and 16 males and 14 females ≥6 years of age. Adult male and young-aged female grizzly bears were present in the harvest at about the same proportions in which they were present in the population. Young-aged males were twice as likely to be harvested than their presence in the population would suggest and adult females half as likely (Table 14). This pattern indicates little selectivity by hunters in the area for large bears or, if there is selectivity, that it is equally countered by hiding behavior of bears or some other factor. This relationship might not hold for other areas with a lower rate of harvest or in areas where hunter selectivity differs. Harvest data were pooled over an 11-year period; data for individual years were more variable.

Young males are the most vulnerable segment of the population because of movement and behavioral characteristics (Bunnell and Tait 1980). Adult females are the least vulnerable segment of the population, primarily because hunting regulations prohibit killing females accompanied by cubs (defined as offspring in the first or second year of life; many hunters are hesitant to kill females accompanied by 2-year-olds because they are uncertain of the age of the offspring).

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) 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 (Tables 9, 11, 13). During 1989-92, harvest rates of 16.7%, including unreported wounding loss, will result in a spring 1993 projected adult female population of only 14. Unless the adult female population recovers, it is probable that with this loss of productive capacity the population will decline further. The estimated population within the study area has already declined from an adjusted minimum of 72 in 1981 to 54 in 1992. Based on only those bears ≥2 years of age, the trend is similar, but apparently more severe; minimum adjusted estimates were 55 bears in 1981 and 31 bears in 1992 (Table 3).

The recovery of the population will be dependent upon lower rates of mortality of female adults and the young age classes that act as replacements for those adults that die. During the same 1981-92 period, the number of females in the 3- to 5-year-old age class fluctuated from 12 in 1982 to 4 in 1989, and then recovered to 8 by 1991. If survival in this age class is high, the number of adult females could recover by 1994 or 1996.

Compensatory Production or Survival in Response to Harvest

Although compensatory changes in production or survival rates may occur in reduced populations, as hypothesized by Stringham (1983) and McCullough (1981), such responses to harvest have yet to be documented for grizzly bears. On the south side of the Alaska Range in Game Management Unit 13, no compensatory responses were identified in a heavily harvested and declining grizzly bear population (Miller 1990*b*).

While compensatory response to reduced populations could take the form of increased production and survival of any sex and age class in the population, recovery of the adult female segment is probably most important (Knight and Eberhardt 1984; McLellan 1989*b*,*c*; Miller 1990*c*).

Recovery of the productive female segment of the population in the study area would depend on either a reduction in the human-caused mortality rate (harvest, defense of life or property kills, and wounding loss) of adult females and/or 3- to 5-year-old females, or on compensatory changes in population production and/or survival of females. The most likely mechanisms of compensatory changes are (1) increased litter size production, (2) increased survival to weaning, (3) decreased reproductive interval, or (4) decreased age at first production of young.

Evidence for compensatory mechanisms were equivocal at the present level of exploitation in this study area. Mean litter size was 2.06 (n = 18) during 1982-86 compared with 2.12 (n = 26) during 1987-92. This difference is the result of a higher proportion of one-cub litters produced in the earlier period; however, factors responsible for the failure of cub production during 1983 may also have affected litter sizes. It is not appropriate to compare total production of cubs between the two periods because more females were under observation during the latter period. Survival rate of cubs during their first year of life was 0.69 (n = 35) in the 1982-86 period compared with 0.83 (n = 24) in the 1987-92 period. Again, factors that affected loss of the 1983 cohort may also have affected cub survival in the earlier period, especially since survival rates of yearlings were 0.85 during both periods (n = 33, 1982-86; n = 47, 1987-92). Difference in reproductive interval length between the two periods is not a meaningful measure because interval lengths span from 3 to 10 years and overlap both time spans. However, both mean age at weaning and a comparison of the number of litters weaned as 2- and 3-year-olds may also serve as meaningful indicators of differences in reproductive intervals. The mean age at weaning was 2.45 years (n = 24) during 1982-86 and 2.29 years (n = 21) during 1987-92. Similarly, 55% of litters (n = 11) were weaned as 2-year-olds during 1982-86 compared with 71% (n = 21) during 1987-92. However, both of these measures could have been affected by factors responsible for the failure of the 1983 cub cohort as well; only 17% (n = 6) of females accompanied by yearlings or 2-year-olds during 1983 weaned their young as 2-year-olds. Age of reproductive maturity did not change between the two periods. Females produced their first litters, regardless of cub survival, at a mean age of 6.4 years (n = 5) during 1982-86 and 6.2 years (n = 6) during 1987-92. Similarly, they produced their first surviving litters at a mean age of 7.0 years (n = 4) during 1982-86 and 6.9 years (n = 7) during 1987-92. None of these measures can be used convincingly as evidence for compensatory response to the reduced population, but neither can they be used to refute it.

CONCLUSIONS AND RECOMMENDATIONS

In a 3,160-km^2 study area in the northcentral Alaska Range, major findings of grizzly bear research for the 1992 report period included the following:

1. In two portions of the study area, mark-recapture data were collected to estimate population density using three methods: (1) the joint hypergeometric maximum likelihood estimator (MLE), (2) the bear-days Lincoln-Peterson (L-P) estimator, and (3) the mean L-P estimator with bias correction. Application of the MLE analysis resulted in the most useful measure of mark-recapture estimates because confidence intervals were smaller than in the other two L-P methods. MLE density estimates in 950-km^2 and 1,496-km^2 portions of the study area showed that the larger area with a calculated density of 11.2 bears $\geq$2 years of age/1,000 km^2 contained the least amount of bias. Although the MLE density estimate for all bears showed a more narrow confidence interval, inclusion of offspring in the same marked category as their mothers results in an artificial tightening of confidence interval. Also, cub production

in any one year may vary widely and can mask real changes in the population base. Therefore, only estimates of bears $\geq$2 years of age should be used in analysis.

2. Density estimates were conducted in the 950-km^2 portion of the study area for comparison with similar estimates made in the same area in 1986. Although point estimates indicated a decline in density, confidence intervals overlapped so no change could be confirmed.

3. In areas like the northcentral Alaska Range with low population density, the usefulness of the mark-recapture MLE analysis could be improved by increasing sightability, through increases in search intensity or increases in area size and therefore sample size.

4. Application of the direct count method, which has been used annually since 1981 to track population size in the study area, produced estimates that were closely comparable with those calculated by using the three mark-recapture estimates.

5. Human-caused mortality (including hunting, defense of life or property, illegal, wounding, and capture-related deaths) was 11% of both the minimum estimated population and the minimum estimated population adjusted for closure. Mean harvest rate was 16.7% of the estimated population $\geq$2 years of age and adjusted for closure. Harvest rates of 10.4% were observed for adult radio-collared females.

6. In the productive core of the population, only minor fluctuation from 21 to 23 adult females occurred with human-caused mortality of 6.3% during 1981-88. Following increased harvest of 16.7% during 1989-92, including wounding mortality, the estimated adult female population will decline to 14 by 1993.

7. Mean natural mortality rates observed during 1982-92 were 23% for cubs-of-the-year, 6% for yearlings, 5% for 2-year-olds, and 2.5% for adult females.

8. Regaining former population size will require recovery of the adult female segment of the population. This will depend on either a reduction in the human-caused mortality rate (harvest, defense of life or property kills, illegal take, and wounding loss) of adult females and/or 3- to 5-year-old females, or on compensatory changes in population production and/or survival of females.

9. Evidence for compensatory production or survival at the present level of exploitation in this study area was equivocal. The differences in reproductive performance that were observed may have been in part related to conditions in 1982-83 that resulted in the failure of cub production in 1983.

10. In this heavily harvested population, no young females emigrated from the vicinity of their maternal home range and all adult females remained faithful to their established home ranges. All males captured as 2- or 3-year-olds emigrated from their maternal home range or area of capture within 2 years. No adult male emigration from established home ranges was documented; two were killed outside the study area in areas that included their home range.

11. If these patterns hold true for other populations, sustained yield management of grizzly bear populations near areas closed to hunting (often viewed as population reservoirs) should not allow higher rates of female harvest on the perimeter of the closed areas.

12. The grizzly bear population in this area was a productive one: mean age at first production of young was 6.2 years, breeding or production success was 86%, initial litter size was 2.09 cubs, litter size at weaning was 2.0 2- or 3-year-olds, and reproductive interval was 4.0 years.

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 the changes that occur in populations harvested at various rates?

3. If population recovery begins to occur 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 4-6% 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 impacts of various levels of harvest on grizzly populations.

Therefore, I recommend that the mean harvest rates that began during the early 1980s be reduced to 3% of adult females and no more than 6-8% of bears $\geq$2 years of age until at least 1995. Concurrently, research effort should continue to monitor the dynamics of this population to document any recovery of numbers of adult females or compensatory changes in production or survival of offspring. Emphasis should be directed toward determining the response by individual members of the population to high harvest levels and how individual responses affect the population as a whole. Further attention should be directed toward constructing and testing population dynamics models based on measurable productivity and harvest variables.

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Table 1. Capture and marking characteristics of 126 bears captured in the northcentral Alaska Range, 1981-92.

Bear no. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
1301 M	6	5/18/81	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
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
	22	5/10/92	121(267)	Molybdenum Ridge	5.0 TEL M	249/250	W/W
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]

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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
1325 M	Cub	6/10/82	12(27)	Mystic Mountain	0.10/0 M	3161/3031	W/R[f]
	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

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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)	Gilliam 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
	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

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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)	Upper Buchanan Creek	11.0 TEL M	192/193	mG/mG
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
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

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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
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
	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

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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
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
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
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
1395 M	2	5/17/89	86(190)	Molybdenum Ridge	3.1 TEL M	302/301	dkB/W

Table 1. Continued.

Bear No. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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
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
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
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
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
1606 M	2	5/13/90	50(110)	Buchanan Creek	A TEL M	143/144	R/dB
	3	5/8/91	70(155)	Gilliam Glacier	3.6 TEL M	143/144	R/dB
1607 F	8	5/14/90	141(310)	Glacier Creek	5.5 TEL M	188/189	W/lB
1608 F	15	5/14/90	136(300)	Trident Glacier	5.5 TEL M	184/-	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	2/25/92	93(205)	Ptarmigan Creek	A 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
1613 M	7	6/2/91	177(390)	Wood River	12.0 TEL M	131/130	R/O

Table 1. Continued.

Bear no. and sex	Cem. age (yr)	Date of capture	Weight kg (lb)	Location	Drug dosage[a]	Ear tags[b]	Markers[c]
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
1618 F	2	5/7/92	54(120)	Wood River	3.6 TEL M	209/210	lB/lG
1619 F	2	5/7/92	68(150)	Bonnefield Creek	3.6 TEL L	201/202	R/R
1620 M	2	5/7/92	75(165)	Bonnefield Creek	3.6 TEL M	229/230	lB/lB
1621 M	2	5/7/92	82(180)	Bonnefield 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
1624 F	2	5/10/92	70(155)	Molybdenum Ridge	3.6 TEL M	245/246	dB/lB
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

[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.

[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.

Table 1. Continued.

[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. Movement of young-age bears from their maternal home ranges (MHR) subsequent to weaning or from their established home range (EHR) at capture as a 2- or 3-year-old, northcentral Alaska Range, 1981-92.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
1302	1604 F	2	2/1990	Within MHR
			3/1991	Moved 34 km E of MHR, returned
			4/1992	Within MHR
	1605 F	2	2/1990	Moved 15 km SW of MHR, returned
			3/1991	Within MHR
			4/1992	Within MHR
	1606 M	2	2/1990	Within MHR
			3/1991	Within MHR
			4/1992	Within MHR 5/10/92, unknown afterward
1305	1306 M	2	2/1982	Within MHR
			3/1983	Within MHR
			4/1984	Killed by hunter 5/20/84 in MHR
	1307 M	2	2/1982	Within MHR
			3/1983	Within MHR
			4/1984	Sighted once within 15 km of MHR
			5/1985	Moved 12 km NW of MHR
			6/1986	Home range includes MHR
			7/1987	Status unknown, assumed emigrated
1308	1391 F	2	2/1989	Within MHR
			3/1990	Within MHR
			4/1991	Within MHR
			5/1992	Within MHR
	1392 M	2	2/1989	Within MHR
			3/1990	Status unknown
			4/1991	Status unknown
			5/1992	Adjacent to MHR
1311	1372 M	2	2/1986	Within MHR
			3/1987	Moved 40 km WNW of MHR, shed collar?
			4/1988	Status unknown
			5/1989	Moved 70 km WNW of MHR
			6/1990	Status unknown
			7/1991	Status unknown
			8/1992	Status unknown
	1378 F	2	2/1986	Killed by hunter 5/25/86 prior to weaning
	1395 M	2	3/1989	Killed by hunter 9/9/89 98 km W of MHR

Table 2. Continued.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
1318	1380 M	3	3/1988	Within MHR
			4/1989	Status unknown, shed collar
			5/1990	Killed by hunter 4/22/90 46 km SE of MHR
	1382 F	3	3/1988	Within MHR
			4/1989	Killed by hunter 9/9/89 in MHR
1321	1344 M	3	3/1984	Moved 44 km SE of MHR between 5/15 and 6/4/84, remained there through 6/23, killed in MHR by hunter 9/7/84
	1379 F	2	2/1987	Within MHR
			3/1988	Within MHR
			4/1989	Within MHR
			5/1990	Status unknown, shed collar
			6/1991	Status unknown
			7/1992	Killed by hunter 9/16/92 in MHR
	1381 M	2	2/1987	Killed by hunter 9/8/87 in MHR
1322	1336 F	3	3/1984	Within MHR
			4/1985	Within MHR, bred
			5/1986	Within MHR, collar nonfunctional
			6/1987	Within MHR, with 2 cubs
			7/1988	Within MHR, with 2 yearlings
			8/1989	Within MHR, bred
			9/1990	Adjacent to MHR, with 2 cubs
			10/1991	Adjacent to MHR, with 2 yearlings
			11/1992	Adjacent to MHR, with 2 2-year-olds
1323	1324 F	2	2/1984	Within MHR, not radio-collared
			3/1985	Not sighted
			4/1986	Not sighted
			5/1987	Not sighted
			6/1988	Within MHR, with 2 yearlings
			7/1989	Within MHR, bred
			8/1990	Within MHR, with 2 cubs
			9/1991	Within MHR, with 2 yearlings
			10/1992	Within MHR, bred
	1325 M	2	2/1984	Within MHR, killed defense of life or property 9/9/84
1324	1389 M	2	2/1989	Status unknown, shed collar 38 km S of MHR
			3/1990	Assumed emigrated

Table 2. Continued.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
	1390 F	2	2/1989	Within MHR
			3/1990	Killed by hunter 5/18/90 in MHR
1329	1330 M	2[a]	2/1983	Within MHR
			3/1984	Moved outside MHR?, no radio contact
			4/1985	Status unknown, assumed emigrated
1331	1603 F	2	2/1990	Within MHR
			3/1991	Within MHR
			4/1992	Within MHR
1333	1334 M	3	3/1984	Moved 48 km to SE between 6/4 and 6/25/84
			4/1985	Status unknown
			5/1986	Status unknown
			6/1987	Status unknown
			7/1988	Killed by hunter 4/14/88 at den 82 km SE MHR
	1335 F	3	3/1984	Killed by hunter 9/14/84 in MHR
1341	1370 F	2	2/1986	Within MHR
			3/1987	Within MHR, capture mortality
	1371 M	2	2/1986	Killed by hunter 9/7/86 in MHR
1345	1385 F	3	3/1989	Within MHR
			4/1990	Within MHR
			5/1991	Within MHR
			6/1992	Within MHR, with 1 cub
	1386 M	3	3/1989	Within MHR
			4/1990	Within MHR
			5/1991	Stayed in MHR in June, moved 38 km SE by 10/12/91
			6/1992	Killed by hunter 38 km SE on 4/20/92
1348	1367 M	2	2/1986	Killed in defense of life or property 6/28/86 in MHR
	1368 F	2	2/1986	Killed in defense of life or property 5/31/86 in MHR
	1369 M	2	2/1986	Within MHR
			3/1987	Killed in defense of life or property 6/26/87 48 km WSW of MHR
1351	1357 M	3	3/1985	Moved 44 km NNW of MHR by 12/3/85
			4/1986	Killed by hunter 9/23/86 46 km WNW MHR

Table 2. Continued.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
	1361 F	3	3/1985	Within MHR
			4/1986	Within MHR
			5/1987	Shed collar in den
			6/1988	Status unknown
			7/1989	Status unknown
			8/1990	Status unknown
			9/1991	Killed by hunter, with 2-year-old offspring in MHR
1352	1353 M	2[b]	2/1984	Killed by hunter 9/4/84 in MHR
	1354 F	2[b]	2/1984	Not radio-collared, status unknown, assumed dead
1360	1359 M	3[c]	3/1985	Within MHR
			4/1986	Moved 62 km SE MHR, shed collar, assumed emigrated
			5/1987	Status unknown, assumed emigrated
	1363 M	3[c]	3/1985	Within MHR
			4/1986	Shed collar between 4/28 and 5/16/86 within MHR
			5/1987	Status unknown, assumed emigrated
1362	1387 F	2	2/1988	Within MHR
			3/1989	Within MHR
			4/1990	Killed illegally? in MHR
	1388 M	2	2/1988	Within MHR
			3/1989	Status unknown, shed collar
			4/1990	Status unknown, assumed emigrated
1376	1393 M	3	3/1990	Within MHR
			4/1991	Status unknown
			5/1992	Status unknown, assumed emigrated
	1394 F	3	3/1990	Status unknown, collar failed
			4/1991	Status unknown
			5/1992	Status unknown
1398	1397 F	2	2/1989	Within MHR
			3/1990	Status unknown
			4/1991	Status unknown
			5/1992	Adjacent to MHR
	1399 M	2	2/1989	Killed by hunter 16 km W of MHR
1607	1610 F	2	2/1991	Within MHR
			3/1992	Status unknown

Table 2. Continued.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
	1611 M	2	2/1991	Killed by hunter 19 km W of MHR
	1612 F	2	2/1991	Within MHR
			3/1992	Status unknown
1608	1609 F	2	2/1990	Within MHR
			3/1991	Within MHR
			4/1992	Within MHR
Unk	1302 F	2-3[d]	3/1981	Within EHR
			4-7	Shed collar 8/81, no contact until 1986 recapture
			8/1986	Within EHR
			9/1987	Within EHR
			10/1988	Within EHR, with 3 cubs
			11/1989	Within EHR, with 2 yearlings
			12/1990	Within EHR, weaned 3 2-year-olds
			13/1991	Within EHR, with 1 cub
			14/1992	Within EHR, with 1 yearling; killed by adult male
Unk	1303 F	2	2/1981	Within EHR
			3/1982	Within EHR
			4/1983	Within EHR
			5/1984	Within EHR
			6/1985	Within EHR
			7-11	Status unknown
			12/1991	Adjacent to EHR, with 2 cubs
			13/1992	Adjacent to EHR, with 1 yearling
Unk	1340 F	2-3[d]	3/1983	Within EHR
			4/1984	Within EHR
			5/1985	Within EHR, shed collar
			6-12	Status unknown, assumed dead 1992
Unk	1355 M	Unk	3/1983	Within established home range
			4/1984	Within established home range
			5/1985	Killed by hunter 9/13/85 12 km N of home range
Unk	1356 M	Unk	3/1984	Moved 74 km ESE of den area between 4/27 and 5/20/84 when killed by hunter
Unk	1377 M	2	2/1986	Within EHR
			3/1987	Shed collar 83 km W of EHR by 5/18/87
			4/1988	Status unknown, assumed emigrated
			5-6	Status unknown
			7/1991	Killed by hunter 103 km W of EHR

Table 2. Continued.

Maternal female No.	Offspring No. and sex	Age when weaned	Age/year during movement	Movement pattern
Unk	1383 M	2	2/1987	Within EHR
			3/1988	Shed collar, status unknown
			4/1989	Status unknown, assumed emigrated
Unk	1614 M	2-3[d]	3/1991	Within EHR
			4/1992	Within EHR, killed by hunter

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

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

[c] Orphaned when 1360 died during capture.

[d] Captured as 3-year-old, weaned as 2- or 3-year-old.

Table 3. Estimates of grizzly bear density utilizing different methods in the northcentral Alaska Range, 1992 (density figures in parentheses indicate 95% C.I.).

	1,496 km^2 search area (bears/1,000 km^2)			950 km^2 search area, 1992 (bears/1,000 km^2)			950 km^2 search area, 1986 (bears/1,000 km^2)		
Method	All bears	Bears ≥2-yr	Indep. bears	All bears	Bears ≥2-yr	Indep. bears	All bears	Bears ≥2-yr	Indep. bears
Direct count, adjusted for closure (this study)	13.8	10.4	9.1	12.1	10.8	10.8	14.0	11.8	11.7
Mark-recapture Bear-days (Miller et al. 1987)	14.6 (11.6-22.1)	11.2 (8.7-18.4)	10.5 (7.5-20.7)	10.7 (7.7-21.9)	10.0 (4.5-25.0)	10.0 (4.5-15.9)	11.4 (9.4-20.9)	11.2 (8.4-25.4)	11.2 (8.4-25.4)
Mark-recapture L-P adaptation (Eberhart, 1990)	16.2 (9.2-23.2)	12.3 (6.5-18.1)	10.8 (6.6-15.1)	12.9 (5.3-20.5)	11.5 (4.8-18.1)	11.5 (4.8-18.1)	11.3 (5.3-22.1)	10.3 (8.4-21.8)	10.3 (8.4-21.8)
Mark-recapture Maximum likelihood (White and Garrott 1990)	14.6 (12.2-19.7)	11.2 (9.0-15.5)	10.6 (7.9-17.7)	10.1 (8.5-17.1)	10.2 (7.6-19.7)	10.2 (7.6-19.7)	10.3 (9.5-16.5)	11.4 (8.5-21.4)	11.4 (8.5-21.4)

Table 4. Estimate of the minimum spring grizzly bear population size in the northcentral Alaska Range, 1981-92.[a]

Bears alive during spring of year[b]	1981			1982			1983			1984			1985			1986		
	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2
Marked bears	46	41	39	58	50	39	64	54	52	63	55	54	50	41	41	55	46	46
Unmarked young with marked mothers	12	12	0	13	13	0	7	7	0	15	15	1	20	20	0	13	13	0
Unmarked bears killed by hunters	26	19	16	14	9	8	10	7	6	7	4	3	6	3	1	9	5	4
Minimum observed population	84	72	55	85	71	47	81	68	58	86	74	58	76	64	42	77	64	50

Bears alive during spring of year[b]	1987			1988			1989			1990			1991			1992		
	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2	N	Adj	≥ 2
Marked bears	50	40	40	46	38	38	54	44	44	45	36	36	44	35	32	47	39	30
Unmarked young with marked mothers	26	24	0	25	23	0	14	14	0	20	19	0	19	23	0	14	13	0
Unmarked bears killed by hunters	8	5	3	8	6	2	8	6	5	3	3	0	3	3	3	4	2	1
Minimum observed population	84	69	43	78	67	40	76	64	49	68	58	36	70	57	35	65	53	31

[a] Minimum populations are presented as: N, total number present; Adj, or adjusted N, which accounts for those bears that range outside the study area; and ≥ 2, or Adjusted N ≥ 2 years of age. 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 population figures to more accurately reflect the numbers of bears present. Fractional figures were rounded to the nearest whole number.

[b] Number of bears alive during spring of 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 5. Reproductive status and litter sizes of potentially mature females in the northcentral Alaska Range, 1981-92.

Bear No.	Age in 1992[a] (yr)	Offspring No.	Reproductive status[b] 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Reproductive history
1302	14	1604, 1605, 1606, 1UM	NB	UN	UN	UN	UN	B	B	3c	3yl	3 2y/B	1c	1yl/D	No offspring prior 1986; killed by 1601 9/30/92
1303	13	1364, 1UM 2UM	NB	NB	B?	B	2c/B	UN	UN	UN	UN	UN/B	2c	1yl	No offspring prior 1981; lost 2 cubs 1985, lost 1 cub 1991
1305	25	1306, 1307	2yl	2 2y/B D											Hunter kill fall 1982
1308	15	2UM, 1391, 1392, 3UM		?/B	B	2c	2yl	1 2y/B	2c	2yl	2 2y/B	3c	2yl	2 2y	Offspring 1982 or before; lost 1 ylg 1985; lost 1 cub 1990
1311	22	1312, 1313, 1372, 1378, 1UM, 1395, 1624, 1625	UN/B	2c	B	2c	2yl	2 2y/B	2c	2yl	2 2y/B	2c	2yl	2 2y/B	Lost cubs August 1982; lost UM 2yr? spring 1989
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 cub 1982; dead August 1990
1320	24	1UM, 3UM, 2UM		?/B	1c/B?	B	3c	B	2c	1yl	B/D				Weaned or lost offspring 1982; lost cub 1983; lost 3 cubs 1985; lost 1 cub 1987; lost 1 ylg 1988; dead fall 1989
1321	23	1342, 1343, 1344, 1UM, 1379,[c] 1381[c] 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 ylg 1983; lost 3 cubs 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	10	1389, 1390, 1622, 1623		NB	NB	NB	UN/NB?	UN/B	2+c	2yl	2 2y/B	2c	2yl	2 2y/B	
1326	8	1UM		NB	B	B	1c	B/D							No offspring prior 1982; lost cub 1985; hunter kill 1986

Table 5. Continued.

Bear No.	Age in 1992[a] (yr)	Offspring No.	Reproductive status[b] 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Reproductive history
1327	18	1328, 1UM, 3UM	UN/2+c	2yl	B	3c/D									1UM ylg 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 offspring prior 1982; lost ylg 1987
1332	6			NB?	D										No offspring 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	No offspring prior 1983; lost 2 ylg 1988; lost 1 cub 1990
1340	11				NB	NB	B	UN	UN	UN	UN	UN	UN		No offspring prior 1983
1341	16	1UM, 1370, 1371, 2UM, 2UM		UN/1+c	1yl/B	2c	2yl	2 2y/B	B	2c/B	2c/D				Lost ylg 1983; lost 2 cubs 1988; dead fall 1989
1345	16	2UM, 1385, 1386, 3UM			B	2c	1yl/B	2c	2yl	2 2y	2 3y/B	3c	3yl	UN	Lost 1 cub 1984; lost 1 ylg 1985
1348	21	1367, 1368, 1369, 2UM, 1UM, 1619, 1620,1621			?/B	3c	3yl	3 2y/B	2c	2yl/B	1 c/B	3c	3yl	3 2y/D	Probably weaned or lost offspring 1983; lost 2 ylg 1988; lost 1 cub 1989; probable hunter kill 1992
1351	18	1357, 1361, 1UM, 3UM	UN/B	3+c	3yl	3 2y	2 3yr/B	3+c	3yl/D						Lost 1UM offspring 1984; hunter kill 1987, 3UM ylg 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	1+UM				NB	NB	NB	UN	UN/B	1+c	1+yl	1 2y/D		No offspring prior 1985; both 1361 and 2yr hunter kills 1991
1362	12	1387, 1388				UN	B	2c	2yl	2 2y/B	B	UN	UN	UN	No offspring prior 1985

Table 5. Continued.

Bear No.	Age in 1992[a] (yr)	Offspring No.	Reproductive status[b] 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Reproductive history
1374	12	2UM, 2UM, 3UM				UN/B	2+c	2yl	?/B	2+c	2yl	2 2y/B	3c	UN	
1376	18	1393, 1394					UN	?/B	2c	2yl	2 2y	2 3y/D			Offspring prior 1986; dead spring 1990
1379	6									NB	B	UN	UN	D	Dropped collar spring 1990; hunter kill 1992
1385	6											NB	B	1c	
1391	5											NB	B	1c	
1397	5												UN	B	
1398	11	1397, 1399, 2UM						?/B	2+c	2+yl	2 2y/B	UN/B	2c	2yl	
1603	4											NB	B	B	
1607	11	1610, 1611, 1612								?/B	3+c	3yl	3 2y/B	UN	
1608	17	1609?, 2UM							UN/B?	1+c?	1+yl?	1+ 2y?/B	2c	2yl	Assumed 1609 was offspring from strong circumstantial evidence
1626	17	2UM										UN/B	2+c	2yl/D	Probably killed by hunter in defense of life

[a] Age in 1992 <u>or</u> last year in which bear was alive.

[b] Designations: B, observed in breeding condition; NB, not observed in breeding 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 and therefore litter size may have been larger.

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

Table 6. Observed and projected minimum reproductive intervals for adult female grizzly bears in the northcentral Alaska Range, 1981-92.

Bear No.	Age when interval began	Minimum cycle length[a]	Annual reproductive status for adult females[b]												
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
1302	7	5	B?	B	B	C	Y	2/B	C	Y/D	2/B				
1303	5	5,5	B	C/B	B	C	Y	2/B	?	?	C	Y	2/B		
1305	22	3	W/B	C	Y	2/B/D									
1308	6	4,3,4	C?/B	B	C	Y	2/B	C	Y	2/B	C	Y	2	3/B	
1311	10	5,3,3	W/B	C	B	C	Y	2/B	C	Y	2/B	C	Y	2/B	
1318	12	7,3	W/B	C/B	B	B	C	Y	2	3/B	C/D	Y	2/B		
1320	17	10	W/B	C/B?	B	C	B	C	Y/B?	B/D	C	Y	2/B		
1321	14	4,3,5	W/B	C	Y	2	3/B	C	Y	2/B	C	B/D	C	Y	2/B
1322	6	4	B	C	Y	2	3/B								
1323	11	3,6	W/B	C	Y	2/B	?	?/B	C	Y	2/D	3/B			
1324	5	3,3	B	C	Y	2/B	C	Y	2/B						
1326	6	5	B	C/B?	B/D	C	Y	2/B							
1329	11	3	W/B	C	Y	2/D									
1331	7	5	B	C	Y/B	C	Y	2/B/D							
1333	14	4	W/B	C	Y	2	3/B/D								
1336	5	7	B	C	Y	B	C	Y	2/B						
1341	10	5,5	W/B	C	Y/B	C	Y	2/B	B	C/B	C/D	Y	2/B		
1345	8	6,4	B	C	Y/B	C	Y	2	3/B	C	Y	2/D	3/B		
1348	12	3,7	W/B	C	Y	2/B	C	Y/B	C/B	C	Y	2/BD	3/B		
1351	12	4,3	W/B	C	Y	2	3/B	C	Y/D	2/B					
1352	13	3	W/B	C	Y	2/D									
1360	6	4	W/B	C	Y	2	3/D								
1361	6	4	B	C	Y	2/D	3/B								
1362	6	3,4	B	C	Y	2/B	B	C	Y	2/B	C				
1374	4	3,3,3	B	C	Y	2/B	C	Y	2/B	C	Y	2/B			
1376	14	4	W/B	C	Y	2	3?/D								
1385	5	3	B	C	Y	2/B									
1391	4	3	B	C	Y	2/B									
1398	5	3,4	B	C	Y	2/B	?/B	C	Y	2/B					

Table 6. Continued.

Bear No.	Age when interval began	Minimum cycle length[a]	Annual reproductive status for adult females[b]												
			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
1607	6[c]	3	B	C	Y	2/B	C?								
1608	?	3	2?/B	C	Y	2/B									
1626	17	3	W/B	C	Y/D	2/B									

[a] All reproductive cycles or intervals were minimum values because they were partially based on projections prior to or after years when actual observations were made. In addition, all projected calculations assume weaning of young as 2-year-olds; however, in weanings that were observed, 9 of 26 females weaned offspring as 3-year-olds.

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

[c] Based on estimated age.

Table 7. Observed litter size and number of offspring in cub, yearling, 2-year-old, and 3-year-old age classes, northcentral Alaska Range, 1982-92.

Age class	Observed no. of litters											Total		Mean litter size
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	No. of litters	No. of offspring	
Cub														
litter size 1	1	1	0	1	0	0	0	1	0	1	2	7	7	
litter size 2	2	0	4	2	2	7	1	2	2	3	0	25	50	
litter size 3	0	0	2	2	0	0	2	0	4	1	0	11	33	
total	3	1	6	5	2	7	3	3	6	5	2	43	90	2.09
Yearling														
litter size 1	2	1	0	1	0	1	1	1	0	0	2	9	9	
litter size 2	2	2	0	3	2	2	5	1	0	4	3	25[a]	50[a]	
litter size 3	1	1	0	1	1	1	0	1	1	2	0	9	27	
total	5	4	0	5	3	4	6	3	1	6	5	43[a]	86[a]	2.00[a]
2-year-old														
litter size 1	0	2	0	0	1	0	0	0	1	0	0	4	4	
litter size 2	1	1	2	0	2	2	2	5	1	0	4	20	40	
litter size 3	0	1	1	0	1	0	0	0	1	1	1	6	18	
total	1	4	3	0	4	2	2	5	3	1	5	30	62	2.07
3-year-old														
litter size 1	0	0	1	0	0	0	0	0	0	0	0	1	1	
litter size 2	0	0	2	1	0	0	1	1	1	0	0	6	12	
litter size 3	0	0	0	1	0	0	0	0	0	0	0	1	3	
total	0	0	3	2	0	0	1	0	1	0	0	8	16	2.00

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

Table 8. Annual number of breeding females, cubs produced, cub survival to weaning, and subsequent presence of offspring in the northcentral Alaska Range, May 1981-92 (+ indicates minimum figures).

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

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

[b] In three 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 three cubs were assumed dead as well. During September 1986 a hunter killed bear no. 1351; subsequent survival of her three 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

Table 8. Continued.

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 two litters of 2-year-olds to weaning age was assumed because most offspring are weaned at that age. During 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 two accompanying offspring would have been weaned as 3-year-olds.

Table 9. Minimum number of female grizzly bears present in the study population in the northcentral Alaska Range, 1981-92.

	Minimum number of females in population								
		3-5 yrs old				≥6 yrs old			
			Change from previous year				Change from previous year		
Year	No. ≤2 yrs old[a]	No.	+	-	Net	No.	+	-	Net
1981	-[b]	-[c]	-[c]	4	-[c]	23[d]	-[c]	-[c]	-[c]
1982	9-12	12	4	3	-[c]	23	1	1	0
1983	6-8	10	1	3	-2	21	0	2	-2
1984	9-12	8	3	5	-2	22	3	2	+1
1985	8-11[e]	7	3	4	-1	21	3	4	-1
1986	7-8[e]	5	0	2	-2	21	2	2	0
1987	12-14[e]	4	1	2	-1	22	2	1	+1
1988	13-15[e]	2	2	4	-2	23	2	1	-1
1989	10-12[e]	4	2	0	+2	23	0	0	0
1990	12-14	7	4	1	+3	18	0	5	-5
1991	10-12[e]	9	5	3	+2	17	1	2	-1
1992	10-11[e]	10	2	1	+1	15	1	3	-2
1993		12	6	4	+2	14	3	4	-1

[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 1980-81 are likely underestimates because natural mortality is not accounted for. The probable number of adult females present during 1980-81 was more likely 21-24.

Table 9. Continued.

[e] These are minimum figures because not all marked and reproductively active females were observed every year due to radiocollar loss or failure. We assumed that these females remained in the study area and continued to produce offspring. There were two reproductively mature females that were not observed in 1985 and 1991, four in 1986-89, seven in 1990, and three in 1992. Because the number and age of offspring were not known, their estimated numbers are not included here.

Table 10. Number of male grizzly bears which have been present in the study population in the northcentral Alaska Range, 1981-92.

		Number of males in population							
		4-5 yrs old				≥6 yrs old			
			Change from previous year				Change from previous year		
Year	No. ≤3 yrs old	No.	+	-	Net	No.	+	-	Net
1981	17	8	-[a]	-[a]	-[a]	15	-[a]	-[a]	-[a]
1982	19	4	1	5	-4	13	3	5	-2
1983	17	2	1	3	-2	14	3	2	+1
1984	19	6	5	1	+4	12	1	3	-2
1985	15	8	4	2	-2	11	1	2	-1
1986	13	7	3	4	-1	14	3	0	-3
1987	16	3	1	5	-4	14	2	2	0
1988	15	3	2	2	0	15	2	1	+1
1989	19	4	3	2	+1	12	1	4	-3
1990	16	3	2	3	-1	10	1	3	-2
1991	15	4	3	2	+1	9	1	2	-1
1992	12-13	5	2	1	+1	9	0	0	0
1993	-[b]	1	0	4	-4	11	1	3	+2

[a] Because no observations were made prior to 1981, calculations of changes in the numbers within age classes were not made.

[b] Numbers in this age class include cubs that cannot be counted until after their emergence from dens during spring 1993. Other figures for 1993 can be reliably estimated from fall 1992 data.

Table 11. Mortality of grizzly bears in the northcentral Alaska Range, 1981-92.

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

Table 11. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
UM	Unk	Cub	--	6/83	Delta Creek	Unk, offspring 1320
UM	Unk	1	--	5/23-8/21/83	Little Delta River	Unk, offspring 1341
UM	F	14	--	9/16/83	Kansas Creek	Hunter kill
UM	M	7	--	9/19/83	Little Delta River/ Tenmile Creek	Hunter kill
1342	M	2	5/24/83	10/83	Wood River	Nonsport illegal kill
1315	M	15	6/4/82	5/17/84	Delta Creek	Capture mortality
1306	M	4	5/24/82	5/20/84	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	Capture mortality?
3UM	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
3UM	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

Table 11. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
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
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

Table 11. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
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
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	--	5/18/89-6/7/89	Wood River	Unk, offspring of 1348
M	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, GMU 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?

Table 11. Continued.

Bear No.[a]	Sex[b]	Age[c]	Date of initial capture	Date of death	Location	Cause of death
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	Cub/ylg	--	6/6/90-5/6/91	Dry Creek	Unk, offspring 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
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	Unk	1	--	9/11/92	Dry Creek	Defense of life kill; offspring of 1626
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
1621	M	2	5/7/92	10/3/92	Gold King Creek	Hunter kill, shot at cabin; with mother 1348
1348	F	21	5/31/83	10/92	Gold King Creek	Reported hunter kill or DLP; not sealed

Table 11. Continued.

[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.

Table 12. Grizzly bear harvest[a] within the northcentral Alaska Range, 1961-92.

	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[c]	2[c]	1	6
1983	2	2	0	2[d]	6
1984	1	6[e]	2[e]	1[e]	11
1985	0	1[f]	0	1[f]	2
1986	2[g]	3[g]	0	3[g]	8
1987	1	1	2[h]	3	7
1988	0	0	1[i]	1	2
1989	1	7[j]	2[j]	5[j]	15
1990	1[k]	0	0	2[k]	3
1991	1	3[l]	0	1[l]	5
1992	1	2	4[m]	3	10
Totals	24	60	30	72	186

[a] Includes hunter harvest, bears killed in defense of life or property, assumed wounding deaths, and bears killed illegally by hunters.

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

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

Table 12. Continued.

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

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

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

[g] Six marked bears were killed in 1986; four marked bears were taken by hunters (two in Delta Creek and two in the Little Delta River) and two were taken in defense of life or property in the Wood River drainage.

[h] Two marked bears were killed by hunters in Dry Creek during 1987.

[i] One marked bear was killed by a hunter in Dry Creek during 1988.

[j] Six marked bears were killed in the study area during 1989: four were killed by hunters (one each in Wood River, Dry Creek, Little Delta River, and Blair Lake drainages); one was killed on Gold King Creek in defense of life and one was killed illegally on St. George Creek. Strong circumstantial evidence suggested three marked bears died after being wounded and are included here.

[k] Two marked bears were killed in the Wood River drainage of the study area during 1990: one was killed by a hunter and one was very probably killed illegally. Another marked bear probably died after being wounded.

[l] Three marked bears were killed in the study area during 1991: two were killed in the Little Delta River and one at Gold King airstrip. In addition, one of the unmarked bears killed was probably the 2-year-old offspring of No. 1361, one of the marked bears killed.

[m] Three marked bears were documented as killed by hunters during 1992: two in the Gold King Creek drainage and one near Slide Creek. A female and one of her offspring that were killed as they mauled a hunter were reportedly not marked; however, a radiocollar signal located at the site is circumstantial evidence that the female was No. 1626. Another hunter reported that a radio-collared bear (probably No. 1348) was killed near Gold King Creek, but the bear was not sealed by December 1992.

Table 13. Human-caused mortality[a] and mortality rates for a grizzly bear population[b] in the northcentral Alaska Range, 1981-92.

		Minimum population of all age classes		Minimum population $\geq$2 yrs of age		Adult females $\geq$6 yrs 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	22	1	5
1988	2	67	3	40	5	22	0	0
1989	15[d]	65	23	49	31	22	5	22
1990	4	58	7	36	11	18	2	11
1991	5	57	9	35	14	17	2	12
1992	11[e]	54	20	31	32	15	4	27
Mean	7	65	11	45	16	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. 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. Note that mortality rates are based upon observed minimum populations, which do not include the 10-15 bears we estimate as present in the population but not captured or killed.

Table 13. Continued.

[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 one in 1992 and are included in calculations of adult female mortality rates for 1983 and 1992 but not in human-caused mortality rates.

[d] Did not count four cubs with mothers.

[e] Includes one yearling reported but not substantiated as killed in defense of life or property.

Table 14. Comparison of grizzly bear harvest[a] within sex and age classes with percentage occurrence in the minimum population of bears $\geq$2 years of age, northcentral Alaska Range, 1981-91.

	Age of males		Age of females	
	2-5 years	$\geq$6 years	2-5 years	$\geq$6 years
$\bar{x}$ annual percentage in minimum population $\geq$2 years of age	22	22	17	39
$\bar{x}$ annual percentage in harvest	40	22	21	16

[a] Harvest included hunter-killed bears and those taken in defense of life or property, but not those that died as a result of capture, from illegal causes, or from probable wounding loss.

Appendix A. Physical attributes[a] of grizzly bears captured in the northcentral Alaska Range, 1981-92.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1301	5/18/81	M	6	120	180	119	31	61	114	101	21.0	36.8	3.4	3.0
1302	5/19/81	F	3	75	165	102	26	55	100	90	16.7	30.5	3.0	2.7
	6/12/86	F	8	114	180	--	--	61	106	--	19.2	33.1	--	--
	5/12/89	F	11	109	161	--	--	59	103	--	19.1	33.5	--	--
1303	6/17/81	F	2	57	122	87	23	53	89	78	15.1	27.7	2.5	2.7
	6/27/83	F	4	82	159	97	26	55	91	79	18.4	32.3	3.0	2.9
	6/14/85	F	6	73	--	--	--	47	85	--	18.8	32.2	--	--
	5/31/91	F	12	210	173	--	--	57	104	--	20.0	32.1	--	--
1304	6/19/81	M	5	136	196	121	30	63	108	109	20.0	36.0	3.9	3.5
	5/21/87	M	11	255	205	--	--	80	132	--	24.0	39.7	--	--
	6/7/89	M	13	245	217	--	--	77	147	--	26.0	39.2	--	--
	6/1/91	M	15	272	236	--	--	94	151	--	26.2	40.2	--	--
1305	6/19/81	F	24	114	174	103	28	60	100	96	20.1	32.6	3.0	3.3b
1306	5/24/82	M	2	44	131	85	26	44	73	76	15.1	29.6	2.7	2.8
1307	5/24/82	M	2	44	148	84	28	46	74	83	15.4	27.3	2.6	2.5
	6/17/85	M	5	114[d]	--	--	--	55	94	--	19.2	34.8	--	--
1308	5/25/82	F	6	111	186	103	32	63	100	101	20.2	33.1	3.0	2.2b
	6/20/84	F	8	120	--	--	--	64	116	--	20.8	34.1	--	--
	6/8/87	F	11	123	183	--	--	56	106	--	21.5	34.9	--	--
	5/6/91	F	15	125	182	--	--	62	107	--	21.8	33.9	--	--
1309	5/25/82	M	8	318[d]	238	150	36	89	152	128	25.0	39.1	4.0	3.5
1310	5/25/82	M	13	250[d]	--	--	--	--	--	--	--	--	b	--
	6/20/84	M	15	255	--	--	--	74	129	--	24.6	39.3	--	--
	5/21/87	M	18	264	212	--	--	80	143	--	25.5	39.1	--	--
1311	5/26/82	F	12	120	190	107	30	63	113	105	21.8	33.8	3.0	2.6
	6/21/84	F	14	116	--	--	--	59	100	--	20.0	34.2	--	--
	6/8/87	F	17	123[d]	188	--	--	62	115	--	21.2	34.1	--	--
	6/3/91	F	21	125	177	--	--	62	108	--	21.2	34.1	--	--
	5/10/92	F	22	121	178	--	--	60	112	--	24.5	36.0	--	--
1312	5/26/82	F	cb	12	81	48	15	28	43	42	10.2	16.5	m	m
1313	5/26/82	F	cb	12	76	50	15	30	48	45	11.1	16.8	m	m

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1314	5/27/82	M	6	116	191	114	33	61	105	99	18.5	34.8	3.6	3.3
1315	6/4/82	M	13	273	197	126	36	96	154	122	26.4	38.2	3.5	3.3
	5/17/84	M	15	295	--	--	--	97	139	--	26.8	37.5	--	--
1316	6/7/82	M	11	236	211	133	33	81	133	135	24.0	40.7	3.8	3.7
1317	6/8/82	F	3	36	142	91	24	38	62	72	14.2	27.9	2.9	2.9
	5/16/84	F	5	55	--	--	--	45	89	--	16.2	29.7	--	--
	5/23/85	F	6	59	--	--	--	43	77	--	16.4	30.3	--	--
1318	6/8/82	F	13	104	188	113	31	57	--	113	19.5	33.5	3.1	2.8
	6/22/84	F	15	118[d]	--	--	--	59	105	--	19.8	33.5	--	--
	6/2/87	F	18	105[d]	--	--	--	--	--	--	--	--	--	--
1319	6/8/82	M	cb	12	85	52	14	26	34	44	10.8	17.2	m	m
1320	6/8/82	F	17	102	181	110	29	65	103	100	21.0	33.1	2.9w	2.7w
	6/25/84	F	19	139	--	--	--	62	106	--	21.0	33.0	--	--
	6/12/87	F	22	114	173	--	--	58	106	--	21.7	33.4	--	--
1321	6/9/82	F	16	141	199	107	34	69	105	115	22.1	35.8	3.5	3.1
	5/17/83	F	17	127	178	91	30	69	109	112	21.9	36.0	2.4b	3.2
	7/22/85	F	19	218	--	--	--	63	121	--	22.1	35.6	--	--
	6/6/89	F	23	170	199	--	--	71	125	--	22.0	35.9	--	--
1322	6/9/82	F	8	91	169	100	29	62	97	97	18.9	32.8	3.2	3.0
1323	6/10/82	F	11	95	171	106	32	57	98	93	20.0	33.5	3.2	2.9
	6/29/84	F	13	132	--	--	--	61	109	--	20.9	33.6	--	--
1324	6/10/82	F	cb	12	77	49	16	29	47	39	10.6	17.5	m	m
	5/26/88	F	6	111	158	--	--	63	109	--	18.8	34.0	--	--
	5/26/92	F	10	129	179	--	--	63	111	--	20.8	34.5	--	--
1325	6/10/82	M	cb	12	86	54	15	26	48	42	11.5	18.0	m	m
	5/15/84	M	2	67	--	--	--	46	80	--	16.5	30.1	--	--
1326	6/18/82	F	4	93	172	102	27	54	88	98	17.9	31.4	3.1	2.9
	6/21/84	F	6	109	--	--	--	58	92	--	18.9	32.8	--	--
	6/27/85	F	7	111	--	--	--	52	95	--	20.1	33.3	--	--
1327	7/8/82	F	16	127	175	106	29	62	100	117	20.9	32.9	2.3	2.8
	6/23/84	F	18	125	--	--	--	61	109	--	21.0	33.5	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1328	7/8/82	F	1	43	122	83	26	41	75	68	14.5	25.7	2.0	1.7
1329	7/9/82	F	13	120	186	112	30	59	106	104	19.8	34.2	3.3	3.0
1330	7/9/82	M	1	48	130	83	27	45	75	67	14.4	26.2	1.4	1.8
	6/28/84	M	3	102	--	--	--	50	99	--	17.5	32.9	--	--
1331	7/10/82	F	4	77	161	102	28	50	96	98	17.0	30.5	--	--
	5/20/87	F	9	114[d]	175	--	--	56	104	--	19.8	33.4	--	--
	5/15/90	F	12	111	189	--	--	54	90	--	20.5	34.0	--	--
1332	7/12/82	F	5	104	173	100	32	54	92	97	18.0	33.4	3.1	2.9
1333	7/13/82	F	16	141	175	112	33	65	117	124	21.0	34.0	3.1	2.6
1334	7/13/82	M	1	49	129	86	27	42	87	72	14.4	24.9	1.3	1.6
	6/27/84	M	3	107	--	--	--	52	104	--	18.1	31.3	--	--
1335	7/13/82	F	1	38	127	77	24	40	76	73	13.5	24.0	1.6	1.8
	6/25/84	F	3	80	--	--	--	47	90	--	16.8	30.0	--	--
1336	5/16/83	F	2	47	141	86	27	56	90	86	14.9	28.2	2.6	2.4
	6/26/84	F	3	89	--	--	--	49	101	--	16.9	31.7	--	--
	6/17/85	F	4	102	--	--	--	61	102	--	18.3	33.3	--	--
	5/15/87	F	6	109	160	--	--	67	103	--	18.8	34.6	--	--
	5/17/89	F	8	145	175	--	--	67	133	--	21.2	33.2	--	--
	5/7/92	F	11	116	--	--	--	55	--	--	--	--	--	--
1337	5/18/83	M	20	289	210	122	36	98	151	135	26.6	39.8	4.0b	b
	6/15/88	M	25	277	210	--	--	84	135	--	26.6	39.4	--	--
1338	5/20/83	M	6	111	175	89	29	35	107	101	19.9	34.8	3.5	3.4
1339	5/20/83	M	6	120	174	103	29	37	109	100	19.7	34.4	3.6	3.1
	5/17/84	M	7	168	--	--	--	60	102	--	20.0	35.0	--	--
1340	5/23/83	F	3	71	159	86	27	58	95	91	15.7	30.2	3.2	3.2
	5/19/84	F	4	91[d]	--	--	--	51	95	--	17.3	31.8	--	--
	6/27/85	F	5	100	--	--	--	54	94	--	18.5	33.6	--	--
1341	5/23/83	F	10	107	171	110	31	63	125	110	20.7	33.2	3.2	3.1
	6/13/85	F	12	107	--	--	--	57	104	--	--	--	--	--
	6/14/88	F	15	164	185	--	--	59	114	--	21.8	34.1	--	--
1342	5/24/83	M	2	49	133	85	27	52	91	67	15.6	27.2	2.5	2.8

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1343	5/24/83	M	2	43	139	85	26	48	88	69	15.5	27.1	3.0	3.0
1344	5/24/83	M	2	56	151	79	--	49	93	--	14.9	28.5	2.5	2.5
	6/23/84	M	3	123	--	--	--	55	105	--	18.5	33.2	--	--
1345	5/24/83	F	8	--	175	99	30	65	110	98	18.3	33.0	3.1	2.8
	5/23/85	F	10	105[d]	--	--	--	56	103	--	18.6	33.6	--	--
	5/13/89	F	14	118	165	--	--	65	105	--	19.6	33.2	--	--
1346	5/25/83	M	5	114	145	98	30	71	110	94	19.7	25.1	3.2	3.0
	5/14/90	M	12	--	213	--	--	88	141	--	26.0	39.1	--	--
	6/1/91	M	13	249	213	--	--	87	143	--	25.4	39.1	--	--
1347	5/31/83	M	6	189	188	119	23	71	144	114	22.0	37.5	3.7	3.4
1348	5/31/83	F	12	--	175	107	20	72	123	110	20.0	37.6	3.2	2.9
	5/16/86	F	15	116	180	--	--	58	100	--	20.2	32.8	--	--
	5/12/90	F	19	141	191	--	--	57	112	--	21.0	33.3	--	--
	5/9/91	F	20	120	180	--	--	60	109	--	20.0	34.5	--	--
	5/9/92	F	21	107	--	--	--	--	--	--	--	--	--	--
1349	6/2/83	M	18	264	217	124	33	93	145	125	25.6	35.5	4.0b	3.4
1350	6/2/83	M	8	202	201	119	30	77	118	118	22.5	--	3.7	3.1
	6/12/86	M	11	205	207	--	--	76	--	--	23.7	38.2	--	--
1351	6/23/83	F	14	114[d]	181	91	23	69	114	116	21.0	38.0	3.3	3.2
	6/10/85	F	16	111	--	--	--	56	98	--	21.3	35.5	--	--
	5/19/87	F	18	130	178	--	--	64	110	--	22.0	35.5	--	--
1352	6/27/83	F	14	111	175	102	29	59	103	108	19.5	34.1	3.1	2.8
1353	6/27/83	M	1	27	107	75	20	34	54	56	12.4	21.9	r	r
1354	6/27/83	F	1	12	87	60	17	24	41	43	11.0	18.4	r	r
1355	6/30/83	M	3	60	138	98	27	45	77	77	15.2	27.5	--	--
	6/3/85	M	5	70	--	--	--	49	84	--	17.4	31.6	--	--
1356	6/30/83	M	2	50	--	--	24	46	69	--	14.9	25.2	--	--
1357	5/15/84	M	2	63	--	--	--	53	90	--	14.7	27.5	--	--
	6/24/85	M	3	93	--	--	--	50	88	--	18.5	31.1	--	--
1358	5/18/84	M	13	205[d]	--	--	--	86	--	--	--	38.4	--	--
	5/20/86	M	15	236	216	--	--	79	143	--	24.2	38.5	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1359	5/28/85	M	3	61	--	--	--	44	--	--	14.4	29.1	--	--
1360	5/28/85	F	10	95	--	--	--	--	89	--	19.5	34.4	--	--
1361	5/28/85	F	3	63	--	--	--	44	81	--	17.3	30.0	--	--
	5/19/86	F	4	100	155	--	--	51	100	--	18.6	32.1	--	--
1362	6/5/85	F	6	--	--	--	--	--	--	--	--	--	--	--
	6/24/85	F	6	114	--	--	--	55	98	--	19.2	33.1	--	--
	5/15/88	F	9	--	181	--	--	56	102	--	20.0	34.0	--	--
1363	6/5/85	M	3	55	128	--	--	50	86	--	16.0	28.3	--	--
1364	6/14/85	M	cb	7	69	--	--	20	37	--	9.8	15.6	--	--
1365	6/19/85	M	5	118	--	--	--	57	97	--	18.9	34.9	--	--
1366	7/22/85	M	8	234	--	--	--	83	130	--	23.2	36.3	--	--
1367	5/19/86	M	2	61	138	--	--	48	91	--	15.5	28.8	--	--
1368	5/19/86	F	2	48	140	--	--	51	82	--	15.0	27.0	--	--
1369	5/19/86	M	2	68	158	--	--	56	98	--	16.4	30.2	--	--
1370	5/20/86	F	2	47	136	--	--	41	81	--	14.9	25.5	--	--
	5/20/87	F	3	69	136	--	--	46	92	--	16.3	29.0	--	--
1371	5/20/86	M	2	57	150	--	--	51	83	--	16.5	28.2	--	--
1372	5/20/86	M	2	72	--	--	--	--	--	--	--	--	--	--
	5/17/89	M	5	186	186	--	--	84	118	--	23.3	37.5	--	--
1373	5/21/86	M	7	193	190	--	--	69	119	--	22.6	37.1	--	--
1374	5/21/86	F	6	106	171	--	--	64	99	--	19.8	35.2	--	--
	6/9/89	F	9	148	178	--	--	68	109	--	21.8	35.7	--	--
1375	6/13/86	M	6	186	208	--	--	67	117	--	21.0	36.6	--	--
	5/13/89	M	9	281	211	--	--	87	141	--	25.2	39.5	--	--
	5/31/91	M	11	295	224	--	--	92	152	--	26.0	39.3	--	--
1376	6/13/86	F	14	130	171	--	--	64	103	--	21.8	34.2	--	--
1377	8/28/86	M	3[d]	132	174	--	--	58	98	--	17.3	31.6	--	--
1378	5/20/86	F	2	130[d]	--	--	--	--	--	--	--	--	--	--
1379	5/15/87	F	2	67	--	--	--	52	96	--	15.4	27.3	--	--
	6/6/89	F	4	105	156	--	--	63	99	--	19.4	33.5	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1380	5/18/87	M	2	65	153	--	--	49	84	--	16.6	30.3	--	--
	5/17/88	M	3	109	178	--	--	50	92	--	17.5	33.5	--	--
1381	5/21/87	M	2	73	158	--	--	45	83	--	16.3	29.6	--	--
1382	5/14/88	F	3	68	154	--	--	46	83	--	16.2	30.3	--	--
	6/7/89	F	4	84	174	--	--	49	89	--	17.8	31.9	--	--
1383	6/12/87	M	2[d]	77	146	--	--	52	88	--	17.4	30.9	--	--
1384	5/15/88	M	7[d]	191	198	--	--	83	116	--	24.5	39.8	--	--
1385	5/15/88	F	2	68	142	--	--	50	76	--	15.5	27.4	--	--
	5/13/89	F	3	82	140	--	--	50	92	--	17.2	30.8	--	--
	5/11/90	F	4	95	178	--	--	50	85	--	18.3	32.1	--	--
	6/2/91	F	5	118	189	--	--	57	103	--	19.5	32.0	--	--
1386	5/15/88	M	2	73	146	--	--	45	75	--	16.0	29.1	--	--
	5/13/89	M	3	91	162	--	--	49	88	--	17.7	32.5	--	--
	6/7/90	M	4	120	183	--	--	61	99	--	19.0	35.2	--	--
	5/31/91	M	5	156	178	--	--	68	115	--	20.6	36.4	--	--
1387	5/23/88	F	2	55	129	--	--	58	79	--	15.8	27.5	--	--
	5/12/89	F	3	77	137	--	--	49	83	--	16.5	28.8	--	--
	5/15/90	F	4	84	166	--	--	49	87	--	17.3	31.7	--	--
1388	5/25/88	M	2	68	148	--	--	50	93	--	16.3	29.0	--	--
1389	5/13/89	M	3	84	157	--	--	53	88	--	17.6	33.1	--	--
1390	5/13/89	F	3	77	148	--	--	50	83	--	16.2	30.0	--	--
1391	5/13/89	F	2	68	139	--	--	50	83	--	16.1	29.4	--	--
	5/12/90	F	3	95	171	--	--	52	97	--	18.5	31.5	--	--
	5/7/91	F	4	109	176	--	--	59	112	--	18.7	33.1	--	--
	5/23/92	F	5	111	175	--	--	60	117	--	20.2	32.4	--	--
1392	5/13/89	M	2	89	145	--	--	55	86	--	17.1	31.0	--	--
	5/26/92	M	5	229	215	--	--	84	133	--	23.2	39.3	--	--
1393	5/17/89	M	2	66	150	--	--	51	85	--	17.0	28.7	--	--
	5/24/90	M	3	100	169	--	--	52	92	--	18.3	31.5	--	--
1394	5/17/89	F	2	59	144	--	--	49	83	--	16.1	26.2	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1395	5/17/89	M	2	86	159	--	--	63	103	--	18.5	30.7	--	--
1396	5/18/89	M	13[d]	295	206	--	--	91	163	--	25.0	38.1	--	--
1397	5/18/89	F	2	61	142	--	--	45	76	--	15.4	26.8	--	--
	5/25/92	F	5	116	180	--	--	63	110	--	19.1	34.3	--	--
1398	5/18/89	F	8[d]	127	188	--	--	67	104	--	20.2	33.1	--	--
1399	5/18/89	M	2	66	157	--	--	50	78	--	15.3	27.0	--	--
1400	6/8/89	M	8[d]	239	208	--	--	88	--	--	23.8	39.5	--	--
1601	6/9/89	M	7[d]	193	193	--	--	88	135	--	23.2	38.2	--	--
	5/7/91	M	9[d]	245	199	--	--	84	135	--	24.5	39.0	--	--
	10/4/92	M	10[d]	354	202	--	--	79	--	--	24.8	39.5	--	--
1602	5/13/90	M	7[d]	166	198	--	--	69	110	--	21.3	35.8	--	--
	5/25/92	M	9[d]	200	198	--	--	83	129	--	22.5	39.3	--	--
1603	35/13/90	F	2[d]	55	150	--	--	42	73	--	16.3	28.1	--	--
	5/8/91	F	3	70	162	--	--	53	94	--	18.8	30.3	--	--
	5/24/92	F	4	102	174	--	--	65	104	--	20.3	33.4	--	--
1604	5/13/90	F	2	48	141	--	--	42	69	--	14.5	26.6	--	--
	5/7/91	F	3	59	157	--	--	47	77	--	15.4	29.6	--	--
	5/25/92	F	4	95	168	--	--	62	199	--	17.2	31.5	--	--
1605	5/13/90	F	2	59	140	--	--	43	76	--	15.3	26.7	--	--
	5/8/91	F	3	68	168	--	--	46	88	--	16.8	30.3	--	--
	5/26/92	F	4	102	174	--	--	54	101	--	18.3	33.0	--	--
1606	5/13/90	M	2	50	135	--	--	43	68	--	14.7	27.4	--	--
	5/8/91	M	3	70	162	--	--	48	85	--	16.7	28.5	--	--
1607	5/14/90	F	10[d]	141	198	--	--	--	107	--	21.6	36.8	--	--
1608	5/14/90	F	16[d]	136	189	--	--	68	111	--	22.5	35.3	--	--
1609	5/14/90	F	2[d]	61	145	--	--	56	84	--	15.7	27.5	--	--
	5/7/91	F	3	77	162	--	--	59	85	--	17.6	30.6	--	--
	5/25/92	F	4	93	172	--	--	59	142	--	19.5	33.1	--	--
1610	5/6/91	F	2	70	152	--	--	46	80	--	16.8	31.3	--	--
1611	5/6/91	M	2	91	157	--	--	58	102	--	17.3	30.6	--	--
1612	5/6/91	F	2	73	155	--	--	53	86	--	16.5	28.6	--	--

Appendix A. Continued.

Bear No.	Date	Sex	Age (yr)[b]	Measured weight	Total length	Shoulder height	Hind foot	Neck	Girth	Body length	Head width	Head length	Left upper canine[c]	Left lower canine[c]
1613	6/2/91	M	6	177	190	--	--	71	113	--	22.0	37.5	--	--
1614	6/2/91	M	3[d]	109[d]	78	--	--	65	98	--	--	--	--	--
1615	6/3/91	M	4[d]	125	191	--	--	60	97	--	20.1	33.4	--	--
1616	5/7/92	M	5[d]	168	204	--	--	69	118	--	32.6	37.2	--	--
1617	5/7/92	F	2	54	146	--	--	41	73	--	--	--	--	--
1618	5/7/92	F	2	54	149	--	--	42	73	--	--	--	--	--
1619	5/7/92	F	2	68	158	--	--	43	77	--	16.0	29.9	--	--
1620	5/7/92	M	2	75	163	--	--	45	77	--	17.8	29.7	--	--
1621	5/7/92	M	2	82	164	--	--	48	80	--	16.7	32.3	--	--
1622	5/9/92	M	2	100	180	--	--	--	96	--	18.0	34.2	--	--
1623	5/9/92	F	2	95	169	--	--	55	92	--	18.1	33.6	--	--
1624	5/10/92	F	2	70	165	--	--	49	86	--	17.0	29.8	--	--
1625	5/10/92	M	2	84	169	--	--	53	89	--	19.9	31.5	--	--
1626	5/23/92	F	17[d]	109	176	--	--	62	112	--	19.0	32.3	--	--

[a] Weights in kg and measurements in cm; head measurements made using calipers, all others were with a steel tape and were judged less accurate.

[b] Age determined by cementum layering; cubs of the year are designated as cb.

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

[d] Estimate after close examination.

Appendix B. Quadrat size and daily search effort, Alaska Range grizzly bear population density estimate, 1992.

Quadrat No.	Quadrat Size (km^2)	5/22 Time (min)	5/22 Min $/km^2$	5/23 Time (min)	5/23 Min $/km^2$	5/24 Time (min)	5/24 Min $/km^2$	5/25 Time (min)	5/25 Min $/km^2$	5/26 Time (min)	5/26 Min $/km^2$	$\bar{x}$ min $/km^2$
A	52	55	1.1	55	1.1	98	1.9	60	1.2	57	1.1	1.25
B	61	49	0.8	63	1.0	60	1.0	81	1.3	49	0.8	0.99
C	76	58	0.8	89	1.2	90	1.2	72	1.0	65	0.9	0.98
D	64	62	1.0	60	0.9	60	0.9	56	0.9	75	1.2	0.98
E	70	56	0.8	52	0.7	90	1.3	37	0.5	60	0.9	0.84
F	52	74	1.4	70	1.4	72	1.4	76	1.5	69	1.3	1.39
G	69	66	1.0	74	1.1	39	0.6	57	0.8	65	0.9	0.87
H	84	42	0.5	36	0.4	72	0.9	49	0.6	56	0.7	0.61
I	94	70	0.7	73	0.8	92	1.0	78	0.8	50	0.5	0.77
J	83	69	0.8	80	1.0	99	1.9	111	1.3	67	0.8	1.03
K	85	63	0.7	47	0.6	41	0.5	101	1.3	89	1.1	0.80
L	82	56	0.7	50	0.6	36	0.4	40	0.5	67	0.8	0.61
M	78	87	1.1	60	0.8	55	0.7	66	0.9	72	0.9	0.87
P	81	56	0.7	127	1.6	65	0.8	75	0.9	104	1.3	1.05
Q	49	47	1.0	48	1.0	43	0.9	40	0.8	40	0.8	0.89
R	61	59	1.0	40	0.7	69	1.1	57	0.9	41	0.7	0.87
S	75	28	0.4	48	0.6	95	1.3	75	1.0	43	0.6	0.77
U	68	41	0.6	60	0.9	83	1.2	52	0.8	73	1.1	0.91
V	121	71	0.6	79	0.7	110	0.9	54	0.5	95	0.8	0.68
W	91	48	0.5	73	0.8	86	1.0	58	0.6	60	0.7	0.71
Totals	1,496	1,157	0.8	1,274	0.9	1,455	1.0	1,295	0.9	1,297	0.9	0.87

Appendix C. Grizzly bear captures, recaptures, and capture-related mortalities, northcentral Alaska Range, 1981-92.

Year	Bear No.		Total no. captured during year	Cumulative no. total captures	Capture mortalities			
					Yearly total	Bear No.	Percentage	
	New captures	Recaptures					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

Appendix C. Continued.

Year	Bear No.		Total no. captured during year	Cumulative no. total captures	Capture mortalities			
	New captures	Recaptures			Yearly total	Bear No.	Percentage Year	Percentage Cumulative
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, 1601	1302, 1304, 1321, 1336, 1345, 1372, 1374, 1375, 1379, 1382, 1385, 1386, 1387	26	165	0	--	0	5
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

Appendix C. Continued.

	Bear No.		Total no.	Cumulative	Capture mortalities			
			captured	no. total	Yearly		Percentage	
Year	New captures	Recaptures	during year	captures	total	Bear No.	Year	Cumulative
1992	1616-1626	1311, 1324, 1336, 1348, 1391, 1392, 1397, 1601, 1602, 1603, 1604, 1605, 1609	24	227	0	--	0	4

[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 three cubs probably died without her care.

Appendix D. Status of marked bears in the northcentral Alaska Range, 1992.

Bear No.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1992
1301	M	6	5/18/81	5/18/81	Dead, capture mortality
1302	F	3	5/19/81	9/30/92	Alive spring, killed/eaten by bear 1601, 9/30/92
1303	F	2	6/17/81	9/30/92	Alive, functional collar; with yearlings
1304	M	5	6/19/81	9/30/92	Alive, functional 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	9/30/92	Alive, functional collar; with 2-year-olds
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	9/30/92	Alive, functional collar; with 2-year-olds
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	6/8/82	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	9/30/92	Alive, functional collar; bred
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, unknown cause summer-fall 1990
1332	F	5	7/12/82	10/31/82	Dead, died in den winter 1982-83
1333	F	16	7/12/82	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	Alive, functional collar; with 2-year-olds
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, unknown cause fall 1989
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	8/29/91	Unknown, with yearlings 1991
1346	M	5	5/25/83	6/1/91	Unknown, collar nonfunctional

Appendix D. Continued.

Bear No.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1992
1347	M	6	5/31/83	5/31/83	Dead, capture mortality
1348	F	12	5/31/83	9/30/92	Probably dead, defense of life or property? 10/92
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 radio-collared, 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	5/18/89	Unknown, collar nonfunctional
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
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	9/18/91	Unknown; with cubs 1991
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	8/10/88	Died between 5/5/90 and 5/15/90
1377	M	3[a]	8/28/86	3/25/87	Alive spring, hunter kill 9/6/91 west of study area
1378	F	2	6/20/86	6/20/86	Dead, hunter kill
1379	F	2	5/15/87	9/16/92	Alive spring, hunter kill 9/16/92
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	6/12/87	9/19/87	Unknown, shed collar between 9/19/87 and 4/18/88
1384	M	7[a]	5/15/88	4/23/89	Dead, hunter kill
1385	F	2	5/15/88	5/10/92	Alive, functional collar, with 1 cub
1386	M	2	5/15/88	4/20/92	Alive spring, emigrated, hunter kill 4/20/92
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	5/26/92	Alive, functional collar, with 1 cub
1392	M	2	5/13/89	9/30/92	Alive, functional collar

Appendix D. Continued.

Bear No.	Sex	Initial capture Age	Initial capture Date	Date last location	Status 1992
1393	M	2	5/17/89	5/13/90	Unknown, heard only 6/1/91
1394	F	2	5/17/89	5/10/90	Unknown, nonfunctional collar?
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
1397	F	2	5/18/89	5/25/92	Alive, functional collar
1398	F	8[a]	5/18/89	9/30/92	Alive, functional collar; with yearlings
1399	M	2	5/18/89	9/9/89	Dead, hunter kill
1400	M	8[a]	6/8/89	5/11/92	Alive spring, hunter kill 5/11/92
1601	M	7[a]	6/9/89	10/4/92	Alive, functional collar
1602	M	7[a]	5/13/90	5/25/92	Alive, functional collar
1603	F	2[a]	5/13/90	5/24/92	Alive, functional collar
1604	F	2	5/13/90	9/30/92	Alive, functional collar
1605	F	2	5/13/90	9/30/92	Alive, functional collar
1606	M	2	5/13/90	5/10/92	Alive, functional collar
1607	F	10[a]	5/14/90	5/7/92	Alive, functional collar
1608	F	16[a]	5/14/90	5/1/92	Alive, functional collar; with yearlings
1609	F	2[a]	5/14/90	9/30/92	Alive, functional collar
1610	F	2	5/6/91	10/12/91	Unknown
1611	M	2	5/6/91	5/27/91	Dead, hunter kill
1612	F	2	5/6/91	5/6/91	Unknown, nonfunctional collar
1613	M	6[a]	6/2/91	6/19/91	Unknown, nonfunctional collar
1614	M	3[a]	6/1/91	8/29/91	Alive spring, hunter kill 9/23/92
1615	M	4[a]	6/3/91	6/3/91	Unknown, shed collar by 8/31/91
1616	M	5[a]	5/7/92	5/7/92	Alive spring, shed collar by 10/5/92
1617	F	2	5/7/92	5/7/92	Alive, functional collar
1618	F	2	5/7/92	5/7/92	Alive, functional collar
1619	F	2	5/7/92	9/18/92	Alive spring, hunter kill 9/18/92
1620	M	2	5/7/92	9/30/92	Alive, functional collar
1621	M	2	5/7/92	10/3/92	Alive spring, hunter kill 10/3/92
1622	M	2[a]	5/9/92	5/9/92	Alive, functional collar
1623	F	2[a]	5/9/92	9/30/92	Alive, functional collar
1624	F	2	5/10/92	9/30/92	Alive, functional collar
1625	M	2	5/10/92	9/30/92	Alive, functional collar
1626	F	17[a]	5/23/92	9/30/92	Alive spring, may have been killed in defense of life or property 9/92

[a] Estimate.

Appendix E. Status summary of marked bears in the northcentral Alaska Range, spring 1992.

			Shed or nonfunctional collar unknown status		
Dead		Alive, active collar	Alive in the area?	Dispersed? or dead?	Never collared, dead?
1301	1353	1302	1362	1307	1354
1305	1355	1303	1372	1316	
1306	1356	1304	1375	1330	
1309	1357	1308	1383	1339	
1310	1358	1311	1388	1340	
1312	1360	1324	1394	1343	
1313	1361	1336	1396	1359	
1314	1364	1345	1610	1363	
1315	1367	1346	1612	1365	
1317	1368	1374[a]	1615	1366[a]	
1318	1369	1379[b]		1386	
1319	1370	1385		1387	
1320	1371	1391		1389	
1321	1373	1392		1393	
1323	1376	1397		1613	
1325	1377	1398			
1326	1378	1400			
1327	1380	1601			
1328	1381	1602			
1329	1382	1603			
1331	1384	1604			
1332	1390	1605			
1333	1395	1606			
1334	1399	1607			
1335	1611	1608			
1337		1609			
1338		1614			
1341		1616			
1342		1617			
1344		1618			
1347		1619			
1349		1620			
1350		1621			
1351		1622			
1352		1623			
		1624			
		1625			
		1626			

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

[b] Alive but with nonfunctional collars.

Appendix F. Status of maternal grizzly bears and their offspring in the northcentral Alaska Range, 1981-92.

Maternal female			Offspring			
Bear No.	Age at capture (yrs)	Present status	Bear No. and sex	Year of birth	Age at weaning (yrs)	Present status
1302	3	Dead 1992	1604 F	1988	2	Weaned 1990
			1605 F	1988	2	Weaned 1990
			1606 M	1988	2	Weaned 1990
			UM[a,b]	1991	--	With mother 1992
1303	2	Alive	1364 M	1985	--	Assumed dead 1985
			UM	1985	--	Assumed dead 1985
			UM	1991	--	With mother 1992
			UM	1991	--	Assumed dead 1991
1305	24	Hunter kill 1982	1306 M	1980	2	Hunter kill 1984
			1307 M	1980	2	Last observed 1986
1308	6	Alive	UM	1984	--	Assumed dead 1985
			UM	1984	2	Probable hunter kill 1986
			1391 F	1987	2	Had cub 1992
			1392 M	1987	2	Last observed 1992
			UM	1990	--	Assumed dead 1990
			UM	1990	--	With mother 1992
			UM	1990	--	With mother 1992
1311	12	Alive	1312 F	1982	--	Assumed dead 1982
			1313 F	1982	--	Assumed dead 1982
			1372 M	1984	2	Last observed 1989
			1378 F	1984	2	Hunter kill 1986
			UM	1987	2	Hunter kill 1989?
			1395 M	1987	2	Hunter kill 1989
			1624 F	1990	2	Weaned 1992
			1625 M	1990	2	Weaned 1992
1318	13	Dead 1989	1319 M	1982	--	Assumed dead 1982
			1380 M	1985	--	Hunter kill 1990
			1382 F	1985	--	Hunter kill 1989
			UM	1989	--	Assumed dead 1989
			UM	1989	--	Assumed dead 1989
1320	17	Dead 1989	UM	1983	--	Assumed dead 1983
			UM	1985	--	Assumed dead 1985
			UM	1985	--	Assumed dead 1985
			UM	1985	--	Assumed dead 1985
			UM	1987	--	Assumed dead 1987
			UM	1987	--	Assumed dead 1987
1321	16	Hunter kill 1989	1342 M	1981	--	Illegal kill 1983
			1343 M	1981	3	Last observed 1984
			1344 M	1981	3	Hunter kill 1984
			UM	1985	--	Assumed dead 1986
			1379 F	1985	2	Hunter kill 1992
			1381 M	1985	2	Hunter kill 1987
			UM	1988	--	Assumed dead 1988

Appendix F. Continued.

Maternal female			Offspring			
Bear No.	Age at capture (yrs)	Present status	Bear No. and sex	Year of birth	Age at weaning (yrs)	Present status
			UM	1988	--	Assumed dead 1988-89
			UM	1988	--	Assumed dead 1988-89
1322	8	Hunter kill 1991	1336 F	1981	3	Had cubs 1987, 1990
			UM?	1989?	2?	May have had 2 ylg 1990
1323	11	Hunter kill 1989	1324 F	1982	2	Had cubs 1987, 1990
			1325 M	1982	2	Killed DLP[c] 1984
			UM	1987	--	With mother 8/18/89
			UM	1987	--	With mother 8/18/89
1324	0	Alive	?1389 M	1987	2	Last observed 1989
			?1390 F	1987	2	Hunter kill 1990
			?1622 M	1990	2	Weaned 1992
			?1623 F	1990	2	Weaned 1992
1326	4	Hunter kill 1986	UM	1985	--	Assumed dead 1985
1327	16	Dead 1984	1328 F	1981	--	Assumed dead 1982
			UM	1981	--	Capture death 1982
			UM	1984	--	Assumed dead 1984
			UM	1984	--	Assumed dead 1984
			UM	1984	--	Assumed dead 1984
1329	13	Dead 1983	1330 M	1981	2[b]	Last observed 1984
1331	4	Dead 1990	UM	1986	--	Assumed dead 1987
			?1603 F	1988	2	Weaned 1990
1333	16	Hunter kill 1984	1334 M	1981	3	Hunter kill 1988
			1335 F	1981	3	Hunter kill 1984
1336	2	Alive	UM	1987	--	Assumed dead 1988
			UM	1987	--	Assumed dead 1988
			UM	1990	--	Assumed dead 1990
			1617 F	1990	--	With mother 1992
			1618 M	1990	--	With mother 1992
1341	10	Dead 1989	UM	1982	--	Assumed dead 1983
			1370 F	1984	2	Capture death 1987
			1371 M	1984	2	Hunter kill 1986
			UM	1988	--	Assumed dead 1988
			UM	1988	--	Assumed dead 1988
			UM	1989	--	Assumed dead 1989
			UM	1989	--	Assumed dead 1989
1345	8	Alive	UM	1984	--	Assumed dead 1984
			UM	1984	--	Assumed dead 1985
			1385 F	1986	3	Weaned 1989
			1386 M	1986	3	Hunter kill 1992
			UM	1990	--	With mother 1991
			UM	1990	--	With mother 1991
			UM	1990	--	With mother 1991

Appendix F. Continued.

Maternal female			Offspring			
Bear No.	Age at capture (yrs)	Present status	Bear No. and sex	Year of birth	Age at weaning (yrs)	Present status
1348	12	Dead? 1992	1367 M	1984	2	Killed DLP 1986
			1368 F	1984	2	Killed DLP 1986
			1369 M	1984	2	Killed DLP 1987
			UM	1987	--	Assumed dead 1988
			UM	1987	--	Assumed dead 1988
			UM	1989	--	Assumed dead 1989
			1619 F	1990	--	With mother 1992, killed by hunter
			1620 M	1990	--	With mother 1992
			1621 F	1990	--	With mother 1992, killed by hunter
1351	14	Hunter kill 1987	UM	1982	--	Assumed dead 1984
			1357 M	1982	3	Hunter kill 1986
			1361 F	1982	3	Hunter kill 1991
			UM	1986	1	Assumed dead 1987[d]
			UM	1986	1	Assumed dead 1987[d]
			UM	1986	1	Assumed dead 1987[d]
1352	14	Hunter kill 1984	1353 M	1982	--	Hunter kill 1984
			1354 F	1982	--	Assumed dead 1984
1360	11	Dead 1985	1359 M	1982	--	Last observed 1986
			1363 M	1982	--	Last observed 1986
1361	3	Hunter kill 1991	UM M	1989	--	Hunter kill 9/7/91
1362	6	Alive	1387 F	1986	2	Illegal kill? 1990
			1388 M	1986	2	Last observed 1988
1374	6	Alive	UM	1985	2?	Weaned 1987?
			UM	1985	2?	Weaned 1987?
			UM	1988	2	Weaned 1990
			UM	1988	2	Weaned 1990
			UM	1991	--	With mother 1991
			UM	1991	--	With mother 1991
			UM	1991	--	With mother 1991
1376	23[e]	Dead May 1990	1393 M	1987	3	Weaned 1990
			1394 F	1987	3	Last observed 1990
1398	8[e]	Alive	1397 F	1987	2	Bred 1992
			1399 M	1987	2	Hunter kill 1989
			UM	1991	--	With mother 1992
			UM	1991	--	With mother 1992
1607	10[e]	Alive	1610 F	1989	2	Weaned 1991
			1611 M	1989	2	Hunter kill 1991
			1612 F	1989	2	Weaned 1991
1608	16[e]	Alive	1609?F	1988	2	Weaned 1990
1626	17[e]	Dead 1992	UM	1991	--	With mother 1992
			UM	1991	--	Killed? DLP 1992

Appendix F. Continued.

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[a] UM denotes unmarked.

[b] Orphaned when mother was killed and eaten by adult male.

[c] Killed legally in defense of life or property.

[d] Orphaned, assumed dead after mother was killed by hunter, fall 1987.

[e] Estimate.

Appendix G. Presence of radio-collared grizzly bears in search areas during a mark-recapture density estimate conducted in the northcentral Alaska Range, 1992. Presence of bears in the area was recorded for both the entire search area (All) and for a portion of the search area (Old) in which a density estimate was conducted during 1986.

Bear no./ sex	Assn.[a]	5/22				5/23				5/24				5/25				5/26			
		All	Obs	Old	Obs[b]	All	Obs	Old	Obs	All	Obs	Old	Obs	All	Obs	Old	Obs	All	Obs	Old	Obs
1302F	1 yl	in	N	in	N	in	Y	in	Y	in	N	in	N	in	Y	in	Y	in	N	in	N
1304M	breed	in	N	in	N	in	Y	in	Y	in	N	in	N	in	Y	in	Y	in	N	out	
1308F	2 2y	in	N	out	N	in	N	out		in	Y	out		in	Y	out		in	N	out	
1311F	lone	in	N	in	N	in	N	in	N	out	-	out	-	out	-	out	-	out	-	out	-
1346M	lone	out	-	out	-	in	N	in	N	out	-	out	-	out	-	out	-	in	N	in	N
1391F	1 c	in	N	out	N	in	N	out		in	N	out		in	N	out		in	N	out	
1397F	breed	(collar shed, recaptured 5/25)																in	N	in	N
1602M	breed	(collar shed, recaptured 5/25)																in	N	in	N
1603F	lone	(collar shed, recaptured 5/24)												in	N	in	N	in	N	in	N
1604F	lone	(collar shed, recaptured 5/25)																in	Y	in	Y
1605F	lone	in	N	in	N	in	N	out		in	N	in	N	in	Y	in	Y	in	N	in	N
1606M	lone	out	-	out	-	out	-	out		out	-	out	-	in	N	in	N	out	-	out	
1609F	lone	(nonfunctional collar, recaptured 5/25)																in	N	in	N
1617F	lone?	out	-	out	-	out	-	out	-	out	-	out	-	in	N	out		out	-	out	-
1624F	lone	in	N	in	N	in	N	out		out	-	out	-	out	-	out	-	out	-	out	-
1625M	lone	out	-	out	-	in	N	out		out	-	out	-	out	-	out	-	out	-	out	-
1626F	2 yl	(new capture 5/23)								in	N	out		in	N	out		in	Y	out	-
TOTALS:[c]																					
Individuals		12	0	6	0	13	3	5	3	12	3	4	0	15	7	6	4	18	4	9	1
≥2 yr of age		9	0	5	0	11	2	4	2	8	3	3	0	11	6	5	3	14	2	8	1
Independent		7	0	5	0	9	2	4	2	6	1	3	0	9	4	5	3	12	2	8	1

[a] Associations of bears present in the search area were abbreviated as follows: c, with cubs; yl, with yearlings; 2y, with 2-year-olds; breed, member of a breeding pair for at least one observation; lone, no associations observed. Offspring that accompanied a radio-collared mother were assigned the same marked status as their mother.

Appendix G. Continued.

[b] A radio-collared bear's presence in the search area (All or Old) is indicated as either in or out. Whether a bear was observed (Obs) is indicated by N (No), Y (Yes), or - (not in search area).

[c] Totals include: Individuals, all radio-collared individuals regardless of family or breeding group association; $\geq$2 yr of age, all radio-collared individuals of 2 or more years of age; and Independent, all radio-collared bears independent of family groups.

Appendix H. Observations of marked and unmarked bears used for calculation of a mark-recapture estimation of density in a portion of the northcentral Alaska Range, 1992. Presence of bears in the area was recorded for both the entire search area (All) and for a portion of the search area (Old) in which a density estimate was conducted during 1986.

	5/22		5/23		5/24		5/25		5/26	
	All	Old	All	Old	All	Old	All	Old	All	Old
Marked bears present (n_1)[a]										
Total	12	6	13	5	12	4	15	6	18	9
≥2 yrs of age	9	5	11	4	8	3	11	5	14	8
Independent	7	5	9	4	6	3	9	5	12	8
Marked bears seen (m_2)										
Total	0	0	3	3	3	0	7	4	4	1
≥2 yrs of age	0	0	2	2	3	0	6	3	2	1
Independent	0	0	2	2	1	0	4	3	2	1
Unmarked bears seen[a]										
Total	2	2	3	0	1	1	3	2	1	1
≥2 yrs of age	2	2	1	0	1	1	3	2	1	1
Independent	2	2	1	0	1	1	3	2	1	1
Total bears seen (marked and unmarked)(n_2)										
Total	2	2	6	3	4	1	10	6	5	2
≥2 yrs of age	2	2	3	2	4	1	9	5	3	2
Independent	2	2	3	2	2	1	7	5	3	2

[a] Offspring that accompanied mothers were assigned the same marked or unmarked status as their mothers.

Appendix I. Daily availability of marked bears and observations of marked and unmarked bears in a 950-km^2 search area of the northcentral Alaska Range, 1986[a] (Reynolds et al. 1987).

Date	No. of marked bears present (n_1)	No. of marked bears observed (m_2)	No. of bears observed (n_2)
9 Jun	8	3	6
11 Jun	8	2	2
12 Jun	4	1	2
Total	20	6	10

[a] Only those bears ≥ 2 years of age are included in these data.

Appendix J. Estimates of grizzly bear population size in a 1,496-km^2 area of the northcentral Alaska Range using White and Garrott's (1990) joint hypergeometric maximum likelihood estimator (MLE) modification of the Lincoln-Peterson (L-P) method, 1992.

Date	Total marked	Marked avail.	Marked seen	Unmarked seen	L-P est.	MLE	95% CI lower	95% CI upper	80% CI lower	80% CI upper
Population size and density estimates for bears of all ages, dependent offspring counted as independent sightings:										
5/22	15	12	0	2	38.0		-4.4	80.4	10.3	65.7
5/23	15	13	3	3	23.5		11.6	35.4	15.7	31.3
5/24	18	12	3	1	15.3		9.9	20.6	11.8	18.7
5/25	19	15	7	3	21.0		15.7	26.3	17.5	24.5
5/26	23	18	4	1	21.8		15.4	28.2	17.6	26.0
						21.8	18.2	29.5	19.1	26.2
Population size and density estimates for bears ≥2 years of age, dependent 2-year-olds counted as independent:										
5/22	11	7	0	2	23.0		-2.4	48.4	6.4	39.6
5/23	11	9	2	1	12.3		6.9	17.8	8.8	15.9
5/24	12	6	1	1	9.5		3.7	15.3	5.7	13.3
5/25	13	9	4	3	15.0		9.5	20.5	11.4	18.6
5/26	17	12	2	1	16.3		8.9	23.8	11.5	21.2
						15.9	11.8	26.5	12.8	21.6
Population size and density estimates of independent bears, dependent offspring not included:										
5/22	13	9	0	2	29.0		-3.2	61.2	7.9	50.1
5/23	13	11	2	1	15.0		8.2	21.8	10.6	19.4
5/24	14	8	3	1	10.3		7.0	13.5	8.1	12.4
5/25	15	11	6	3	16.1		11.9	20.3	13.4	18.9
5/26	19	14	2	1	19.0		10.2	27.8	13.3	24.7
						15.9	11.8	26.5	12.8	21.6

Appendix K. Estimates of grizzly bear population size in a 950-km^2 area of the northcentral Alaska Range using White and Garrott's (1990) joint hypergeometric maximum likelihood estimator (MLE) modification of the Lincoln-Peterson (L-P) method, 1992.

Date	Total marked	Marked avail.	Marked seen	Unmarked seen	L-P est.	MLE	95% CI lower	95% CI upper	80% CI lower	80% CI upper
Population size and density estimates for bears of all ages, dependent offspring counted as independent sightings:										
5/22	6	6	0	2	20.0		-2.0	42.0	5.6	34.4
5/23	7	5	3	0	5.0		5.0	5.0	5.0	5.0
5/24	7	4	0	1	9.0		0.2	17.8	3.3	14.7
5/25	8	6	4	2	8.8		6.6	11.0	7.3	10.3
5/26	12	9	1	1	14.0		5.2	22.8	8.3	19.7
						9.6	8.1	16.2	8.5	13.1
Population size and density estimates for bears $\geq$2 years of age, dependent 2-year-olds counted as independent:										
5/22	5	5	0	2	17.0		-1.6	35.6	4.8	29.2
5/23	6	4	2	0	4.0		4.0	4.0	4.0	4.0
5/24	6	3	0	1	7.0		0.2	13.8	2.6	11.4
5/25	7	5	3	2	8.0		5.4	10.6	6.3	9.7
5/26	11	8	1	1	12.5		4.7	20.3	7.4	17.6
						9.7	7.2	18.7	7.6	14.2
Population size and density estimates of independent bears, dependent offspring not included:										
5/22	5	5	0	2	17.0		-1.6	35.6	4.8	29.2
5/23	6	4	2	0	4.0		4.0	4.0	4.0	4.0
5/24	6	3	0	1	7.0		0.2	13.8	2.6	11.4
5/25	7	5	3	2	8.0		5.4	10.6	6.3	9.7
5/26	11	8	1	1	12.5		4.7	20.3	7.4	17.6
						9.7	7.2	18.7	7.6	14.2

Appendix L. Estimates of grizzly bear population size in a 950-km^2 portion of the northcentral Alaska Range using White and Garrott's (1990) joint hypergeometric maximum likelihood estimator (MLE) modification of the Lincoln-Peterson (L-P) method. Mark-recapture data were collected during 1986 (Reynolds et al. 1987).

Date	Total marked	Marked avail.	Marked seen	Unmarked seen	L-P est.	MLE	95% CI lower	95% CI upper	80% CI lower	80% CI upper
Alaska Range, 1986 data, 950 km^2 area, all bears										
6/9	13	8	3	3	14.8		8.0	21.5	10.3	19.2
6/11	13	11	5	0	11.0		11.0	11.0	11.0	11.0
6/12	13	4	1	1	6.5		2.7	10.3	4.0	9.0
						9.8	9.0	15.7	9.9	13.0
Alaska Range, 1986 data, both ≥2-year-olds and independent bears										
6/9	10	8	3	3	14.8		8.0	21.5	10.3	19.2
6/11	10	8	2	0	8.0		8.0	8.0	8.0	8.0
6/12	10	4	1	1	6.5		2.7	10.3	4.0	9.0
						10.8	8.1	20.3	8.4	15.6

Appendix M. Estimate of population size and density in a 1,496-km^2 area of the northcentral Alaska Range calculated using Miller et al.'s (1987) bear-days modification of the Lincoln-Peterson (L-P) method, 1992.

Date	n1 (marks pres.)	m2 (marks seen)	n2 (total seen)	Daily L-P	Sighta-bility	N* Bear days est.	Density bears/ 1,000km^2	95% Binomial CI population size lower	95% Binomial CI population size upper	95% Binomial CI bears/1,000km^2 lower	95% Binomial CI bears/1,000km^2 upper	80% Binomial CI population size lower	80% Binomial CI population size upper	80% Binomial CI bears/1,000km^2 lower	80% Binomial CI bears/1,000km^2 upper
Bears of all ages, dependent offspring treated as independent sightings:															
5/22	12	0	2	38.0	0.000	38.00	25.401	14.25		9.53		17.55		11.73	
5/23	13	3	6	23.5	0.231	28.75	19.218	16.55	146.71	11.07	98.07	19.07	85.09	12.75	56.88
5/24	12	3	4	15.3	0.250	23.19	15.502	15.63	58.48	10.45	39.09	17.33	42.79	11.58	28.61
5/25	15	7	10	21.0	0.467	21.52	14.384	16.40	35.76	10.96	23.91	17.67	30.06	11.81	20.09
5/26	18	4	5	21.8	0.222	21.89	14.632	17.37	33.04	11.61	22.09	18.53	28.69	12.38	19.18
	mean daily L-P =			23.91	0.2429										
	SE =			3.39											
All bears ≥2 years of age; dependent 2-year-olds counted as independent:															
5/22	9	0	2	29.0	0.000	29.00	19.385	10.69		7.15		14.20		9.49	
5/23	11	2	3	15.0	0.182	20.50	13.703	11.72	189.75	7.83	126.84	13.27	89.13	8.87	59.58
5/24	8	3	4	10.3	0.375	15.78	10.547	10.81	44.03	7.23	29.43	11.82	31.01	7.90	20.73
5/25	11	6	9	16.1	0.545	15.58	10.417	11.79	27.27	7.88	18.23	12.69	22.50	8.48	15.04
5/26	14	2	3	19.0	0.143	16.77	11.211	12.94	27.58	8.65	18.43	13.88	23.26	9.28	15.55
	mean daily L-P =			17.88	0.2453										
	SE =			2.79											
Independent bears only; dependent offspring are not included, but breeding or sibling pairs counted as independent observations:															
5/22	7	0	2	23.0	0.000	23.00	15.374	8.31		5.56		11.04		7.38	
5/23	9	2	3	12.3	0.222	16.50	11.029	9.37	151.80	6.27	101.47	10.62	71.30	7.10	47.66
5/24	6	1	2	9.5	0.167	15.00	10.027	8.99	74.07	6.01	49.51	10.17	43.24	6.80	28.90
5/25	9	4	7	15.0	0.444	14.75	9.860	10.07	33.64	6.73	22.48	11.14	25.44	7.45	17.01
5/26	12	2	3	16.3	0.167	15.64	10.455	11.17	30.92	7.46	20.67	12.24	24.54	8.18	16.41
	mean daily L-P =			15.23	0.2093										
	SE =			2.03											

Appendix N. Estimate of population size and density in a 950-km^2 area of the northcentral Alaska Range calculated using Miller et al.'s (1987) bear-days modification of the Lincoln-Peterson (L-P) method, 1992.

Date	n1 (marks pres.)	m2 (marks seen)	n2 (total seen)	Daily L-P	Sighta-bility	N* Bear days est.	Density bears/1,000km^2	95% Binomial CI population size lower	95% Binomial CI population size upper	95% Binomial CI bears/1,000km^2 lower	95% Binomial CI bears/1,000km^2 upper	80% Binomial CI population size lower	80% Binomial CI population size upper	80% Binomial CI bears/1,000km^2 lower	80% Binomial CI bears/1,000km^2 upper
Bears of all ages, dependent offspring treated as independent sightings:															
5/22	6	0	2	20.0	0.000	20.00	21.053								
5/23	5	3	3	5.0	0.600	8.50	8.947								
5/24	4	0	1	9.0	0.000	9.00	9.474								
5/25	6	4	6	8.8	0.667	8.69	9.147								
5/26	9	1	2	14.0	0.111	10.13	10.663	7.29	20.79	7.67	21.88	7.93	16.26	8.35	11.44
	mean daily L-P =			11.36	0.2667										
	SE =			2.32											
All bears ≥2 years of age; dependent 2-year-olds counted as independent:															
5/22	5	0	2	17.0	0.000	17.00	17.895								
5/23	4	2	2	4.0	0.500	7.83	8.242								
5/24	3	0	1	7.0	0.000	8.33	8.768								
5/25	5	3	5	8.0	0.600	8.00	8.421								
5/26	8	1	2	12.5	0.125	9.46	9.958	6.34	23.71	4.46	24.96	7.02	17.35	7.39	18.26
	mean daily L-P =			9.70	0.2400										
	SE =			2.04											
Independent bears only; dependent offspring are not included, but breeding or sibling pairs counted as independent observations:															
5/22	5	0	2	17.0	0.000	17.00	17.895								
5/23	4	2	2	4.0	0.500	7.83	8.242								
5/24	3	0	1	7.0	0.000	8.33	8.768								
5/25	5	3	5	8.0	0.600	8.00	8.421								
5/26	8	1	2	12.5	0.125	9.46	9.958	6.34	23.71	4.46	24.96	7.02	17.35	7.39	18.26
	mean daily L-P =			9.70	0.2400										
	SE =			2.04											

Appendix O. Estimates of grizzly bear density in a 1,496 km^2 area of the northcentral Alaska Range calculated using Eberhardt's (1990) modifications of the Lincoln-Peterson (L-P) method, 1992.

Date	n_1, marks present	m_2, marks seen	n_2, total seen	Minimum present	Daily L-P	Bias corrected estimate	95% CI population size lower	95% CI population size upper	Density bears/ 1,000 km^2	95% CI bears/1,000 km^2 lower	95% CI bears/1,000 km^2 upper
Population size and density estimates for bears of all ages, dependent offspring counted as independent sightings:											
5/22	12	0	2	14	38.0						
5/23	13	3	6	16	23.5	33.50	-58.6	125.6	22.4	-39.2	84.0
5/24	12	3	4	13	15.3	26.92	-1.7	55.5	18.0	-1.1	37.1
5/25	15	7	10	18	21.0	24.79	9.4	40.2	16.6	6.3	26.9
5/26	18	4	5	19	21.8	24.21	13.7	34.7	16.2	9.2	23.2
Population size and density estimates for bears ≥2 years of age, dependent 2-year-olds counted as independent:											
5/22	9	0	2	11	29.0						
5/23	11	2	3	12	15.0	25.44	-63.5	114.4	17.0	-42.4	76.5
5/24	8	3	4	9	10.3	19.43	-4.8	43.7	13.0	-3.2	29.2
5/25	11	6	9	14	16.1	18.02	5.3	30.8	12.0	3.5	20.6
5/26	14	2	3	15	19.0	18.38	9.7	27.0	12.3	6.5	18.1
Population size and density estimates of independent bears, dependent offspring not included:											
5/22	7	0	2	9	23.0						
5/23	9	2	3	10	12.3	20.43	-47.3	88.2	13.7	-31.6	59.0
5/24	6	1	2	7	9.5	17.28	-0.4	35.0	11.6	-0.3	23.4
5/25	9	4	7	12	15.0	15.98	6.7	25.2	10.7	4.5	16.9
5/26	12	2	3	13	16.3	16.22	9.9	22.5	10.8	6.6	15.1

Appendix P. Estimates of grizzly bear density in a 950-km^2 area of the northcentral Alaska Range calculated using Eberhardt's (1990) modifications of the Lincoln-Peterson (L-P) method, 1992.

Date	n_1, marks present	m_2, marks seen	n_2, total seen	Minimum present	Daily L-P	Bias corrected estimate	95% CI population size lower	95% CI population size upper	Density bears/1,000 km^2	95% CI bears/1,000 km^2 lower	95% CI bears/1,000 km^2 upper
Population size and density estimates for bears of all ages, dependent offspring counted as independent sightings:											
5/22	6	0	2	8	20.0						
5/23	5	3	3	5	5.0	13.62	-81.7	108.9	14.3	-86.0	114.6
5/24	4	0	1	5	9.0	13.11	-6.2	32.4	13.8	-6.5	34.1
5/25	6	4	6	8	8.8	11.43	1.1	21.7	12.0	1.2	22.9
5/26	9	1	2	10	14.0	12.27	5.1	19.5	12.9	5.3	20.5
Population size and density estimates for bears ≥2 years of age, dependent 2-year-olds counted as independent:											
5/22	5	0	2	7	17.0						
5/23	4	2	2	4	4.0	12.14	-70.4	94.7	12.8	-74.2	99.7
5/24	3	0	1	4	7.0	11.51	-5.4	28.4	12.1	-5.7	29.9
5/25	5	3	5	7	8.0	10.06	1.2	19.0	10.6	1.2	20.0
5/26	8	1	2	9	12.5	10.91	4.6	17.2	11.5	4.8	18.1
Population size and density estimates of independent bears, dependent offspring not included:											
5/22	5	0	2	7	17.0						
5/23	4	2	2	4	4.0	12.14	-70.4	94.7	12.8	-74.2	99.7
5/24	3	0	1	4	7.0	11.51	-5.4	28.4	12.1	-5.7	29.9
5/25	5	3	5	7	8.0	10.06	1.2	19.0	10.6	1.2	20.0
5/26	8	1	2	9	12.5	10.91	4.6	17.2	11.5	4.8	18.1