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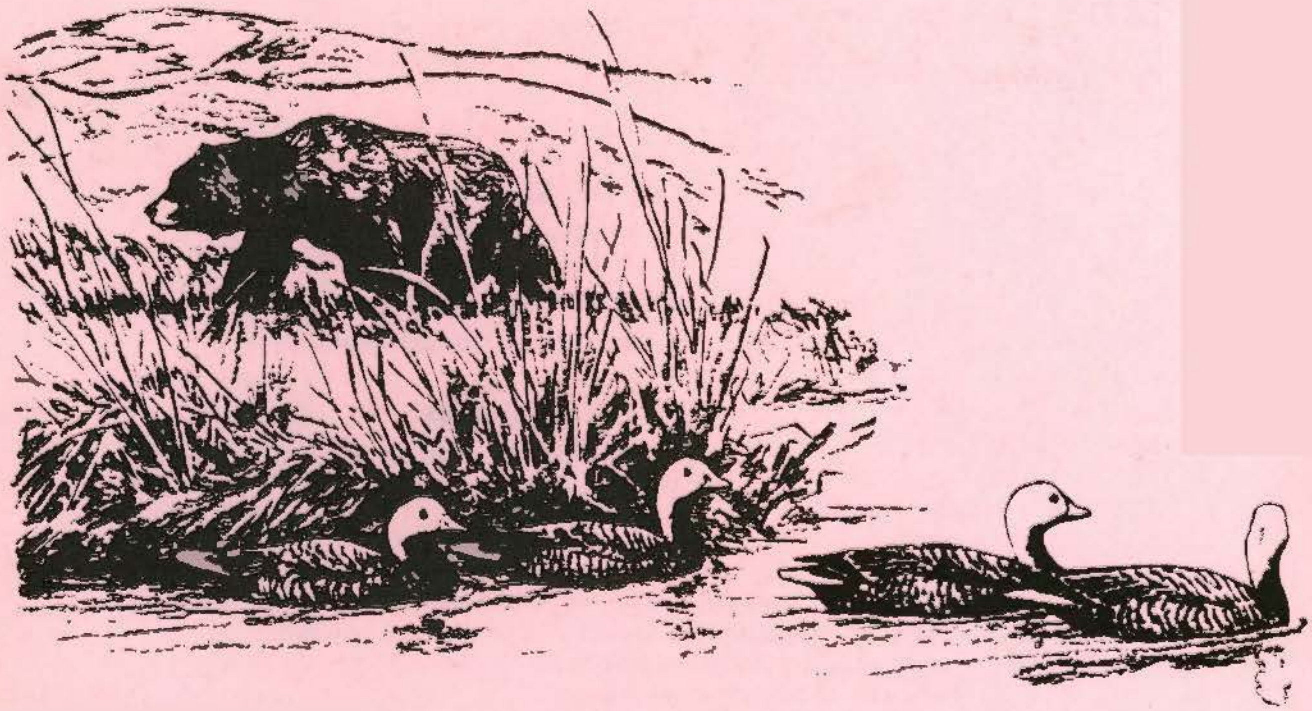
Research Progress Report

DEMOGRAPHY OF NOATAK GRIZZLY BEARS IN RELATION TO HUMAN EXPLOITATION AND MINING DEVELOPMENT



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PROGRESS REPORT (RESEARCH)

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SUMMARY

During 1987, 34 grizzly bears (*Ursus arctos*) were immobilized with a mixture of tiletamine hydrochloride and zolazepam hydrochloride (Zoletil 100, Wildlife Laboratories, Fort Collins, CO). An average of 8.7 and 9.3 mgs/kg were required for successful immobilization of adult females and males, respectively. Induction times averaged between 8 and 12 min. One mortality (2.9%) occurred from an apparent overdose. This drug has many advantages over other drugs used on bears.

During 1986 and 1987, 54 adult grizzly bears were radio-collared. A high proportion (75%) of adult females captured were lactating but were not accompanied by young; this suggested high cub mortality. Only two of 11 adult radio-collared females were observed with cubs in 1987. Average litter size at den emergence for 6 litters was 2.83 in 1986 and 1987. Survival of cubs during their first summer averaged 79%, while survival of yearlings averaged 86%. During 1987, 46 radio-collared grizzlies were relocated from fixed-wing aircraft on 613 occasions. Status of radio-collared adults is presented.

An intensive mark-recapture census of grizzly bears in a 719-mi^2 (1,862 km^2) area surrounding the Red Dog Mine was conducted during late May and early June 1987. Six fixed-wing aircraft were flown a total of 196.7 hr during the 7 days that bear surveys were conducted. Search effort averaged 2.35 min/mi^2/day. Radio-collared bears were used as the marked portion of the sample, and unmarked adults were captured and radio-collared as they were observed. Radio collars were used to assess population closure. Twelve radio-collared grizzlies occurred within the study area prior to the census. Twenty-nine radio-collared adult bears were known to occur within the census area on one or more occasions during the survey. Based on mark-recapture data, the number of adults (>3 years age) in the census area population was estimated at 28 (80% confidence interval [CI] of 25 to 35). The total number of bears, including cubs, estimated within the census area was 37 (80% CI of 33 to 43). Density estimates were 1 adult (>3 years) bear/25.7 mi^2 (66.5 km^2) and 1 bear (all ages)/19.4 mi^2 (50.3 km^2). Some of the biases and problems associated with the method are discussed.

Key Words: grizzly bear, Ursus arctos, harvest rates, density, population, estimates, mining development, Noatak, productivity, mortality

CONTENTS

BACKGROUND

Conservation of brown/grizzly bears (Ursus arctos) in Alaska is partially dependent on the availability and use of assessment methods that allow game managers to monitor the status of populations on a regular basis. Managers have primarily relied on harvest data to assess trends and effects of harvest. However, the basis for use of harvest statistics for monitoring population status is not well documented or understood, and in some cases, reported harvests may not even represent trends in actual mortality. Fortunately, bear populations appear to be healthy and abundant in many areas of Alaska. If the status quo is to be maintained, however, appropriate methods must be developed and tested so that managers can accurately identify and remedy declines and demographic shifts.

Increasing human populations have drastically altered the abundance and distribution of grizzly bears in North America (Cowan 1972). Although abundance and distribution of bears in Alaska have changed little in historical times, significant changes in the environment could permanently alter the productivity and survival of bear populations. Current understanding of grizzly bear population dynamics in relation to human developments is inadequate for providing effective guidelines to agencies or private companies for minimizing and mitigating impacts to bear populations. This inadequacy exists because such impacts, although occurring relatively recently, have long-term effects and the research has been usually of short duration (Peek et al. 1987).

The present study developed out of conflicting testimony about the status of the bear population and its potential for incurring adverse impacts from development and operation of the Red Dog Mine in northwest Alaska. Background for the study is provided by Ballard (1987). Briefly, this study was designed to evaluate effects of human harvests by comparing bear density with known reported harvests and to provide baseline data on bear density, population structure, movements, and reproductive parameters prior to large scale mine development. Actual impacts from the Red Dog Mine and other associated developments will be assessed at a later date by repeating the study and by using identical study methods. Obviously, obtaining an accurate and precise estimate of bear density in the potential impact area is a high priority and key objective of this research effort. This progress report focuses on the estimation of bear density in the study area in 1987.

OBJECTIVES

To estimate density, population structure, movements, and reproductive parameters of grizzly bears in the west Brooks Range.[1]

STUDY AREA

During 1986 we studied bears within the 2,600-mi² (6,700 km²) area encompassing the Red Dog Mine (Fig. 1); i.e., the Noatak River Study Area (NRSA). A brief description of the proposed mine development and study area was provided by Ballard (1987). A thorough description of the proposed mine was provided in an environmental impact statement (EPA and USDI 1984). The NRSA boundaries were also selected to encompass an area receiving a moderate amount of harvest pressure. Because the NRSA was too large for an intensive census, a smaller area was selected based upon movements of radio-collared bears in 1986 and location of the mine and associated roads (Fig. 2); i.e., the Red Dog Mine Census Area or census area. For this report, we refer to the bear density estimation procedure described by Miller et al. (1987) as a census.

The census area was initially divided into 12 count areas (CAs) ranging in size from 62 to 78 mi² (161-202 km²) and totalling 852 mi² (2,207 km²) (Fig. 2). Natural landmarks such as streams and ridgetops were used as boundaries between CAs. After the first survey day, CAs 11 and 12 were eliminated; they were not surveyed because we were uncertain whether the entire census area could be adequately covered each day with available personnel and aircraft. On the first day, 40.1 man-hours were spent surveying; of these, 10.6 man-hours were allocated to CAs 11 and 12. By eliminating CAs 11 and 12, the total size of the census area was reduced to 719 mi² (1,862 km²).

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[1] Study design was provided by Ballard (1987).

The census area was characterized by steep, mountainous terrain traversed by several major rivers and creeks. Vegetation types ranged from riparian stands of willow (Salix spp), birch (Betula nana, B. glandulosa, and B. spp.), and cottonwood (Populus balsamifera) along the streams and rivers to closed and tall shrub, low shrub, open low shrub, tundra, and then bare rock and ice as elevations increased. Relatively thick stands of black spruce (Picea glauca) occur in the southern half of CAs 3, 4, and 8 along the Noatak River and near the mouths of Wrench and No Name Creeks in CA 10. Elevations in the census area ranged from approximately 200 to 3,904 ft along the southern and northern boundaries, respectively. The census area included the den sites of 7 radio-collared bears. Although habitat use by bears has not yet been quantified for the NRSA, nearly all of the census area was considered useable bear habitat. The elevation of a relatively small portion of the census area exceeded 3,000 ft. These latter areas are rarely used by grizzly bears; consequently, no correction in calculations for topography was made for density estimates.

The NRSA is characterized by a polar maritime climate along the coast and a continental climate inland. Summer temperatures range from 36 to 90 F, and winter temperatures range as low as -15 to -53 F. Extremely low winter temperatures reportedly occur less frequently in the mountains because of temperature inversions. Annual precipitation averages 10 in (25 cm) along the coast to 20-30 in (51-76 cm) in the mountains, with half occurring during July through September. Snow cover usually occurs from mid-October to mid-May. Caribou (Rangifer tarandus), moose (Alces alces), and Dall sheep (Ovis dalli) occur within the study area and serve as either carrion or prey for grizzly bears. No black bears (Ursus americanus) have been observed in the area. All of the major rivers and their drainages provide habitat for fish that are an important source of food for bears. Arctic char (Salvelinus alpinus), grayling (Thymallus arcticus), and chum salmon (Oncorhynchus keta) are among the most important species. Salmon migration usually occurs from July through September each year. Late autumn chum runs appear to be particularly important, because they provide a source of food for bears just prior to denning. The late chum runs in the Noatak area are among the latest in North America (C. Lean, pers. commun.) and may have some relevance to bear densities mentioned later in this report.

METHODS

Bears were captured for radio-collaring and/or marking using standard helicopter immobilization procedures that have become widely used in Alaska (Spraker et al. 1981, Ballard et al.

1982, Reynolds and Hechtel 1985, Miller et al. 1987). Bears were immobilized with a mixture of tiletamine hydrochloride and zolazepam hydrochloride (Zoletil 100, Wildlife Laboratories, Fort Collins, CO), which was delivered from either a dart projectile fired from a Cap-Chur gun (Palmer Chemical Equipment Co., Douglasville, Georgia) or by hand injection. This drug is commonly referred to by the trade name Telazol and will be identified as such in this report. A bear was considered to be immobile if sternally recumbent and workable for processing. Induction was the time from initial injection to immobilization. Each captured bear was sexed, weighed, measured, individually marked with 1-3 lip tattoos and roto ear tags, and if judged to be ≥5 years of age, radio-collared; radios were manufactured by Telonics (Mesa, Arizona). During the census, several subadult (probably 3- to 5-year-olds) bears were fitted with radio collars designed to fall off after several weeks. These collars were of the same design as the standard Telonics ones, except that the attachment was modified to allow the collar to fall off. Instead of 1 standard hardware attachment, 2 sets were used; 1 set was added to each end of the collar. The ends were connected by inserting surgical tubing snugly under each attachment.

Premolars were extracted from each immobilized bear judged to be >1 year of age. Extracted teeth were used for aging; these were processed in a manner similar to methods described by Mundy and Fuller (1964). Several vials of blood were collected from each adult bear; 1 vial containing sodium heparin was used for determining percent hemoglobin and packed cell volume. Sera were separated and frozen to be saved for future analyses of physical condition and surveys for microbial pathogens. Each bear was administered an injection of antibiotic to reduce the risk of infection associated with capture and handling. Following processing, each bear was left lying on its sternum. The status of each animal was checked from fixed-wing aircraft several hours after immobilization.

Relocation flights in 1987 were more frequent than in 1986. During 1987 selected radio-collared bears were relocated on a weekly basis from den emergence to den entrance. We subjectively selected bears that could potentially use the habitats that would be affected or altered by the Red Dog Mine. Other bears were monitored less frequently because of funding limitations. These latter bears were relocated on 2 or 3 occasions during summer to monitor status and survival of the young and at least twice in late autumn to locate den sites. At each relocation, the date; time; number, sex, and age of associates; activity; and type of habitat occupied were recorded on standard forms. Habitat types were based on overstory vegetation that could be identified from aircraft. Generally, vegetation within 1 full turn of the aircraft was catalogued using vegetation classifications described by Viereck and Dyrness (1980). Prey and carrion observed while relocating bears were also recorded; those observed at the location of radio-collared bears were considered to have been caused by that bear if freshly killed (as evidenced by fresh blood and an intact carcass) and no other bears or predators were observed. Because no carcasses were examined on the ground, the exact causes of death were not determined and, accordingly, our deductions could be biased (Boertje et al., in press; Appendix A). If more than one bear was observed on a carcass, the carcass was proportionately attributed to each bear.

Bear Census

Except where specifically stated, methods used for censusing bears were identical to those described by Miller et al. (1987). Mark-recapture methods using radiotelemetry were used to correct for population closure, which assumes that (1) the entire population is available for capture and (2) no bears move in or out of the search area; the latter is an assumption that is frequently violated in the use of mark-recapture methods for population estimation. Obviously bears move in and out of the area regularly, but by using radio telemetry, these movements can be corrected for during the mark-recapture studies. Our study procedure involved using fixed-wing aircraft to thoroughly search (without aid of telemetry) individual CAs until a bear or group of bears was spotted. Once spotted, radiotelemetry was used to determine whether animals were marked (radio-collared). Only sightings of bears with functioning radio collars were considered as resightings of marked individuals. For some sets of population and density estimates that are identified later, we also considered the young accompanied by their mothers to have the same status (marked or unmarked) as their mothers. Bears without functioning radio collars were considered unmarked. If unmarked, the location of the animal was transmitted to a nearby helicopter. Once immobilized and radio-collared, the animal was potentially available as a recapture in subsequent searches. If time permitted, effort was made to capture all unmarked adult bears, excluding subadults accompanying their mothers. All unmarked adult captures were successful, except for one adult female accompanied by one 2.5-year-old (age estimated based on size) that escaped. The census occurred during the breeding season; consequently adults were sometimes observed together. These sightings were treated as independent observations.

Equations for calculating population size, density, and associated confidence intervals (CI) were provided by Miller et al. (1987) and are quoted here for convenience of the reader:

Calculation of population estimates followed Seber (1982) where:

$$N^* = \frac{(n_1 + 1)\ (n_2 + 1)}{(m_2 + 1)} - 1 \qquad (1)$$

However, instead of using the daily values of n_1, n_2, and m_2, as would be done if the population was closed, we obtained values used for these parameters by cumulating the daily values recorded during the capture period. This resulted in a different population estimator, N_d*. We defined N_d*, conceptually, as the total number of bear-days our search area was occupied during the search period. The average number of bears that inhabited the search area during a search period of (n) days was then (N_d*/n). Substituting N_d* for N* in eq. 1 required redefining the parameters of eq. 1 as:

n_1 = cumulative number of radio-marked bear-days in the study area during a study period of n days as determined by telemetry (1 radio-marked bear verified in the study area during 1 day = 1 marked bear-day present); and

n_2 = cumulative number of bear-days observed by spotter planes during a study period of n days (1 bear, either marked or unmarked, seen in any 1 day = 1 bear-day observed); and

m_2 = cumulative number of radio-marked bear days observed by the spotter planes during a study period of n days.

Confidence intervals for N_d* were similarly calculated by substituting the previously defined values of n_1, n_2, and m_2 into the appropriate equations provided by Seber (1982). These were approximations to the hypergeometric distribution based on the binomial or normal distributions. Seber (1982) recommended criteria for choosing which distribution to use based on the values of n_2 and p*, where p* was estimated as (m_2/n_2).

Because the binomial approximation to the hypergeometric distribution was appropriate for the Noatak data, confidence intervals were calculated according to criteria given by Seber (1982) using Clopper-Pearson graphs (example in Overton and Davis 1969:413). Using p* as the entering variable on the x axis of the Clopper-Pearson graph, corresponding values for upper (p_u) and lower (p_1) limits that were associated with the isoclines for n_2 were read from the y axis of the Clopper-Pearson graph. Then the upper and lower limits of the confidence interval were, respectively:

$$N_d{*}u = n_1/p{*}_u \quad \text{and,} \quad N_d{*}1 = n_1/p{*}_1$$

These limits, as well as the estimate for N_d*, can be converted from bear-days to bears by dividing by (n), and the number of days in the search period.

During this study, we did not use Clopper-Pearson graphs as described by Miller et al. (1987) because Dan Reed and Jesse Venable (ADF&G, Fairbanks) developed a computer software program using DBASE III that calculates the binomial CI's for the 80%, 90%, 95%, and 99% level. These values were then entered into a computer software worksheet using LOTUS that was developed by Sterling Miller (ADF&G, Anchorage), and CI's for bear-days, numbers of bears, and density were calculated automatically.

Several weeks prior to the census, we modified and rewrote an instructional memorandum originally prepared by Sterling Miller and Larry Van Daele (ADF&G, Anchorage) concerning (1) procedures to be used during bear censuses and (2) safety precautions for handling immobilized grizzly bears. This memorandum was distributed to study participants prior to the census for instructional purposes and to stimulate questions (Appendix B).

Twenty individuals from 3 agencies, 2 private companies, and the Noatak community participated in the census, which was conducted from 29 May through 4 June 1987 (Table 1). Fixed-wing aircraft and 1 helicopter (Bell Jet Ranger 206B) were used during the census. The fixed-wing aircraft consisted of 5 searching (3 PA-18's, 1 PA-12, 1 Arctic Tern) and 1 tracking aircraft (Cessna 185). The tracking aircraft was used primarily for radio-tracking each day to determine degree of population closure (number and identification of individual radio-collared bears that were either in or out of individual CAs), but it was also used (2 days) for surveying. In both instances, population closure was assessed after the assigned CAs had been searched. During other days, radiotracking to determine population closure occurred simultaneously with surveys. Depending on the location of search aircraft and availability of helicopter, staff on the tracking aircraft also assumed responsibility for unmarked bears that had been spotted by survey aircraft and which needed to be captured and radio-collared. This relieved the survey aircraft staff from the tedious task of watching bears until the helicopter became available, and it also allowed them to continue the survey with minimum delay. The tracking aircraft staff did not transmit (via radio) the identity or whereabouts of any of the radio-collared bears.

Search aircraft pilot-observer teams and assigned CAs were rotated daily (Table 2). In some cases, pilots were also rotated into spotting and assisting with bear tagging. To prevent the biasing of search efforts in succeeding days, pilot-observer teams were careful not to discuss the location of sighted bears during or after the census. Personnel in the tracking aircraft were not rotated. One biologist was assigned permanently to the helicopter to insure consistency in immobilizing and handling procedures. All search aircraft personnel, except professional pilots and tracking personnel, were rotated into the tagging team to provide a break from spotting and to allow everyone the opportunity to gain experience with handling bears.

RESULTS AND DISCUSSION

Immobilizations

Thirty-four grizzly bears were immobilized with Telazol between 28 May and 4 June 1987 within the NRSA (Table 3). One female (No. 058) was immobilized twice because the new radio collar malfunctioned. The 34 individuals were composed of 11 adult (≥3 years old) males, 18 adult females, and 5 cubs of the year (COY).

Five adults were recaptured to replace radio collars before or during the census, and 7 adults were radio-collared outside but near the periphery of the census area boundary in an effort to increase the number of potential marks in the population. One of the latter adults, a young adult female (No. 054) in poor physical condition, apparently died from a drug overdose. Six adult males and 12 adult females were captured and radio-collared as part of the census effort. Of the 12 adult females, eight were unaccompanied by young, one was accompanied by 3 COY, two were accompanied by 3 yearlings, and one was accompanied by three 2.5-year-olds.

Two concentrations of Telazol were used: 200mg/ml and 300mg/ml (Table 3). The larger concentrations were used on larger adult males to reduce the volume of drug needed for immobilization. Excluding COY, 1 mortality, and 1 bear (No. 056) requiring an abnormal volume of drug (probably due to many incomplete injections in poor locations), an average of 8.73 and 9.34 mg of drug per kilogram of body weight (mg/kg) were used to immobilize adult female (*N* = 17, SD = 2.95) and male (*N* = 11, SD = 3.06) grizzlies, respectively. There was no difference ($P > 0.05$, $t = 0.49$) in mg/kg of drug required for successful immobilization between sexes. Six of 17 females and seven of 11 males required multiple doses of drug. We are aware of at least 4 incomplete injections caused by dart malfunctions, and based on our results, others probably occurred. When only single injections were required for successful mobilization, the mean dosage required was reduced to 6.59 (*N* = 11, SD = 2.57) and 6.60 (*N* = 4, SD = 2.57) mg/kg for females and males, respectively. These latter doses were close to the 5.1 mg/kg used by Haigh et al. (1985) for polar bears (*Ursus maritimus*).

Cubs of the year were immobilized by hand injection of 0.1 ml of drug (200mg/ml) to prevent them from leaving the area while the sow recovered. Induction occurred within 2-3 min (Table 3). All COY recovered and remained with their sows. Haigh et al. (1985) reported that COY of polar bears recovered from immobilization more quickly than adults. We could not confirm this with grizzly bears, but if true, it could help reduce separation of COY from mothers as a result of capture activities.

Excluding COY, 1 mortality, and 1 bear with unexplainable complications, average induction times of adult females and males, regardless of dosage, were 8.7 (*N* = 16, SD = 2.85) and 12.1 min (*N* = 10, SD = 3.48), respectively. As expected, when only single dosages were used, induction times were much less, averaging 4.3 (*N* = 11, SD = 2.07) and 5.3 min (*N* = 4, SD = 2.29) for females and males, respectively. These times were comparable to those reported for adult polar bears (Haigh et al. 1985).

Following induction, rectal temperatures were variable, depending on when taken (Table 3). Highest temperatures occurred immediately after induction; thereafter, temperatures declined. Recorded temperatures ranged from 98.3 to 106.9 F. Similarly, respirations (breaths/min) were greatest immediately following induction, declining thereafter.

Although we checked the status of each bear from fixed-wing aircraft following processing, exact recovery times are available for only 3 bears (Nos. 031, 058, and 066). Time from induction to full movement ranged from 166 to 285 min (Table 3).

The one capture-related mortality was a young, possibly subadult female that weighed about 56.7 kg. The bear's weight was overestimated from the helicopter, and she was overdosed with a single injection of 15.2 mg/kg. She died within 41 min following induction. She was extremely emaciated and appeared weak following darting. We suspect her weakened condition contributed greatly to her death. In spite of this mishap, the relatively low mortality rate of 2.9% (3.3% excluding COY) is either lower or comparable to that of etorphine hydrochloride (M-99), phencyclidine hydrochloride (Sernylan), or carfentanil. In addition, Telazol has several major advantages over other drugs: (1) relatively inexpensive, (2) much larger human safety margin than M-99 or carfentanil, and (3) performance similar to Sernylan, which is no longer commercially available in the United States. Results of these immobilizations are being combined with other Alaskan bear studies and prepared for technical publication (Taylor et al., unpubl. data).

Sex-age Structure, Morphometrics, and Reproductive Status

Seventy-four individual grizzly bears (44 females and 30 males) were captured and handled during 1986 and 1987 (Tables 4 and 5). Of that total, 54 (30 females and 24 males) were radio-collared. Twenty-one new adults (7 males and 14 females) were radio-collared during 1987, while seven originally captured in 1986 were recaptured and fitted with radios.

Physical characteristics, ages, ear tag numbers, and other important identifying criteria are summarized in Tables 6-9. Cementum ages for bears captured in May and June 1986 were received in March 1987 and are included in this report (Table 10). Detailed analysis of age and morphometric data is not warranted because of relatively small sample sizes.

Because there was a relatively high incidence of infection compared with other areas, particularly in southcentral Alaska, we discontinued use of duflex ear tags during 1987. H. Reynolds (pers. comm.) had a similar problem with duflex tags in arctic study areas. We suspect the tag is too large to allow air to circulate around the wound. To reduce this problem, we began using large roto tags that do not cover the wound. Reynolds came to an identical conclusion and began using roto tags to reduce risk of infection.

Ballard (1987) reported that 46% of the adult females captured in 1986 were not accompanied by young but were lactating, suggesting high cub mortality (Table 4); this same pattern was evident in 1987. Of 8 examined adult females unaccompanied by young, six (75%) were lactating. Also during 1986, 10 (83%) of 12 adult females were in estrus when captured; consequently, several radio-collared females were expected to have litters in 1987. Of 11 radio-collared adult females, only two (18%) were observed with litters in 1987 (Table 10).

Similar to 1986, seven (64%) of 11 adult females were in estrus when captured. We suspect that high cub mortality is occurring either in dens or shortly after emergence.

Average litter sizes in 1986 and 1987 were 2.7 (N = 3, SD = 1.63) and 3.0 (N = 3, SD = 1.73), respectively (Table 10). For both years combined, average litter size was 2.83 (N = 6, SD = 1.68). Excluding capture-related separations, survival of COY from den emergence to den entrance averaged 79% (N = 6 litters), while survival of yearlings averaged 86% (N = 8 litters). Only 50% of the 2.5-year-olds accompanying their sows at den emergence were still accompanying them the following autumn. This latter figure does not necessarily reflect survival, but it probably represents a natural separation.

During 1987 the 46 radio-collared grizzlies were observed on 9 ungulate carcasses (Table 11). Caribou, which composed 66% of the identified carcasses, appear to be an important source of food; they are utilized on an opportunistic basis whenever they migrate through a bear's home range. Some of the problems associated with estimating predation rates by grizzly bears on ungulates are described by Ballard et al. (in press). Although not part of this study, this manuscript is included in Appendix A for informational purposes.

Movements and Status

During 1987, 613 relocations were obtained on 46 radio-collared grizzly bears (Tables 12 and 13); the average number of relocations/bear was 13.3 (SD = 5.26, range 1-22). For both years of study, 891 relocations were obtained on 54 bears (16.5/bear). All relocations and base maps were digitized in early 1988, but no analysis of home ranges or movement patterns has been done. In conjunction with capture activities in 1987, den sites of radio-collared bears identified during fall 1986 were visited to record their characteristics. These data have not been summarized, but analyses will be included in future progress reports.

As of January 1988 status of the 30 adult female grizzly bears captured (excluding capture mortalities that are reported elsewhere) during 1986 and 1987 was as follows: 25 (83%) had functioning collars upon entering dens, two (7%) with break-away collars had lost them, one (3%) was missing because of a malfunctioning collar or unreported harvest, one (3%) shed its collar, and one (3%) was reported harvested (Table 12). For the 24 males captured and radio-collared during 1986 and 1987, status was as follows: 10 (42%) possessed functioning radio collars, six (25%) shed their collars that were put on too loosely, four (17%) were reported legal harvests, two (8%) were missing because of radio-collar failures or unreported harvests, one (4%) shed a break-away collar, and one (4%) died apparently of natural causes (Table 13). Rate of collar slippage for males was high but not unexpected, because the collars were deliberately fitted loosely on the bears to avoid rub marks or injury. Excluding the bears with slipped collars, 22% of the radio-collared males were harvested by hunters.

A comparison of the age structure of the reported harvest of bears from 1969 through 1985 with that of bears captured in 1986 indicates the population has become skewed towards younger males (Fig. 3). Historical harvests may have reduced the number of older males in the population. The same phenomena, however, does not appear true for the female segment of the population (Fig. 4). If hunters select larger bears that are older, increased bear harvests may place additional pressure on older female cohorts. Whether such changes would be detrimental to the bear population are not known. Further interpretation of harvest, natural mortality, and productivity statistics have been deferred until appropriate age and harvest information become available. Ideally, long-term productivity data would be desirable to assess long-term trends.

Population Estimates and Density

During 29 May through 4 June 1987, 196.7 hr were expended by personnel in 6 fixed-wing aircraft searching for grizzly bears within the 712-mi^2 (1,862 km^2) Red Dog Mine census area (Table 14). Search effort averaged 2.35 $min/mi^2/day$. Search effort per count area varied from 2.08 $min/mi^2/day$ for a count area characterized by relatively flat terrain, low elevational relief, and high sightability (i.e., CA 2) to 2.53 $min/mi^2/day$ for a rugged, mountainous area in the north (i.e., CA 9) where observability was difficult. As mentioned earlier, the census area had originally encompassed an additional 2 CAs totaling 133 mi^2, but these areas were eliminated after the first day because they required disproportionate survey effort totaling 10 hours 33 min. Personnel using the 5 aircraft expended 40.1 hr of search effort on the first day of the survey, excluding commuting time or time spent observing bears to be marked prior to capture. On that first day, 6 bears were captured and marked within or along the borders of the 2 CAs that were eliminated from the census. Initially, no marked bears were observed during the first survey day, so the confidence interval (CI) around the estimate went to infinity. We later realized that an error had been made: a radio-collared sow with 3 COY had been sighted. In retrospect, we may have been able to census the original area by reducing search intensity or having the tracking aircraft participate earlier as a survey aircraft. However, the efficiency of search personnel declined with fatigue, and it appeared desirable not to extend search effort beyond 4-5 hr without breaks. Average search effort per airplane was 5.62 hr/day, excluding time spent commuting or watching bears during immobilization. Concensus among survey personnel indicates this was close to the maximum effort per day that should be attempted. If a larger area needs to be censused, we suggest additional aircraft be used.

Prior to the census, 12 radio-collared grizzlies (8 females [Nos. 02, 08, 09, 20, 22, 28, 41, and 43], 4 males [Nos. 24, 34, 45, and 46]) that had been captured and radio-collared in 1986 were available as marked bears. The home ranges of these 12 bears overlapped into the census area, and 8 bears denned within the census area. Female No. 28 was accompanied by 2 COY, and sow No. 22 by one 2.5-year-old. Three of the previously marked males and six of the previously marked females were resighted at least once during survey days 2 through 7 (Tables 15 through 21). No marked bears were observed during the first day of the census.

Twenty-nine radio-collared adult bears were observed within the census area on one or more occasions during the census (Table 22). One of the key assumptions in mark-recapture estimates is that all individuals have an equal chance of being captured (sighted, in our case). This assumption was probably violated in this study. Several studies conducted in Alaska have reported differences in sightability between sows with COY and other age-sex classifications (Spraker et al. 1981, Miller and Ballard 1982, Ballard et al. 1982, Miller et al. 1986). Although we did not statistically test for differences in sightability among the various sex and age classes because of small sample sizes, there appeared to be a sightability bias for sows with COY. Two radio-collared sows with COY were within the census area on 11 of 12 possible days but were only observed twice (sightability = number of times seen divided by number of times within the area = 18.2%). The latter was the lowest sightability of the groups examined. Sightability for other groups was as follows: (1) all males (10 individuals, 37 occasions within, 12 occasions seen), 32.4%; (2) all females (19 individuals, 72 occasions within, 22 occasions seen), 30.6%; (3) single females (14 individuals, 47 occasions within, 16 occasions seen), 34.0%; (4) females accompanied by young 1-year-olds (3 individuals, 14 occasions within, 4 occasions seen), 28.6%; and (5) all females except those with COY (17 individuals, 61 occasions within, 20 occasions seen), 32.8%. Sightability for all bears was 31.2% (29 individuals, 109 occasions in, 34 occasions seen). There did not appear to be any significant difference in sightability between bears that had been captured and radio-collared prior to the census and those captured during the census; sightability was 28.6% and 36.4% for males and 40.0% and 23.5% for single females captured before and during the census, respectively.

Data from this study will be combined with data sets from several other Alaskan studies where mark-recapture techniques have been utilized (Miller et al., unpubl. data). With larger combined sample sizes, statistically significant differences among sex, age, and family groups can be properly tested. A recent preliminary analysis indicated that there were no significant differences ($P > 0.05$) in capture sightability of marked bears by family class, age class, or geographic area (Becker 1988). Becker also tested for capture homogeneity by day and individual and was unable to detect any differences for the Noatak area ($P = 0.316$) or among the 4 study areas ($P = 0.449$) where mark-recapture estimates have been made (GMU 13, GMU 23, GMU 4, and Karluk Lake in GMU 8). One study area (Terror Lake) in GMU 8 was significantly different ($P = 0.005$), but reasons for that difference have not yet been examined. Based on these results, there is no basis for concluding that bear observability is a function of area or class of bear.

Two types of population estimates were made in this study: (1) numbers of adult bears >3 years of age and (2) total number of bears, including COY and other offspring. The most statistically valid estimate was the former, because fewer crucial assumptions were violated. The adult (>3-year-olds) population estimate within the 1,862-km^2 study area was 28, and the total population estimate was 37. The 80% CI for the adult estimate was 25 to 35, while the total estimate ranged from 33 to 43 (Table 23). Density estimates were 1/25.7 mi^2 (66.5 km^2) for adult bears and 1/19.4 mi^2 (50.3 km^2) for total bears, including young treated with the same status as their sows (marked or unmarked). The adult estimate was similar to the total number of radio-collared bears (29) known to have been present on one or more occasions within the census area during the 7-day search effort. The estimate for all bears was slightly lower than the number that we observed in the area on one or more days (37 vs 40). Binomial CI's at the 80%, 90%, 95%, and 99% levels for both population, density, and bear-days estimates are contained in Tables 23-26, respectively. Terminology used in these tables include the following: (1) sightability equals the percentage of radio-collared bears known to be present within the census area that were actually observed on a particular day by survey aircraft; (2) Cum. n_1 equals cumulative number of marked bears present in the census area; (3) Cum. m_2 equals cumulative number of marked bears seen; and (4) Cum. n_2 equals cumulative number of all bears seen. The population estimates for adult and total bears along with their 80% and 90% binomial CI's by survey day are graphically depicted in Figs. 5 through 8. As observed in other bear census efforts (Miller et al. 1987), CI's narrowed as the census progressed. Population estimates and associated CI's leveled off by day 6; we surveyed for 1 additional day to confirm that result and terminated the census effort after day 7.

Because grizzly bears are threatened with extinction in many areas of the United States and Alaska contains about 65% of the North American population (Peek et al. 1987), particular care should be taken to minimize development impacts on grizzly bear populations. Historically, declining or depressed grizzly bear populations have either failed to increase or the population response has been slow. Management of all grizzly bear populations has been hampered by an inability to accurately monitor the population status in a timely and cost-effective manner. Typically, by the time an adverse change in status of a bear population is identified, needed remedial actions are severe and often ineffective. For these reasons, we recommend that the 80% CI be used for evaluation of impacts of Red Dog Mine development on the grizzly bear population. This would partially prevent making a Type II error; i.e., falsely concluding that there has been no change in the population as a result of development. The risk of this approach is that actions may be taken when no change in population status has actually occurred. However, if errors are made in the other direction, a valuable and formerly renewable resource may be lost.

A large portion of the expense involved with conducting a mark-recapture study on grizzly bears is associated with using a helicopter to mark new individuals during the census. We developed estimates for the adult as well as the total bear population and their respective CI's depending on whether or not new radio-collared individuals were included (Tables 25 and 27, Figs. 6, 7, 9, and 10). If no new bears had been radio-collared during the census, the resulting adult population estimate would have been only 1.8% less than the estimate obtained by including new individuals. However, the resulting 95% CI would have been much wider if no new bears had been marked (-29% to +64% of estimate compared with -17% to +39% of estimate obtained by additional marking). The total population estimate if no new bears had been captured and marked would have been 29.8% larger than the estimate obtained. Differences in CI's were similar to those obtained for adult bears (-31% to +67% of the estimate if no new bears were collared, compared with -16% to +26% of the estimate obtained during this study). We conclude that the primary benefit of capturing and marking new bears as encountered is the attainment of narrower CI's and perhaps a more accurate total estimate.

Total cost of the Noatak bear census was $64,713 (Table 28). Approximately half the cost was attributed to capturing and radio-collaring 25 adult bears. We were interested in continuing to relocate the radio-collared individuals after the census effort, so some of these costs were unavoidable. If we had not been interested in permanently marking the bears, costs could have been reduced several thousand dollars by employing only break-away collars or some other temporary method of attachment. If we had used that approach, the radio collars could have been retrieved and used elsewhere. Expenses for this census would have been substantially higher without the benefit of a contract for helicopter costs and use of government-owned or leased aircraft. Using charter aircraft at commercial rates, the projected cost of the census could have been as high as $108,000 (Table 28). Considering the remoteness and size of our census area, total cost of $64,000 was comparable to or lower than the $60,000 needed by Miller et al. (1987) to census a 508-mi^2 (1,317 km^2) area in Southcentral Alaska.

Otis et al. (1978) and White et al. (1982) list 4 assumptions that must be met for capture-recapture population estimation methods to be valid. The four assumptions are (1) the population is closed, (2) animals do not lose their marks during the experiment, (3) all marks are correctly noted and recorded at each trapping occasion, and (4) each animal has a constant, equal, and independent probability of capture on each trapping occasion. This also implies that capture and marking do not affect the future catchability of the animal. We suggest that these assumptions be either met or only minimally violated so that reasonable use of mark-recapture methods for estimation of grizzly bear population size in small areas can be provided. Use of radio collars to monitor which individual bears (bear-days estimate) are present or absent from the census area compensates for lack of population closure. Assumption No. 2 is met even when an animal loses its mark, because with radio collars and subsequent visual identification, the loss would be detected before the animal was included in daily calculations (e.g., during this study, one bear shed its collar on the next to last day of the census; this was identified on the day that it occurred, and the bear was subsequently treated as an unmarked individual after the loss of its mark). We believe that assumption No. 3 was met in all cases. The largest potential problem is the potential violation of assumption No. 4. This particular assumption has hampered all mark-recapture studies, and it was the principal topic discussed by Otis et al. (1978). If Becker's (1988) analyses are substantiated by future replications, they will provide significant ramifications for use in estimating bear numbers. Although there were no differences in sightability by age and family class or geographic area, differences among individuals exist; this is potentially a serious problem, but perhaps the concept that equal catchability is an unattainable ideal in natural populations (White et al. 1982) may require modification for grizzly bears in certain areas and under specific sets of conditions. One additional factor related to assumption No. 4 and not mentioned above is that all observations are independent of one another. Because that assumption is violated when unmarked young are treated in the same manner as their mothers (marked or unmarked), the total population estimate, which includes bears of all ages, must be viewed with caution. Similar violations of assumption No. 4 could also occur during the mating season; during this period, it is common to see 2 adult bears together. The largest problem with including these sightings and/or age classes in the estimate is that it will inflate the sample size and cause the variance of the estimate to be biased towards the low side (E. Becker, pers. comm.). However, this problem does not appear to cause serious problems with the point estimate.

Use of mark-recapture procedures in this study was partially successful because a relatively high (>50%) proportion of the population was marked and bear densities were relatively high. At lower bear densities, the method has a number of biases and sample size problems that may be overcome with further refinement (Reynolds et al. 1987; Miller, unpubl. data). In spite of real and potential problems and biases, the method allows managers to quickly and objectively estimate population size and density within a relatively small area. Most importantly, the resulting estimates are repeatable and statistically comparable. Other methods, which have relied to a large extent on the experience and expertise of the investigator, have been expensive and time consuming and usually contain no measure of precision.

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Table 1. Personnel participating in Noatak grizzly bear census from 29 May-4 June 1987 in the southwest Brooks Range of northwest Alaska.

Dwight Arnold		Noatak, Alaska
Roland Ashby		Noatak, Alaska
Lee Anne Ayres	NPS	Kotzebue, Alaska
Bill Bailey		Noatak, Alaska
Warren Ballard	ADFG	Nome, Alaska
John Coady	ADFG	Nome, Alaska
David James	ADFG	Kotzebue, Alaska
Victor Karmun	ADFG	Kotzebue, Alaska
Richard Kemp	OAS	Kotzebue, Alaska
Doug Larsen	ADFG	Kotzebue, Alaska
Steve Machida	ADFG	Nome, Alaska
Mark McNay	ADFG	Fairbanks, Alaska
Robert Nelson	ADFG	Nome, Alaska
Sam Patten	ADFG	Bethel, Alaska
Dan Reed	ADFG	Fairbanks, Alaska
Kate Roney	NPS	Kotzebue, Alaska
Jim Rood	NW Aviation	Kotzebue, Alaska
Finn Sandegren	Swedish Sportsmen's Assoc.	Uppsala, Sweden
John Schoen	ADFG	Juneau, Alaska
Paul Walters	ERA	Anchorage, Alaska

Table 2. List of pilot-observer teams and the areas they surveyed each day during the grizzly bear census conducted near Red Dog Mine from 29 May through 4 June 1987 in GMU-23 of northwest Alaska.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Coady-Reed (tracking)	Coady-Reed	Coady-Nelson	Coady-Nelson	Coady-Nelson	Coady-Nelson	Coady-Nelson
Kemp-Ayres CA-7,9	Kemp-Larsen CA-1,2	Kemp-Roney CA-3,4	Kemp-Roney CA-5,6	Kemp - OFF	Kemp-Patten CA-3,5	Kemp-Ayres CA-8,10
McNay-Roney CA-8,10	McNay- Sandegren CA-8,10	McNay-Ayres CA-2,6	Schoen-Karmun CA-8,10	Larsen-Ayres CA-3,4	McNay-Karmun CA-4,9	Rood-Patten CA-6,9
James-Patten CA-3,4,11	James-Ayres CA-5,6	James- Sandegren CA-1,5	James- Villager CA-3,7	Schoen- Machida CA-5,7	Rood-Ayres CA-7,10	McNay- Sandegren CA-3,5
Rood-Larsen CA-5,6,12	Rood-Patten CA-7,9	Rood-Machida CA-8,10	Rood-Patten CA-2,9	Rood-Roney CA-8,10	Machida- Larsen CA-1,2	Larsen-Roney CA-1,4
Machida- Schoen CA-1,2	Machida- Schoen CA-3,4	Schoen-Larsen CA-7,9	Machida-McNay CA-1,4	James-Karmun CA-2,6	James- Villager CA-6,8	Machida- Schoen CA-2,7
Chopper- Walters Ballard Schoen	Walters Ballard Roney Nelson	Walters Ballard Patten	Walters Ballard Larsen Ayres	Walters Ballard Sandegren McNay	Walters Ballard Schoen Roney	Walters Ballard Karmun James

Table 3. Statistics associated with capture and handling of grizzly bears using Telazol as the immobilizing agent from 28 May through 4 June 1987 in the southwest Brooks Range of northwest Alaska.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
9	05/31	F	129.3/158.8	E-15	200	3.5	8:48	Rump			
				C-15	300	1.5	9:01	Rump			
					300	1.5	9:12	Rump			
						6.5	9:15	Down			
								some head movement			
							9:30		102	68	5
10	05/29	M	-/136.1	C-13	200	3.3	2:21	Back			
							2:20	Rear legs			
								Down			
						1.8	2:32	Rump			
							2:38	Head waving, good movement			
						1.5	2:41	Rump			
						1.5	2:50	Rump			
						8.1	3:00	Down hard			
28	05/28	F	115.7/127.0	E-11	200	4.0	5:31	Rump			
				C-11			5:34	Down			
							5:50		100.6	20	1
							6:31		99.6		

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
31	06/04	M	102.1/127.0	C-5	300	2.9	12:24	Back			
							12:30	Down			
							12:50			12	5
							15:15	Up and moving			
32	06/01	F	90.7/194.3	E-5	200		5:37	Missed shot			
				C-5		3.0	5:43	Flank			
							5:45	Down but head up			
							6:00		106.9	60	4
							6:05		105.3	40	
							6:14		104.8		
							6:26		103.4		
35	06/03	M	133.8/124.7	C-7	200	3.9	6:45	Side			
							6:55				
						3.5	7:00	Side			
							7:05	Walking but wobbly			
							7:08	Down (light)			5
						1.0	7:22	IM (med.)			
						8.4	7:39			10	
						-4.0	2 incomplete injections (4.0 mls)				
						4.4					
42	06/02	M	117.9/147.4	C-6	300	3.5	10:23	Rump			
							10:26	Staggering			
						1.0	10:32				
						4.5	10:37	Head down but movement			
							10:42		105.1	24	4
							10:46		105.2		
							10:53		101.1	24	

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
48	05/28	M	10.0/-	0.5	200	.1	10:48	IM			
							10:50	Down			5
										102.9	
49	05/28	F	8.2/-	0.5	200	.1	10:50	IM			
							10:52	Down			5
										101.9	
50	05/28	M	136.1/204.1	E-8	200	7.3	7:16	Rump			
						7.3	7:32	Rump			
						14.6	7:36	Down			
						-3.7	7:50		106.1	104	5
						10.9	7:55		106.3		
							7:58		106.5		
							8:06		92		
					1 incomplete injection received				1/2 first injection		
51	05/28	F	102.1/127.0	E-6.5	200	4.0	9:36	Rump			
						2.0	9:50	Shoulder			
						6.0	9:53	Down, head waving			
							10:18		100.7	14	4
52	05/29	F	-/136.1	E-14	200	4.3	3:33	Rump			
							3:36	Down			
							4:05		98.3	6	3
							Medium sedation				

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
53	05/29	F	102.1/113.4	E-13	300	2.5	4:41	Tail			
							4:44	Down (est)			
							5:05		104.2	47	5
						Medium sedation					
54	05/29	F	56.7 est/136.1	E-4-5	200	4.3	7:21	Back			
							7:24	Down			
							7:45		99.6	12	4
							8:05	DEAD			
55	05/29	F	90.7/127.0	E-9	200	4.0	8:23	Bounced off leg			
						2.0	8:35	Rump			
						6.0	8:37	Down			
							8:50		103.7	25	3
						Medium sedation					
56	05/29	M	181.4 est/136.1	E-11	200	4.0	8:30	Bounced off			
							8:37	No sign			
						4.0	8:37	Tail			
							9:51	Legs down			
						1.0	9:58	Bounced off			
						9.0	10:00	Down (est.)			
							10:08		102.2	32	
						Medium sedation					
57	05/30	M	147.4//158.8	E-7.0	300	2.5	12:13	Tail			
							12:17	Down, head up			
							12:19	Head down but moving			
							12:30		103.5	32	3
							12:45		103.5		

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
58	05/30	F	117.9/117.9	E-13	200	3.5	2:36	Back			
							2:44	Down w/head up			
							2:56		101.5		3
							3:08			14	
							5:30	Up and gone			
						Medium sedation					
58	06/01	F	117.9/-		200	3.0		Down within 4 min.			
						Light sedation					
59	05/30	F	95.3/127.0	E-17	200	3.5	3:56	Back			
							3:59	Down			
							4:16		100.7	14	4
60	05/30	F	2.7/-	cub	200	0.1		Down in 3 min.			
61	05/30	F	3.6/-	cub		0.1		Down in 3 min.			
62	05/30	F	3.6/-	cub		0.1		Down in 3 min.			
63	05/30	F	104.3/113.4	E-17	200	3.0	6:36	Rump			
							6:41	Rear legs down, head up			
							6:45	Head down			
							6:59		100.2	14	2
							7:15		100.4	12	

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
64	05/30	M	222.3/158.8	E-12	300	3.3	7:37	Rump			
							7:42	Down-head up			
							8:00		102.4	14	
							8:10		101.5		
							8:14			12	
65	05/31	F	113.4/104.3	E-16	200	3.0	2:07	Rump			
							2:14	Fell down twice			
							2:18	Up and down			
							2:19	Circling			
						1.0	2:31	Rump			
						1.0	2:39	Rump			
							2:44	Rear down but good head mobility			
						1.0	2:49	Unworkable			
						1.0					
						7.0	3:00	Down			
							3:35		100.4	35	5
						Medium sedation					
66	05/31	F	59.0/104.3	E-4	200	3.2	4:43	Bounced off back			
						3.2	4:49	Tail			
						3.0	5:01	Rump			
						9.4	5:04	Down			
							5:30		101.3	16	5
							8:30	Up on front legs			
						Medium sedation					
					Suspected bad vial of drug for this bear and #65.						

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
67	05/31	F	104.3/102.1	E-7	300	2.5	10:51	Rump			
							10:54	Down			
									102.7	26	1
68	05/31	M	227+/204.1	E-18	300	4.2	11:36	Rump			
						2.0	11:45	Rump			
							11:46	Down w/head up			
						1.0	11:55	Side			
						7.2	11:56	Down (est.)			
									104.7	35	3
69	06/02	F	111.1/113.4	E-13	200	3.5	1:18	Rump			
							1:22	Down			
							1:27		104.5	28	4
							1:33		104.7		
							1:35		104.6	24	
							1:45		104.5	28	
						Medium sedation					
70	06/02	F	90.7/113.4	E-7	200	3.2	3:18	Back			
							3:28	No sign			
						3.0	3:29	Rump			
						6.2	3:32	Down			
						-1.5	3:45		101.1	16	5
						4.7	3:48		100.8	20	
					1 incomplete injection (did not receive 1/2-2nd shot)						
71	06/02	F	81.7 est/108.9	E-6	200mg	3.5	8:15	Foot			
						3.0	8:23	Rump			
						6.5	8:26	Down			5
							9:30	Up and stumbling			

Table 3. Continued.

ID	Date	Sex	Weight (kgs) Actual/Est.	Age (C=Cem.) (E=Est.)	Conc. (mg/ml)	Dosage (ml)	Time of hit	Location of hit	Temp.	Resp. (beats/min)	Dist.
72	06/02	M	179.2/186.0	E-11	300	4.0	8:31	Rump			
							8:35	Down			
						1.0	9:00	IM			
						1.0	9:15	IM			
						6.0	9:21		101.3	50	2
73	06/04	M	126.1/147.4	E-8	300	3.5	11:18	Rump			
							11:21	Staggering			
							11:22	Down			
							11:34			28	3
							11:47			24	
74	06/04	F	117.9/124.7	E-12	300	3.0	5:24	Side			
							5:27	Staggering			
							5:29	Down			
							6:55			84	

Table 4. Date, location, age, reproductive and family status of female grizzly bears captured in the southwest Brooks Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	Date of capture	Location	Cem. age	No. young	ID of young if captured	Age of young[a]	Lact.[b]	Repro. status[c]	Phy. cond.[d]
001*	05/31/86	Above Noatak Village	5.5	3		0.5	Y	2	3
002*	05/31/86	Mouth of Kelly River	5.5	0			N	1	2
004*	06/01/86	Omikviorok River	6.5	2	(005-006)	0.5	Y	2	3
005	06/01/86	Omikviorok River	0.5						
006	06/01/86	Omikviorok River	0.5						3
008*	06/02/86	Middle Wulik River	4.5	0			N	3	1
009	06/02/86	Opposite No Name Creek	13.5	0			Y	1	3
009*	05/31/87	Wrench Creek	14.5	0			Y	2	2
011	06/03/86	Upper Jade Creek	0.5						1
013	06/03/86	Upper Jade Creek - capture mortality	7.5	0			Y	2	4
014*	06/03/86	Upper Jade Creek	9.5	3		0.5	Y	2	4
018*	06/03/86	SE of Sivukat Mountain	8.5	0			Y	1	4
020*	06/04/86	Middle Wrench Creek	5.5	0			N	1	4
021*	06/03/86	Upper Wrench Creek	12.5	0			Y		2
022*	06/04/86	5 miles up Kelly River	8.5	1	(023)	1.5	Y	2	4
025*	06/04/86	Middle Kelly River	12.5	0			N	1	3
026	06/04/86	Mouth Avan River	3.5	0			N	2	3
028	06/05/86	Between Wulik River and Ikalukrok Creek	9.5	0			Y	2	3
028*	05/28/87	Wulik River	10.5	2	(048-040)	0.5	Y	2	3
032	06/05/86	Middle Ikalukrok Creek	3.5				N	2	4
032*	06/01/87	Wulik River	14.5	0			N	2	3
033	06/06/86	South of Kagvik Creek	7.5	0			N	1	4
036	06/07/86	Mulgrave Hills - capture mortality		2	(037-038)	2.5	Y	1	4
038	06/07/86	Mulgrave Hills	3.5	0			N		2
039*	06/07/86	Upper Rabbit Creek	8.5	0			Y	1	4
041*	06/08/86	Kelly River, Opposite mouth No Name Creek	6.5	0			N	1	4
043*	06/09/86	Middle Ikalukrok Creek	17.5	0			N	1	2
047	06/05/86	Middle Ikalukrok Creek		2		2.5			5
049	05/28/87	Wulik River	0.5						

Table 4. Continued.

Bear ID (tattoo)	Date of capture	Location	Cem. age	No. young	ID of young if captured	Age of young[a]	Lact.[b]	Repro. status[c]	Phy. cond.[d]
051*	05/28/87	Alutunitok Hills		0			Y	1	3
052*	05/29/87	Count Area 11		2		1.5	Y	2	4
053*	05/29/87	Wrench Creek		1		1.5	Y	2	2
054	05/29/87	Wrench Creek - capture mortality		0			N	2	5
055*	05/29/87	No Name Creek		3		1.5	Y	2	5
058*	05/30/87	Red Dog Mine		3		2.5	Y	2	4
058	06/01/87	Red Dog Mine							
059*	05/30/87	No Name Creek		3	(060,061,062)	0.5	Y	2	5
060	05/30/87	No Name Creek	0.5						
061	05/30/87	No Name Creek	0.5						
062	05/30/87	No Name Creek	0.5						
063*	05/30/87	SW Red Dog Mine		2		1.5	Y	2	
065*	05/31/87	West Wulik River		0			Y	1	4
066*	05/31/87	No Name Creek		0			N	2	4
067*	05/31/87	South of Wrench Creek		0			N	1	4
069*	06/02/87	Count Area 4		0			Y	1	4
070*	06/02/87	Ferric Creek		0			Y	1	4
071*	06/02/87	Count Area 9		0			N	1	4
074*	06/04/87	Count Area 8		0			Y	4	3

* Radio-collared.
[a] Estimated unless captured.
[b] Lactating: Y = Yes, N = No.
[c] Reproductive status: 1 = in estrus, 2 = not in estrus, 3 = pre-estrus, 4 = post-estrus.
[d] Condition: from 1 = good, to 5 = bad.

Table 5. Date, location, age, and physical condition of male grizzly bears captured in the Southwest Brooks Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	Date of capture	Location	Cementum age	Physical condition[a]
003*	05/31/86	Mouth of Kelly River	7.5	2
007*	06/02/86	Upper Ikalukrok Creek	8.5	1
010*	06/02/86	Opposite No Name Creek	11.5	
010	05/29/87	Count Area 11	12.5	
012*	06/02/86	Upper Kelly River	12.5	1
012	06/08/86	No Name Creek	12.5	
015	06/03/86	Upper Jade Creek	0.5	2
016	06/03/86	Upper Jade Creek	0.5	2
017	06/03/86	Rabbit Creek	2.5	3
019*	06/04/86	SE of Sivukat Mountain	11.5	3
023	06/04/86	5 miles up Kelly River	1.5	4
024*	06/04/86	Middle Kelly River	8.5	2
027*	06/05/86	Middle Ikalukrok Creek	8.5	3
029*	06/05/86	Between Wulik River and Ikalukrok Creek	7.5	2
030*	06/05/86	Tutak Creek	11.5	2
031	06/05/86	Upper Wulik River	3.5	3
031*	06/04/87	Wulik River	4.5	4
034*	06/07/86	South of Sivukat Mountain	5.5	4
035	06/07/86	Mouth of No Name Creek	5.5	3
035*	06/03/87	Upper Kagvik Creek	6.5	4
037	06/07/86	Mulgrave Hills	2.5	3
040*	06/07/86	Upper Rabbit Creek	7.5	2
042*	06/08/86	10 Miles NW of Noatak	4.5	3
042	06/02/87	Rabbit Creek	5.5	3
044*	06/08/86	Middle Ikalukrok Creek	7.5	2
045*	06/09/86	West of Sheep Mountain	8.5	3
046*	06/09/86	Mouth Wrench Creek	8.5	4
048	05/28/87	Wulik River	0.5	

Table 5. Continued.

Bear ID (tattoo)	Date of capture	Location	Cementum age	Physical condition[a]
050*	05/28/87	West Fork Wulik River		1
056*	05/29/87	No Name Creek		2
057*	05/30/87	Kelly River		4
064*	05/30/87	Deadlock Mountain		4
068*	05/31/87	Deadlock Mountain		4
072*	06/02/87	Count Area 9		3
073*	06/04/87	Wulik River		4

* Radio-collared.
[a] Condition: 1 = good, to 5 = bad.

Table 6. Weight, ear tag numbers, and statistics associated with capturing female grizzly bears in the southwest Brooks Range of GMU 23 during spring and early summer 1986 and 1987.

Bear ID (tattoo)	Weight (kgs)	Left ear tag Color[a]/no.	Right ear tag Color[a]/no.	Drug[b]	CC dose	Induction (min)	Location[c] of injection	Level of disturbance[d]
001	106.6	WD/2235	WD/2231	PHCL	3.0	6	2	3
002	95.3	WD/2233	WD/2243	PHCL	6.0[e]	54	1	5
004	102.1	WD/2276	WD/2298	PHCL	3.0	11	1	2
005	9.8	WD/2236	WD/2270	PHCL	0.8	2	1	
006	12.7	WD/2286	WD/2290	PHCL	0.8	2	1	
008	95.3	WD/2282	WD/2296	PHCL	3.0	6	7	2
009	112.5	WD/2300	WD/2287	PHCL	6.5[e]	40	1	3
009	129.3	WD/2300	WD/2287	TELA	5.5	27	1	5
011	6.0	WD/2203	WD/2241	PHCL	1.0		1	5
013	106.6	Dead at capture		PHCL	10.0[e]	28	7	4
014	95.3	WD/2283	WD/2297	PHCL	5.5[e]	21	1	4
018	145.2	WD/2291	WD/2295	PHCL	3.0	18	6	
020	63.5	WD/2242	WD/2240	PHCL	3.0	2	1	1
021	113.4	WD/2212	WD/2227	PHCL	5.5[e]	33	2	2
022	97.5	WD/2211	WD/2202	PHCL	3.0	7	1	2
025	102.1	WD/2292	WD/2293	PHCL	3.0	9	6	3
026		WD/2239	WD/2238	M-99	4.0	4	6	3
028	117.9	OD/2550	OD/2579	M-99	3.5	9	1	
028	115.7	OD/2550	OD/2579	TELA	4.0	3	1	1
032	62.6	WD/2232	WD/2245	M-99	3.5	5	8	2
032	90.7	WD/2232	WD/2445	TELA	3.0	2	3	4
033	70.3	WD/2249	WD/2244	M-99	3.5		3	4
036		Dead at capture		M-99	3.5	5	6	3
038	83.9	WD/2277	WD/2299	M-99	2.3[e]	25	1	5
039	124.7	WD/2204	WD/2210	M-99	2.5	4	3	2
041	84.4	WD/2234	WD/2228	M-99	3.5	4	2	4
043	125.2	WD/2230	WD/2250	M-99	5.0[e]	13	2	5
047[g]				M-99	3.5	2	6	1
049	8.2			TELA	0.1	2	1	5
051	102.1	BL/0762	BL/0761	TELA	6.0[e]	17	1	4
052		BL/0750	BL/0749	TELA	4.3	3	1	3
053	102.6	BL/0737	BL/0736	TELA	2.5	3	6	5
054	56.7	Dead at Capture		TELA	4.3	3	2	4
055	90.7			TELA	6.0[e]	14	7	3

Table 6. Continued.

Bear ID (tattoo)	Weight (kgs)	Left ear tag Color[a]/no.	Right ear tag Color[a]/no.	Drug[b]	CC dose	Induction (min)	Location[c] of injection	Level of disturbance[d]
058	117.7	BL/0757	BL/0758	TELA	3.5	8	2	3
058				TELA	3.0	4	1	4
059	95.3	BL/0732	BL/0733	TELA	3.5	3	2	4
060	2.7			TELA	0.1	3	1	5
061	3.6			TELA	0.1	3	1	5
062	3.4			TELA	0.1	3	1	5
063	104.3	BL/0748	BL/0747	TELA	3.0	9	1	2
065	113.4	BL/0729	BL/0728	TELA	7.0[e]	53	1	5
066	59.0	BL/0745	BL/0727	TELA	9.4[e]	21	6	5
067	104.3	BL/0738	BL/0739	TELA	2.5	3	1	1
069	111.1	RD/1273	RD/1041	TELA	3.5	4	1	4
070	90.7	RD/1274	RD/1262	TELA	4.7[e,g]	14	2	5
071		RD/1114	RD/1287	TELA	6.5[e]	11	1	5
074	117.9	BL/0760	BL/0764	TELA	3.0	5	3	

[a] OD = orange duflex, WD = white duflex, BL = blue roto, RD = red roto.
[b] PHCL = phencylidine hydrochloride (Sernylan), M-99 = etorphine hydrochloride, TELA = telazol (zoletil).
[c] 1 = rump, 2 = back, 3 = side, 4 = neck, 5 = head, 6 = tail, and 7 = rear leg.
[d] Level of disturbance: 1 = slight, to 5 = run hard before immobilization resulted.
[e] Multiple injections required for immobilization.
[f] Immediately released due to poor physical condition.
[g] Incomplete injection of at least 1 dart confirmed.

Table 7. Weight, ear tag numbers, and statistics associated with capturing male grizzly bears in the southwest Brooks Range of GMU 23 during spring and early summer 1986 and 1987.

Bear ID (tattoo)	Weight (kgs)	Left ear tag Color[a]/no.	Right ear tag Color[a]/no.	Drug[b]	CC dose	Induction (min)	Location[c] of injection	Level of disturbance[d]
003	186.9	OD/2530	OD/2534	PHCL	4.0	12	6	2
007	176.9	OD/2546	OD/2526	PHCL	4.0	12	1	4
010		OD/2589	OD/2544	PHCL	5.5[e]	22	7	3
010		OD/2589	OD/2655	TELA	8.1[e]	39	2	3
012	215.5	OD/2597	OD/2536	PHCL	5.0	11	1	1
012		Recapture		M-99	5.0	7	7	3
015	6.0	OD/2595	OD/2546	PHCL	1.0		1	5
016	7.0	OD/2593	OD/2538	PHCL	0.5		5	
017	36.3	OD/2548	OD/2540	PHCL	2.5	3	6	1
019		OD/2598	OD/2533	PHCL	6.0[e]	18	6	5
023	35.4	OD/2559	OD/2569	M-99	1.5	6	6	2
024	197.3	OD/2591	OD/2537	PHCL	7.5[e]		3	4
027	152.0	OD/2553	OD/2558	PHCL	3.0	9	2	1
029	192.8	OD/2582	OD/2586	PHCL	5.0		2	
030	220.0	OD/2532	OD/2542	PHCL	10.0[e]	55	1	4
031	86.2	OD/2529	OD/2531	M-99	2.5	5	6	2
031	102.1	OD/2529	OD/2531	TELA	2.9	6	2	5
034	140.6	OD/2528	OD/2592	M-99	5.0	12	6	5
035	97.5	OD/2590	OD/2596	M-99	3.5	4	6	1
035	133.8	OD/2590	OD/2596	TELA	4.4[e,f]	23	3	5
037		OD/2549	OD/2547	M-99	2.5[e]	27	6	5
040	197.3	OD/2572	OD/2585	M-99	4.5[e]	16	1	2
042	104.3	OD/2527	OD/2600	M-99	5.0[e]	14	7	3
042	117.9	OD/2526						
		7	OD/2600	TELA	4.5	14	1	4
044	197.3	OD/2555	OD/2554	M-99	7.5[e]	23	1	3
045	176.9	OD/2588	OD/2535	M-99	4.0	9	2	3
046	183.7	OD/2575	OD/2562	M-99	4.0	10	1	3
048	10.0			TELA	0.1	2	1	5

Table 7. Continued.

Bear ID (tattoo)	Weight (kgs)	Left ear tag Color[a]/no.	Right ear tag Color[a]/no.	Drug[b]	CC dose	Induction (min)	Location[c] of injection	Level of disturbance[d]
050	136.1	BL/0773	BL/0774	TELA	10.9[e,f]	20	1	5
056	E181.4	BL/0771	BL/0756	TELA	9.0[e]	93	6	5
057	147.4	BL/0734	BL/0735	TELA	2.5	6	6	3
064	222.3	BL/0746		TELA	3.3	5	1	
068		BL/0740	BL/0730	TELA	7.2[e]	10	1	3
072	179.2	RD/0571	RD/0575	TELA	6.0[e]	4	1	2
073	126.1	BL/0726	BL/0743	TELA	3.5	4	1	2

[a] OD = orange duflex, WD = white duflex, BL = blue roto, RD = red roto.
[b] PHCL = phencylindine hydrochloride (Sernylan), M-99 = etorphine hydrochloride, TELA = Telazol (Zoletil).
[c] 1 = rump, 2 = back, 3 = side, 4 = neck, 5 = head, 6 = tail, and 7 = rear leg.
[d] Level of disturbance: 1 = slight, 5 = run hard before immobilization resulted.
[e] Multiple injections required for immobilization.
[f] Incomplete injection of at least 1 dart confirmed.

Table 8. Physical characteristics of female grizzly bears captured in the southwest Brooks Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	Wt. (kgs)	Head length	Head width (mm)	Head total	Neck (mm)	Total length (mm)	Girth (mm)	Upper canine ant-post[a] (mm)	Upper canine lab-ling[b] (mm)	Lower canine ant-post[a] (mm)	Lower canine lab-ling[b] (mm)	Percent hemoglobin	Packed cell volume
001	106.6	335.0	206.5	541.5	587.5	1733.6	1104.9	R17.3	R13.9	R20.3	R19.7	20.0	58.5
002	95.3	327.2	187.5	514.7		1803.4		U16.0	U11.4	U17.1	U12.3	18.0	53.5
004	102.1	323.0	186.0	509.0		1866.9	1130.3	R20.8	R14.9	R19.8	R13.2	20.0	49.0
005	009.8	165.1	100.1	265.2	250.0	793.8	441.5					17.5	42.5
006	012.7	171.5	103.1	274.6	289.1	844.6						17.0	45.0
008	095.3	306.3	193.8	400.1	520.7	1752.6	1060.5	L15.6	L11.6	L17.9	L12.4	18.5	55.5
009	112.5	325.0	215.0	540.0	609.6	1790.7	1162.1					17.0	44.0
009	129.3	346.1	215.9	562.0	736.6	1625.6							
011	006.0	155.7	95.3	251.0	247.7	660.4						16.0	42.0
013	106.6	330.2	200.2	530.4	673.1	1879.6	1193.8	R20.2	R14.1	R20.5	R17.4	20.0	51.5
014	095.3	311.2	201.7	512.9	635.0	1803.4	1092.2	R16.1	R12.1	L17.5	L12.6	17.0	46.0
018	145.2	316.0	222.3	538.3		1981.2						18.5	50.0
020	063.5	295.4	171.5	466.9	616.0	1473.2	1117.6	L20.6	L11.3	L17.1	L12.4	19.5	54.5
021	113.4	335.0	217.4	552.4		1765.3	1358.9	U17.1	U12.1	U17.3	U13.1	18.5	47.5
022	097.5	330.0	220.2	550.2	584.2	1641.6		R18.2	R10.9	R19.2	R13.0	19.1	47.3
025	102.1	323.9	211.1	535.0	584.2	1803.4	1117.6					19.9	55.0
026	056.7E	352.6											
028	117.9	381.0	215.7	596.9	660.4	1930.4	1016.0	R16.1	R10.0	R15.0	R09.8	20.0	52.0
032	062.6	282.7	149.4	432.1				L15.0	L11.9	L15.1	L12.4	17.5	49.5
032	090.7	304.8	165.1	469.9	520.7	1524.0						16.5	43.0
033	070.3	311.2	190.5	501.7	520.7	1701.8	889.0	L17.7	L15.3	L14.9	L12.5	20.0	55.5
036	106.6E	317.5	209.6	527.1	800.1	1828.8	1168.4	L18.4	L13.7	L18.7	L13.0		
038	083.9	308.0	185.0	493.0	533.4	1676.4	990.6					19.5	49.5
039	124.7	301.8	209.6	511.4	609.6	1803.4	1143.0	L17.3	L13.7	L18.1	L12.5	19.0	48.0
041	084.4	317.5	198.4	515.9	660.4	1676.4	1079.5	L15.2	L13.5	L17.1	L15.2	19.0	52.5
043	125.2	328.7	203.2	531.9	647.7	1854.2	1117.6	L16.3	L13.2	L15.2	L13.1	18.0	53.0

Table 8. Continued.

Bear ID (tattoo)	Wt. (kgs)	Head length (mm)	Head width (mm)	Head total (mm)	Neck (mm)	Total length (mm)	Girth (mm)	Upper canine ant-post[a] (mm)	Upper canine lab-ling[b] (mm)	Lower canine ant-post[a] (mm)	Lower canine lab-ling[b] (mm)	Percent hemoglobin	Packed cell volume
047	045.4E												
049	008.2											17.0	40.3
051	102.1	311.2	184.2	495.4	609.6	1574.8		L16.7	L13.8	L16.6	L12.8	19.5	45.5
052		335.0	210.0	545.0		1720.0	0980.0					18.0	42.8
053	102.6	327.0	208.0	535.0		1660.0	1320.0						
054	056.7	340.0	167.0	507.0		1415.0	1010.0					17.0	42.3
055	090.7	330.2	177.8	508.0	520.7	1606.6	1092.2						
058	117.9	342.9	209.6	552.5		1562.1						17.5	45.8
059	095.3	335.0	211.1	546.1	685.8	1651.0						20.0	44.5
060	002.7												
061	003.6												
062	003.4												
063	104.3	331.8	209.6	541.4	558.8	1739.9						20.0	48.0
065	113.4	292.1	190.5	482.6		1651.0	1092.2					20.0	50.0
066	059.0	298.5	165.1	463.6		1511.3			L11.7	L15.6	L10.6	18.3	42.0
067	104.3	319.1	193.7	512.8	635.0	1524.0						20.0	37.5
069	111.1	336.6	204.8	541.4		1727.2	1092.2					16.5	52.8
070	090.7	317.5	190.5	508.0	546.1	1562.1	0965.2					18.5	46.5
071	081.6E	301.6	182.6	484.2	584.2							18.0	43.5

[a] Ant. = anterior, post. = posterior.
[b] lab. - labial, ling. - lingual.

Table 9. Physical characteristics of male grizzly bears captured in the southwest Brooks Mountain Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	Wt. (kgs)	Head length (mm)	Head width (mm)	Head total (mm)	Neck (mm)	Total length (mm)	Girth (mm)	Upper canine ant-post[a] (mm)	Upper canine lab-ling[b] (mm)	Lower canine ant-post[a] (mm)	Lower canine lab-ling[b] (mm)	Percent hemoglobin	Packed cell volume
003	186.9	384.3	228.6	612.9	838.2	1828.8	1320.8	R21.5	R15.5	L20.4	L18.6	20.0	61.0
007	176.9	317.5	225.6	543.1	547.1	1663.7	1308.1	L20.2	L14.9	L20.8	L14.7	16.0	46.5
010	222.3E	360.4	251.0	611.4	927.1	1892.3		R23.0	R17.7	R21.9	R15.3	20.0	58.5
012	215.5	311.2	257.3	568.5	800.1	2184.4	1384.3	L16.9	L20.8	L19.6	L15.7	17.5	47.5
015	006.0	152.4	108.0	260.4	247.7	660.4						18.0	43.0
016	007.0	162.1	95.3	257.4	279.4	679.5						17.0	39.5
017	036.3	235.0	138.2	373.2	381.0	1219.2	736.6					16.0	42.5
019	181.4E	384.3	241.3	625.6	838.2	1752.6	1378.0	U22.1	U16.0	U26.6	U17.0	17.5	47.0
023	035.4	230.1	134.9	365.0	406.4	1270.0						18.0	49.0
024	197.3	349.9	247.7	587.6	774.7	2013.0	1282.7	L20.1	L15.0	L20.6	L14.8	20.0	54.5
027	152.0	340.0	223.0	563.0	685.8	2120.9	1244.6	L19.6	L18.8	L21.6	L14.1	20.0	53.5
029	192.8	368.3	231.9	600.2	889.0	2184.4		U21.4	U14.1	U22.8	U14.1	20.0	57.3
030	220.0	384.4	257.3	641.6	965.2	1676.4	1524.0	L23.6	L17.5	L22.4	L14.7	15.0	57.5
031	086.2	325.0	177.0	502.0	660.4	1778.0	927.1	L19.3	L13.7	L21.4	L14.4	20.0	59.5
031	102.1	335.0	193.7	528.7	577.9	1828.8						20.0	53.0
034	140.6	342.9	209.6	552.5	660.4	1828.8	1117.6	L16.8	L12.0	L15.0	L12.0	17.5	54.0
035	097.5	342.0	187.0	529.0	558.8	1816.1	965.2	L19.7	L17.8	L20.4	L19.5	20.0	50.5
035	133.8	330.2	200.0	530.2		1778.0						18.0	46.0
037		306.3	184.2	409.5	641.4	1612.9		U17.7	U15.4	U17.6	U15.7		
040	197.3	347.0	239.0	586.0	850.9	2184.4	1320.8					20.0	55.0
042	104.3	310.0	178.0	488.0	609.6	1778.0	1041.4	R14.9	R13.0	R20.0	R13.2	17.5	54.0
044	197.3	365.3	230.1	595.4	876.3	1879.6						18.5	48.5
045	176.9	365.3	222.3	587.6	673.1	1866.9		R21.1	R18.4	R23.4	R13.8	18.5	57.0
046	183.7	365.3	230.1	595.4	736.6	1866.9		R20.0	R14.4	R21.8	R13.4	20.0	52.5
048	010.0											17.8	42.3
050	136.1	371.5	208.0	579.5	660.4	1759.0	1219.2	L19.8	L18.3	L20.4	L13.4	19.5	47.5
056	181.4	342.9	190.5	533.4	660.4		1143.0					20.0	42.5

Table 9. Continued.

Bear ID (tattoo)	Wt. (kgs)	Head length (mm)	Head width (mm)	Head total (mm)	Neck (mm)	Total length (mm)	Girth (mm)	Upper canine ant-post[a] (mm)	Upper canine lab-ling[b] (mm)	Lower canine ant-post[a] (mm)	Lower canine lab-ling[b] (mm)	Percent hemoglobin	Packed cell volume
057	147.4	320.7	184.2	504.9	558.8	1524.0	0090.6					18.5	53.3
064	222.3	398.5	238.1	646.6		2070.1	1422.4					20.0	53.0
068	272.2E	374.7	260.4	635.1	863.6	2311.4						20.0	50.0
072	179.2	360.4	222.3	582.7	736.6	1847.9	1295.4					20.0	46.0
073	126.1	360.4	204.8	565.2	685.8	1765.3	1257.3					20.0	51.5

[a] Ant. = anterior, post. = posterior.
[b] lab. = labial, ling. = lingual.

Table 10. Summary of litter sizes and subsequent losses of offspring for radio-collared adult (>3 yr old) female grizzly bears captured in the southwest Brooks Mountain Range of GMU 23 during 1986 and 1987.

Bear ID	Year	Age	Barren		Cubs		Yearlings		2.5 yr olds	
			EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]
001	1986	5.5			3[c]	2				
	1987	6.5					2	2		
002	1986	5.5	X	X						
	1987	6.5	X	X						
004	1986	6.5			2	2				
	1987	7.5					2	2		
008	1986	13.5	X	X						
	1987	14.5	X	X						
009	1986	14.5	X	X						
	1987	15.5	X	X						
013	1986	7.5	X	Dead						
014	1986	9.5			3[c]	1				
	1987	10.5					1	0		
018	1986	8.5	X	Dead						
020	1986	5.5	X	X						
	1987	6.5	X	X						
021	1986	12.5	X	X						
	1987	13.5			4	3				
022	1986	8.5					1	1		
	1987	9.5							1	x
025	1986	12.5	X	X						
	1987	13.5	X	X						
026	1986	3.5	X							
028	1986	9.5	X	X						
	1987	10.5			2	0-1?				
032	1986	3.5	X	X						
	1987	4.5	X	X						
033	1986	7.5	X							
036	1986	Ad.	X							
038	1986	3.5	X							
039	1986	8.5	X	X						
	1987	9.5	X	X						
041	1986	6.5	X	X						
	1986	7.5	X	X						
043	1986	17.5	X	X						
	1987	18.6	X	X						
047	1986	?							2[d]	
051	1987		X							
052	1987						2[d]	2		
053	1987						1[d]	1		
054	1987		X							
055	1987						3[d]	2		
058	1987								3[d]	2
059	1987				3	3				
063	1987						2[d]	2		

Page 10. Continued.

Bear ID	Year	Age	Barren		Cubs		Yearlings		2.5 yr olds	
			EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]
065	1987		X	X						
066	1987		X	X						
067	1987		X	X						
069	1987		X	X						
070	1987		X	X						
071	1987		X	X						
074	1987		X	X						

[a] EM = Size of litter at emergence from den in spring.
[b] EN = Size of litter at den entrance in autumn.
[c] Capture related mortalities.
[d] Offspring age estimated.

Table 11. Number and species of prey carcasses observed at relocations of radio-collared grizzly bears in southwest Brooks Mountain Range of GMU 23 during 1986 and 1987.

Bear ID	Kills observed 1986	Kills observed 1987
Females		
002	.5 unidentified carcass[a]	
009	.5 possible moose calf[a]	
	1 adult moose carcass[a]	
	.5 unidentified carcass	
014		1 unidentified carcass
018	.5 calf moose	
020	1 adult caribou (old)	
	1 unidentified carcass	
025		1 adult caribou (old)
028		1 undentified carcass
043	0.5 adult caribou (old)	
065		1 calf moose or caribou
Males		
010	1 yearling moose	
	.5 unidentified carcass	
012	1 adult moose	
027	1 calf moose	
029	1 adult moose	
035		1 calf moose (suspected starvation mortality)
044	.5 adult caribou (old)	1 caribou of unknown age
046	1 probably moose calf	
064		1 unidentified ungulate
072		1 adult cow caribou and 1 yearling caribou of unknown sex

[a] When number of adult bear observed on kill was 1 the carcass was divided proportionately to number of bears observed.

Table 12. Summary of numbers of relocations, reproductive history, and status of female grizzly bears captured in the southwest Brooks Mountain Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	No. of relocations 1986	No. of relocations 1987	Status	Reproductive history
001*	13	10	Active, 1987 den located on 10/27/87	w/3 cubs at capture, w/2 cubs 5/86, 10/86, w/2 1.5 yr olds 5/87, 10/87
002*	12	15	Active, 1987 den site located on 11/23/87	Alone - 5/86, 10/86, 5/87, 10/87
004*	13	18	Active, 1987 den site located on 10/28/87	w/2 cubs 6/86-10/86, w/2 1.5 yr olds 5/87-10/87
005			With sow 04 in den on 10/28/87	
006			With sow 04 in den on 10/28/87	
008*	14	19	Active, 1987 den site located on 10/28/87	Alone-6/86, 10/86, 5/87, 9/87
009*	11	14	Active, 1987 den site located on 10/27/87	Alone - 6/86, 10/86, 5/87, 10/87
011			Missing after capture (possible post-capture mortality)	
013			Capture mortality 6/86	
014*	11	15	Active, 1987 den site located on 11/23/87	w/3 cubs at cap, lost 2, w/1 cub 10/86, w/1 1.5-yr old 5/87, lost after 5/28/87
018*	10		Suspect shot between 9/26-10/2/86 (radio at guide camp)	
020*	10	22	Active, 1987 den site located on 10/27/87	Alone 6/86, 10/86, 5/87, 10/87
021*	8	11	Active, 1987 den site located on 10/12/87	Alone 6/86, 10/86, w/4 cubs 5/87, lost 1 5/28 and 6/18, w/3 cubs 10/87
022*	10	21	Active, 1987 den site located on 10/12/87	w/1 1.5 yr old 6/86, 10/86, w/1 2.5 yr old 5/2/87, missing 5/2 and 5/16/87. Alone 10/87

Table 12. Continued

Bear ID (tattoo)	No. of relocations 1986	1987	Status	Reproductive history
025*	11	8	Active, 1987 den site located on 10/28/87	Alone 6/86, 10/86, 5/87, 10/87
026			Unknown after capture	
028*	13	22	Recap, active 1987 den site located on 10/28/87	Alone 6/86, 10/86; w/2 cubs 5/87 lost 1 7/7-7/16, may have lost other 9/30-10/13. Need to confirm in 1988
032*		7	Recap 6/87 w/breakaway collar, off by 08/12/87. Unknown	
033			Unknown after capture	
036			Capture mortality	
038			Unknown after capture	
039*	9	16	Active, 1987 den site located on 10/08/87	Alone 6/86, 10/86, 5/87, 10/87
041*	8	13	Active, 1987 den site located on 10/28/87	Alone 6/86, 10/86, 5/87, 10/87
043*	5	20	Active 1987 den site located on 10/09/87	Alone 6/86, 10/86, 5/87, 1-/87
047			Unknown after capture	
049			See sow 28	
051*		2	Slipped collar between 5/30 and 06/04/87, unknown	Unknown after capture
052*		7	Active, 1987 den site located on 10/08/87	w/2 1.5 yr olds 5/87, and 08/87
053*		15	Active, 1987 den site located on 11/23/87	w/1 1.5 yr old 5/87, 10/87
054			Capture mortality	
055*		17	Active, 1987 den site located on 10/12/87	w/3 1.5 yr olds 5/87, lost 1 9/15 and 10/8/87, 2 yrls 10/87
058*		16	Active, 1987 den site located on 11/23/87	w/3 2.5 yr olds 5/87, lost 1 5/30 and 6/25/87, w/2 10/87

Table 12. Continued.

Bear ID (tattoo)	No. of relocations 1986	No. of relocations 1987	Status	Reproductive history
059*		9	Active, 1987 den located by 10/09/87	w/2 cubs 5/87, 10/87
060			See sow 059	
061			See sow 059	
062			See sow 059	
063*		19	Active, 1987 den site located on 10/27/87	w/2 1.5 yr olds, 5/87 and 10/87
065*		16	Active, 1987 den site located on 10/28/87	Alone 5/87, 10/87
066*		9	Break away collar, dropped 8/19 and 9/8/87, unknown	Unknown after 8/19/87
067*		17	Active, 1987 den site located on 10/27/87	Alone 5/87, 10/87
069*		16	Active, 1987 den site located on 10/12/87	Alone 6/87, 10/87
070*		16	Active, 1987 den site located on 10/27/87	Alone 6/87, 10/87
071*		12	Missing after 09/15/87	Alone 6/87
074*		14	Active, 1987 den site located on 10/27/87	Alone 6/87, 10/87
Total	158	416		

* Radio-collared

Table 13. Summary of number of relocations and status of male grizzly bears in the southwest Brooks Mountain Range of GMU 23 during 1986 and 1987.

Bear ID (tattoo)	No. of relocations 1986	No. of relocations 1987	Status as of den entrance 1987
003*	11	15	Active, den site located on 11/23/87
007*	10	1	Hunting mortality 09/16/87
010*	10	9	Slipped collar 5/87, recap 5/87, slipped 10/87
012*	5		Slipped collar 6/86, recap 6/86, slipped 8/86
015			Missing after capture - capture mortality
016			Assumed dead, missing after 5/28/87, see sow 014
017			Unknown after capture
019*	2		Slipped collar by 6/8/86
023			Unknown after capture
024*	6	9	Slipped collar 8/12/87
027*	4		Missing after 7/3/86
029*	10		Hunting mortality 04/21/87
030*	3		Hunting mortality 04/19/87
031*		10	Recap, active-1987 den site located 11/23/87
034*	10	21	Active, last located on 10/27/87, den not located
035*	6	6	Suspected mortality from unknown causes by 10/9/87
037			Unknown after capture
040*	10	16	Active, 1987 den site located
042*	10	18	Recap, Active-1987 den site located 10/28/87
044*	5		Hunting mortality 04/23/87
045*	8	13	Slipped collar 7/1 and 7/6/87
046*	10	15	Active-1987 den site located on 10/12/87
048			See sow 28
050*		2	Missing after 06/18/87

Table 13. Continued.

Bear ID (tattoo)	No. of relocations 1986	No. of relocations 1987	Status as of den entrance 1987
056*		15	Active, 1987 den site located on 11/23/87
057*		10	Break away collar, missing after 07/07/87 Shot?
064*		18	Active-1987 den site located on 10/28/87
068*			Slipped collar between 06/02 and 06/03/87
072*		10	Active-1987 den site located on 10/28/87
073*		9	Active-1987 den site located on 11/23/87
Total	120	197	

* Radio-collared.

Table 14. Survey effort (min/mi^2) by count area and day conducted for a census of grizzly bears conducted from 29 May through 4 June 1987 near Red Dog Mine in the southwest Brooks Range of northwest Alaska.

Area no.	Mi^2	(km)	Survey day 1	2	3	4	5	6	7	Totals	Min/mi^2 area	Min/mi^2 day
1	62	160.6	179	181	115	183	111	140	135	1044	16.84	2.41
2	78	202.0	215	159	180	130	130	154	165	1133	14.53	2.08
3	74	191.7	237	163	160	150	205	150	140	1205	16.28	2.33
4	71	183.9	158	148	120	173	195	140	175	1109	15.62	2.23
5	72	186.5	171	131	125	116	210	170	185	1108	15.39	2.20
6	70	181.3	117	161	210	190	165	175	160	1178	16.83	2.40
7	70	181.3	150	180	159	200	150	202	135	1176	16.80	2.40
8	76	196.8	170	180	225	205	135	180	175	1270	16.71	2.39
9	77	199.4	185	180	170	180	184	399	165	1364	17.71	2.53
10	69	178.7	188	165	225	195	113	146	185	1217	17.64	2.52
Totals	719	1,862	1770	1648	1689	1722	1593	1757	1620	11804	16.42	2.35
min/mi^2/day			2.46	2.29	2.35	2.39	2.22	2.44	2.25			

Table 15. Summary of observations and survey effort during survey day number 1 (May 29, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer	Time of	Marked bears observed				Unmarked bears observed			
No.	Size (mi^2)	team	survey	No. (ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	Machida-Nelson	1423-1722	0				0			
2	78	Machida-Nelson	1915-2250	0				0			
3	74	Machida-Nelson	2340-0121	0				0			
		James-Patten	2244-0100	0				0			
4	71	Kemp-Ayres	PM	0				1	AD	?	0
		Machida-Nelson	0138-0156	0				1	AD	?	0
5	72	Rood-Larsen	2204-2208	0				1	AD	?	0
			2216-0025					1	AD	?	0
			0032-0110								
6	70	Rood-Larsen	0147-0240	0				0			
		James-Patten	0151-0255								
7	70	Kemp-Ayres	?-2216	0				1	AD	?	0
8	76	McNay-Roney	?-2000	0				1	AD	F	1-Yrlg
								1	AD	?	0
9	77	Kemp-Ayres	?-1412	0				1	AD	F	1-Yrlg
10	69	McNay-Roney	1339-1420	0				1	AD	F	0
			1505-1615								
			1650-1720								
			1948-2035								
TOTAL	719			0				9	AD		2-Yrlg
(total by sex-age)								(6 AD-?/ 3 AD-F)			

Table 16. Summary of observations and survey effort during survey day number 2 (May 30, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer	Time of	Marked bears observed					Unmarked bears observed			
No.	Size (mi^2)	team	survey	No.	(ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	Kemp-Larsen	1303-1604	0					0			
2	78	Coady-Reed	1550-1601 1607-1658 1803-1940	0					0			
3	74	Machida-Schoen	1310-1553	0					0			
4	71	Machida-Schoen	1815-2043	0					0			
5	72	Coady-Reed Rood-Patten Machida-Schoen	2044-2125 PM PM	1	(43)	AD	F	0	2	AD	?	0
6	70	Kemp-Larsen	1803-2044	0					0			
7	70	Rood-Patten	Approx. 1800-2100	0					1 2	AD AD	M F	 3-Yrlgs
8	76	McNay-Sandegren	1405-1515 1650-1750 1900-1950	0					0			
9	77	Rood-Patten	Approx. 1400-1700	1 1	(46) (22)	AD AD	M F	0 0	0			
10	69	McNay-Sandegren	1950-2120 2150-2305	0					1	AD	F	3-Cubs
TOTAL (total by sex-age)	719			3 (2 AD-M 1 AD-F)		AD		0	6 (3 AD-F 1 AD-M 2 AD-?)	AD		6 Young (3-cubs 3-Yrlgs)

Table 17. Summary of observations and survey effort during survey day number 3 (May 31, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer team	Time of survey	Marked bears observed					Unmarked bears observed			
No.	Size (mi^2)			No.	(ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	James-Sandegren	1655-1850	0					0			
2	78	McNay-Ayres	PM	0					0			
3	74	James-Sandegren	1935-2215	0					0			
4	71	Kemp-Roney	?-2100	1	(57)	AD	M	0	0			
5	72	James-Sandegren	1305-1322	1	(43)	AD	F	0	1	AD	F	0
			1342-1500						1	AD	?	0
			1625-1655									
6	70	McNay-Ayres	PM	0					0			
7	70	Schoen-Larsen	1310-1518	1	(63)	AD	F	2-Yrlg	0			
			1525-1556									
8	76	Schoen-Larsen	2045-2300	0					1	AD	M	0
		Kemp-Roney	PM						1	AD	F	0
9	77	Schoen-Larsen	1704-1954	0					0			
10	69	Kemp-Roney	-1500	0					1	AD	F	0
TOTAL	719			3		AD		2	5	AD		0
(total by sex-age)				(2 AD-M 1 AD-F)				(2-Yrlngs)	(3AD-F 1AD-M 1AD-?)			

Table 18. Summary of observations and survey effort during survey day number 4 (June 1, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer	Time of	Marked bears observed					Unmarked bears observed			
No.	Size (mi^2)	team	survey	No.	(ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	Machida-McNay	1655-1958	0					0			
2	78	Machida-McNay Reed-Patten	2045-2155 2100	0					0			
3	74	James-Villager	1100-1349 1430-1659 (Approx.)	0					0			
4	71	McNay-Machida	1230-1523	0					0			
5	72	Kemp-Roney	1626-1700 1730-1852	0					1	AD	F	0
6	70	Kemp-Roney	1210-1520	1	(58)	AD	F	3- 2 yr-olds	0			
7	70	James-Villager	1718-1909 1925-2031 (Approx.)	0					0			
8	76	Schoen-Karmun	1715-2040	0					0			
9	77	Rood-Patten	PM	0					0			
10	69	Schoen-Karmun	1245-1600	1 1	(41) (34)	AD AD	F M	0 0	0			
TOTAL (total by sex-age)	719			3 (1 AD-M 2 AD-F)		AD		3 (3-2.5 yr olds)	1 (1 AD-F)	AD		0

Table 19. Summary of observations and survey effort during survey day number 5 (June 2, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area No.	Count area Size (mi^2)	Pilot/Observer team	Time of survey	Marked bears observed No. (ID)	Marked Age	Marked Sex	Marked Young	Unmarked bears observed No.	Unmarked Age	Unmarked Sex	Unmarked Young
1	62	Coady-Nelson	1624-1815	1 (8)	AD	F	0	0			
2	78	James-Karmun	1200-1410	0				0			
3	74	Larsen-Ayres James-Karmun	PM 1800-1825 (Approx.)	0				0			
4	71	Larsen-Ayres	PM	2 (64/68)	AD	M	0	2	AD	F	0
5	72	Schoen-Machida	1200-1530 (Approx.)	2 (32/65)	AD	F	0	1	AD	?	0
6	70	James-Karmun	1500-1800 (Approx.)	0				0			
7	70	Schoen-Machida	PM	1 (63)	AD	F	2- Yrls	0			
8	76	Rood-Roney	1615-1830	0				0			
9	77	Rood-Roney James-Karmun Schoen-Machida	1931-2045 1830-2000 ?-1930	1 (22)	AD	F	0	1 1	AD AD	F M	0 0
10	69	Rood-Roney	1337-1530	1 (59)	AD	F	3-Cubs	0			
TOTAL (total by sex-age)	719			8 (6 AD-F 2 AD-M)	AD		5 (3-cubs 2-Yrls)	5 (3 AD-F 1 AD-M	AD		0 1 AD-?)

Table 20. Summary of observations and survey effort during survey day number 6 (June 3, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer team	Time of survey	Marked bears observed				Unmarked bears observed			
No.	Size (mi^2)			No. (ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	Machida-Larsen	1405-1630	1 (8)	AD	F	0	0			
2	78	Larsen-Machida	1025-1259	0				0			
3	74	Kemp-Patten	?	0				0			
4	71	McNay-Patten	?	0				0			
5	72	Kemp-Patten	?	1 (45)	AD	M	0	0			
6	70	James-Villager	1530-1715 1750-1900	0				0			
7	70	Rood-Ayres	1039-1305 1447-1508 1533-1608	2 (22,43) 2 (34,64)	AD AD	F M	0	0			
8	76	James-Villager	1020-1200 (-15) 1300-1435	2 (2,67)	AD	F	0	0			
9	77	McNay-Karmun	1105-1245 1640-2000	0				0			
10	69	Rood-Ayres	1619-1845	1 (20)	AD	F	0	0			
TOTAL	719			9	AD		0	0			
(total by sex-age)				(6 ADF) 3 AD-M)							

Table 21. Summary of observations and survey effort during survey day number 7 (June 4, 1987) of Noatak Grizzly Bear Census in northwest Alaska.

Count area		Pilot/Observer	Time of	Marked bears observed				Unmarked bears observed			
No.	Size (mi^2)	team	survey	No. (ID)	Age	Sex	Young	No.	Age	Sex	Young
1	62	Larsen-Roney	1600-1815	0				0			
2	78	Machida-Schoen	1000-1245	0				0			
3	74	McNay-Sandegren	1800-1845	0				0			
		Larsen-Roney	1930-2035								
4	71	Larsen-Roney	0945-1145	0				0			
			1230-1255								
			1525-1546								
5	72	McNay-Sandegren	1000-1025	1 (31)	AD	M	0	1	AD	M	0
			1100-1200								
			1240-1330								
			1455-1515								
			1720-1750								
6	70	Rood-Patten	Early PM	1 (32)	AD	F	0	0			
7	70	Schoen-Machida	1500-1715	1 (63)	AD	F	2-Yrls	0			
8	76	Kemp-Ayres	PM	1 (22)	AD	F	0	1	AD	F	0
				1 (34)	AD	M	0	1	AD	M	0
9	77	Rood-Patten	PM	2 (46,72)	AD	M	0	0			
10	69	Kemp-Ayres	PM	1 (59)	AD	F	3-cubs	1	AD	F	2-Yrls
TOTAL	719			8	AD		5	4	AD		2
total by sex-age)				(4 AD-M 4 AD-F)			(3-cubs 2 Yrls)	(2 AD-M 2 AD-F)			(2 Yrls

Table 22. Summary of presence or absence and sightability of individual radio-collared grizzly bears within the census study area near Red Dog Mine, Alaska from 29 May through 4 June 1987.

Bear ID	Sex	Age	Family status	Days 1	2	3	4	5	6	7
3	M	8.5	Alone	Out	Out	Out	Out	Out	Out	Out
10	M	12.5	Alone	Out	Out	Out	Out	Out	Out	Out
24	M	9.5	Alone	Out	Out	In	Out	Out	Out	Out
31	M	4.5	Alone						New	In[a]
34	M	6.5	Alone	In	In	In	In[a]	In	In[a]	In[a]
35	M	6.5	Alone	Out	Out	Out	Out	Out	Out	Out
40	M	8.5	Alone	Out	Out	Out	Out	Out	Out	Out
42	M	5.5	Alone	Out	Out	Out	Out	Out	Out	Out
45	M	9.5	Alone	In	In	In	In	In	In[a]	Out
46	M	9.5	Alone	In	In[a]	In	In	Out	Out	In[a]
50	M		Alone	Out	Out	Out	Out	Out	Out	Out
56	M		Alone	Out	Out	Out	Out	In	In	Out
57	M		Alone	New	In	In[a]	In	In	In	In
64	M		Alone		New	In	In[a]	In	In[a]	In
68	M		Alone			New	In	In		
72	M		Alone					New	In	In[a]
73	M		Alone							New
2	F	6.5	Alone	Out	Out	Out	Out	Out	In[a]	In
8	F	5.5	Alone	In	Out	Out	In	In	In	In
9	F	14.5	Alone	In	In	In	In	Out	Out	Out
20	F	6.5	Alone	Out	In	In	Out	Out	In[a]	Out
22	F	9.5	Alone	In	In[a]	In	In	In[a]	In[a]	In[a]
25	F	13.5	Alone	Out	Out	Out	Out	Out	Out	Out
32	F	4.5	Alone				New	In[a]	In	In[a]
39	F	9.5	Alone	Out	Out	Out	Out	Out	Out	Out
41	F	7.5	Alone	Out	Out	In	In[a]	In	Out	Out
43	F	18.5	Alone	In	In[a]	In[a]	Out	In	In[a]	In
51	F		Alone	Out	Out	Out	Out	Out	Out	Out
65	F		Alone			New	In	In[a]	Out	In
66	F		Alone			New	Out	Out	Out	In

Table 22. Continued

Bear ID	Sex	Age	Family status	Days 1	2	3	4	5	6	7
67	F		Alone			New	In	In	In[a]	In
69	F		Alone					New	In	In
70	F		Alone					New	In	In
71	F		Alone					New	In	In
74	F		Alone							New
21	F	13.5	w/4 cubs	Out	Out	Out	Out	Out	Out	Out
28	F	10.5	w/2 cubs	In	In	In	In	In	In	In
59	F		w/3 cubs		New	Out	In	In[a]	In	In[a]
1	F	6.5	w/2 yrls	Out	Out	Out	Out	Out	Out	Out
4	F	7.5	w/2 yrls	Out	Out	Out	Out	Out	Out	Out
14	F	10.5	w/1 yrl	Out	Out	Out	Out	Out	Out	Out
52	F		w/2 yrls	Out	Out	Out	Out	Out	Out	Out
53	F		w/1 yrl	New	In	In	In	In	Out	Out
55	F		w/3 yrls	Out	Out	Out	Out	Out	Out	Out
63	F		w/2 yrls		New	In[a]	In	In[a]	In	In[a]
58	F		w/3 2.5 yrls		New	In	In[a]	In	In	In

[a] Observed by search aircraft.

Table 23. Selected portions of a lotus worksheet summarizing daily sightability of radio-collared individuals, bear-days, population, and density estimates with their associated 80% confidence intervals for both adults (>3 yrs. age) and bears of all ages for a census within the Red Dog Mine Study Area of northwest Alaska from 29 May through 4 June 1987.

80% CI for adult bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	80% CI, bear-days N up.	80% CI, bear-days N low.	N up.	+% bears	80% CI, bears N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	8	0	9	89.0	89.0	ERR	35.4	ERR	ERR	35.4	60.2	ERR	1862	ERR	52.6
2 5/30/87	.300	18	3	18	89.3	44.6	285.7	53.9	142.9	220.1	26.9	39.6	115.9	1862	13.0	69.1
3 5/31/87	.231	31	6	26	122.4	40.8	246.0	83.7	82.0	101.0	27.9	31.6	54.1	1862	22.7	66.7
4 6/01/87	.176	48	9	30	150.9	37.7	252.6	111.1	63.2	67.4	27.8	26.4	35.4	1862	29.5	67.0
5 6/02/87	.444	66	17	43	162.8	32.6	224.5	130.7	44.9	37.9	26.1	19.7	18.8	1862	41.5	71.2
6 6/03/87	.450	86	26	52	169.8	28.3	213.4	144.1	35.6	25.7	24.0	15.1	11.6	1862	52.4	77.6
7 6/04/87	.400	106	34	64	197.7	28.2	247.7	176.1	35.4	25.3	25.2	10.9	10.2	1862	52.6	74.0

80% CI for total bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	80% CI, bear-days N up.	80% CI, bear-days N low.	N up.	+% bears	80% CI, bears N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	10	0	11	131.0	131.0	ERR	52.9	ERR	ERR	52.9	59.6	ERR	1862	ERR	35.2
2 5/30/87	.250	22	3	26	154.3	77.1	511.6	92.1	255.8	231.7	46.0	40.3	207.8	1862	7.3	40.5
3 5/31/87	.278	40	8	36	167.6	55.9	298.5	119.0	99.5	78.2	39.7	29.0	59.8	1862	18.7	46.9
4 6/01/87	.250	64	14	43	189.7	47.4	277.1	147.5	69.3	46.1	36.9	22.2	32.4	1862	26.9	50.5
5 6/02/87	.520	89	27	61	198.3	39.7	250.0	166.7	50.0	26.0	33.3	16.0	16.7	1862	37.2	55.9
6 6/03/87	.333	116	36	70	223.5	37.3	269.1	194.3	44.9	20.4	32.4	13.1	12.5	1862	41.5	57.5
7 6/04/87	.481	143	49	89	258.2	36.9	299.8	229.9	42.8	16.1	32.8	11.0	10.0	1862	43.5	56.7

Table 24. Selected portions of a lotus worksheet summarizing daily sightability of radio-collared individuals, bear-days, population, and density estimates with their associated 90% confidence intervals for both adults (>3 yrs. age) and bears of all ages for a census within the Red Dog Mine Study Area of northwest Alaska from 29 May through 4 June 1987.

90% CI for adult bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	90% CI, bear-days N up.	90% CI, bear-days N low.	90% CI, bears N up.	90% CI, bears +% bears	90% CI, bears N low.	90% CI, bears % bears	range	Density km²/bear area(km)	Density km²/bear Lower	Density km²/bear Upper
1 5/29/87	.000	8	0	9	89.0	89.0	ERR	28.3	ERR	ERR	28.3	68.2	ERR	1862	ERR	65.9
2 5/30/87	.300	18	3	18	89.3	44.6	383.0	47.7	191.5	329.1	23.9	46.5	167.6	1862	9.7	78.0
3 5/31/87	.231	31	6	26	122.4	40.8	292.5	76.5	97.5	138.9	25.5	37.5	72.0	1862	19.1	73.0
4 6/01/87	.176	48	9	30	151.0	37.7	289.2	103.2	72.3	91.6	25.8	31.6	46.5	1862	25.8	72.2
5 6/02/87	.444	66	17	43	162.8	32.6	244.4	124.1	48.9	50.2	24.8	23.8	24.1	1862	38.1	75.0
6 6/03/87	.450	86	26	52	169.8	28.3	226.9	138.5	37.8	33.7	23.1	18.4	14.7	1862	49.2	80.7
7 6/04/87	.400	106	34	64	197.7	28.2	261.1	169.9	37.3	32.1	24.3	14.1	13.0	1862	49.9	76.7

90% CI for total bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg # bears	90% CI, bear-days N up.	90% CI, bear-days N low.	90% CI, bears N up.	90% CI, bears +% bears	90% CI, bears N low.	90% CI, bears % bears	range	Density km²/bear area(km)	Density km²/bear Lower	Density km²/bear Upper
1 5/29/87	.000	10	0	11	131.0	131.0	ERR	42.0	ERR	ERR	42.0	67.9	ERR	1862	ERR	44.3
2 5/30/87	.250	22	3	26	154.3	77.1	880.0	80.9	440.0	470.5	40.4	47.6	399.6	1862	4.2	46.0
3 5/31/87	.278	40	8	36	167.6	55.9	396.0	109.6	132.0	136.4	36.5	34.6	95.5	1862	14.1	51.0
4 6/01/87	.250	64	14	43	189.7	47.4	335.1	138.8	83.8	76.7	34.7	26.8	49.1	1862	22.2	53.6
5 6/02/87	.520	89	27	61	198.3	39.7	281.6	160.1	56.3	42.0	32.0	19.3	24.3	1862	33.1	58.2
6 6/03/87	.333	116	36	70	223.5	37.3	295.9	187.7	49.3	32.4	31.3	16.0	18.0	1862	37.8	59.5
7 6/04/87	.481	143	49	89	258.2	36.9	324.3	223.1	46.3	25.6	31.9	13.6	14.5	1862	40.2	58.4

Table 25. Selected portions of a lotus worksheet summarizing daily sightability of radio-collared individuals, bear-days, population, and density estimates with their associated 95% confidence intervals for both adults (>3 yrs. age) and bears of all ages for a census within the Red Dog Mine Study Area of northwest Alaska from 29 May through 4 June 1987.

95% CI for adult bears

						N =	95% CI, bear-days				95% CI, bears			Density km²/bear		
Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	est. avg. # bears	N up.	N low.	N up.	+% bears	N low.	% bears	range	area(km)	Lower	Upper
1 5/29/87	.000	8	0	9	89.0	89.0	ERR	23.8	ERR	ERR	23.8	73.3	ERR	1862	ERR	78.2
2 5/30/87	.300	18	3	18	89.3	44.6	500.0	43.5	250.0	460.2	21.7	51.3	228.3	1862	7.4	85.7
3 5/31/87	.231	31	6	26	122.4	40.8	344.4	70.9	114.8	181.3	23.6	42.1	91.2	1862	16.2	78.7
4 6/01/87	.176	48	9	30	150.9	37.7	326.5	97.2	81.6	116.4	24.3	35.6	57.3	1862	22.8	76.7
5 6/02/87	.444	66	17	43	162.8	32.6	264.0	118.7	52.8	62.2	23.7	27.1	29.1	1862	35.3	78.4
6 6/03/87	.450	86	26	52	169.8	28.3	240.2	134.0	40.0	41.5	22.3	21.1	17.7	1862	46.5	83.4
7 6/04/87	.400	106	34	64	197.7	28.2	273.9	164.9	39.1	38.5	23.6	16.6	15.6	1862	47.6	79.1

95% CI for total bears

						N =	95% CI, bear-days				95% CI, bears			Density km²/bear		
Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	est. avg. # bears	N up.	N low.	N up.	+% bears	N low.	% bears	range	area(km)	Lower	Upper
1 5/29/87	.000	10	0	11	131.0	131.0	ERR	35.1	ERR	ERR	35.1	73.2	ERR	1862	ERR	53.1
2 5/30/87	.250	22	3	26	154.3	77.1	880.0	72.8	440.0	470.5	36.4	52.8	403.6	1862	4.2	51.1
3 5/31/87	.278	40	8	36	167.6	55.9	396.0	102.0	132.0	136.4	34.0	39.1	98.0	1862	14.1	54.7
4 6/01/87	.250	64	14	43	189.7	47.4	335.1	132.0	83.8	76.7	33.0	30.4	50.8	1862	22.2	56.4
5 6/02/87	.520	89	27	61	198.3	39.7	281.6	154.5	56.3	42.0	30.9	22.1	25.4	1862	33.1	60.3
6 6/03/87	.333	116	36	70	223.5	37.3	295.9	182.4	49.3	32.4	30.4	18.4	18.9	1862	37.8	61.3
7 6/04/87	.481	143	49	89	258.2	36.9	324.3	218.0	46.3	25.6	31.1	15.6	15.2	1862	40.2	59.8

Table 26. Selected portions of a lotus worksheet summarizing daily sightability of radio-collared individuals, bear-days, population, and density estimates with their associated 99% confidence intervals for both adults (>3 yrs. age) and bears of all ages for a census within the Red Dog Mine Study Area of northwest Alaska from 29 May through 4 June 1987.

99% CI for adult bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	99% CI, bear-days N up.	N low.	N up.	99% CI, bears +% bears	N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	8	0	9	89.0	89.0	ERR	18.0	ERR	ERR	18.0	79.8	ERR	1862	ERR	103.6
2 5/30/87	.300	18	3	18	89.3	44.6	900.0	36.9	450.0	908.4	18.4	58.7	431.6	1862	4.1	101.0
3 5/31/87	.231	31	6	26	122.4	40.8	484.4	62.2	161.5	295.6	20.8	49.2	140.7	1862	11.5	89.7
4 6/01/87	.176	48	9	30	150.9	37.7	421.1	87.3	105.3	179.0	21.8	42.2	83.4	1862	17.7	85.3
5 6/02/87	.444	66	17	43	162.8	32.6	309.9	109.6	62.0	90.4	21.9	32.7	40.0	1862	30.0	84.9
6 6/03/87	.450	86	26	52	169.8	28.3	269.6	126.3	44.9	58.8	21.0	25.6	23.9	1862	41.4	88.5
7 6/04/87	.400	106	34	64	197.7	28.2	302.9	156.3	43.3	53.2	22.3	20.9	20.9	1862	43.0	83.4

99% CI for total bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	99% CI, bear-days N up.	N low.	N up.	99% CI, bears +% bears	N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	10	0	11	131.0	131.0	ERR	26.2	ERR	ERR	26.2	80.0	ERR	1862	ERR	71.1
2 5/30/87	.250	22	3	26	154.3	77.1	1692.3	60.8	846.2	997.1	30.4	60.6	815.8	1862	2.2	61.3
3 5/31/87	.278	40	8	36	167.6	55.9	526.3	90.1	175.4	214.1	30.0	46.2	145.4	1862	10.6	62.0
4 6/01/87	.250	64	14	43	189.7	47.4	405.1	120.1	101.3	113.6	30.0	36.7	71.2	1862	18.4	62.0
5 6/02/87	.520	89	27	61	198.3	39.7	316.7	145.0	63.3	59.7	29.0	26.9	34.3	1862	29.4	64.2
6 6/03/87	.333	116	36	70	223.5	37.3	324.9	173.1	54.2	45.4	28.9	22.5	25.3	1862	34.4	64.5
7 6/04/87	.481	143	49	89	258.2	36.9	348.8	208.5	49.8	35.1	29.8	19.3	20.0	1862	37.4	62.5

Table 27. Selected portions of a lotus worksheet summarizing daily sightability of radio-collared individuals, bear-days, population, and density estimates with their associated 95% confidence intervals for both adults (>3 yrs. age) and bears of all ages for a census within the Red Dog Mine Study Area of northwest Alaska from 29 May through 4 June 1987.

No new bears captured-95% CI for adult bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	95% CI, bear-days N up.	N low.	95% CI, bears N up.	+% bears	N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	8	0	9	89.0	89.0	ERR	43.2	ERR	ERR	43.2	51.4	ERR	1862	ERR	43.1
2 5/30/87	.375	16	3	18	79.8	39.9	444.4	38.6	222.2	457.3	19.3	51.5	202.9	1862	8.4	96.4
3 5/31/87	.100	26	4	26	144.8	48.3	590.9	74.5	197.0	308.1	24.8	48.6	172.1	1862	9.5	75.0
4 6/01/87	.250	34	6	30	154.0	38.5	441.6	88.1	110.4	186.7	22.0	42.8	88.4	1862	16.9	84.6
5 6/02/87	.286	41	8	43	204.3	40.9	488.1	122.8	97.6	138.9	24.6	39.9	73.1	1862	19.1	75.8
6 6/03/87	.875	49	15	52	164.6	27.4	286.6	113.7	47.8	74.1	18.9	30.9	28.8	1862	39.0	98.3
7 6/04/87	.429	56	18	64	194.0	27.7	318.2	137.3	45.5	64.0	19.6	29.3	25.8	1862	41.0	95.0

No new bears captured-95% CI for total bears

Date	Sight.	Cum. n_1	Cum. m_2	Cum. n_2	Estimated tot. days	N = est. avg. # bears	95% CI, bear-days N up.	N low.	95% CI, bears N up.	+% bears	N low.	% bears	range	Density km²/bear area(km)	Lower	Upper
1 5/29/87	.000	10	0	11	131.0	131.00	ERR	35.1	ERR	ERR	35.1	73.2	ERR	1862	ERR	53.1
2 5/30/87	.300	20	3	26	140.8	70.4	800.0	66.2	400.0	468.4	33.1	53.0	366.9	1862	4.7	56.2
3 5/31/87	.083	32	4	36	243.2	81.1	1032.3	122.6	344.1	324.5	40.9	49.6	303.2	1862	5.4	45.7
4 6/01/87	.200	42	6	43	269.3	67.3	792.5	150.5	198.1	194.3	37.6	44.1	160.5	1862	9.4	49.5
5 6/02/87	.222	51	8	61	357.2	71.4	879.3	210.7	175.9	146.2	42.1	41.0	133.7	1862	10.6	44.2
6 6/03/87	.700	61	15	70	274.1	45.7	488.0	185.4	81.3	78.0	30.9	32.4	50.4	1862	22.9	60.3
7 6/04/87	.333	70	18	89	335.3	47.9	560.0	232.6	80.0	67.0	33.2	30.7	46.8	1862	23.3	56.0

Table 28. Summary of actual and projected costs for censusing grizzly bears within the Red Dog Mine census area of northwest Alaska from 29 May through 4 June 1987.

Expense	Rate	Hours	Government costs	Capture costs	Projects costs at commercial rates: rate	Projects costs at commercial rates: costs
Helicopter						
	$678/day + 177/hr	42.1 25.4 (commute)	$16,685.	$16,685.	$395/hr	$26,662.
Fuel			3,100.	3,100.		
SUBTOTAL			19,785.	19,785.		
Fixed-Wing						
PA-18 - State lease	71/hr	75	5,376.		135/hr	10,125.
C-185 - State lease	84/hr	96	8,022.		180/hr	17,280.
PA-18 - State	--	70			135/hr	9,450.
PA-12 - State	--	70			135/hr	9,450.
Arctic Tern - NPS	48/hr	50	2,400.		135/hr	6,750.
PA-18 - (NW Aviation)	135/hr	52	7,060.	2,025.	135/hr	7,060.
SUBTOTAL			22,858.	2,025.		60,115.
Radio-Collars	$340.	25	$8,500.	$8,500.		$8,500.
Drugs			1,500.	1,500.		1,500.
Fuel			5,390.			5,390.
Travel			2,166.			2,166.
Groceries			2,320.			2,320.
Lodging			440.			440.
Maps			441.			441.
Miscellaneous - Darting/other equipment			1,313.	650.		1,313.
SUBTOTAL			22,070.	10,650.		22,070.
TOTALS			$64,713.	$32,460.		$108,847.

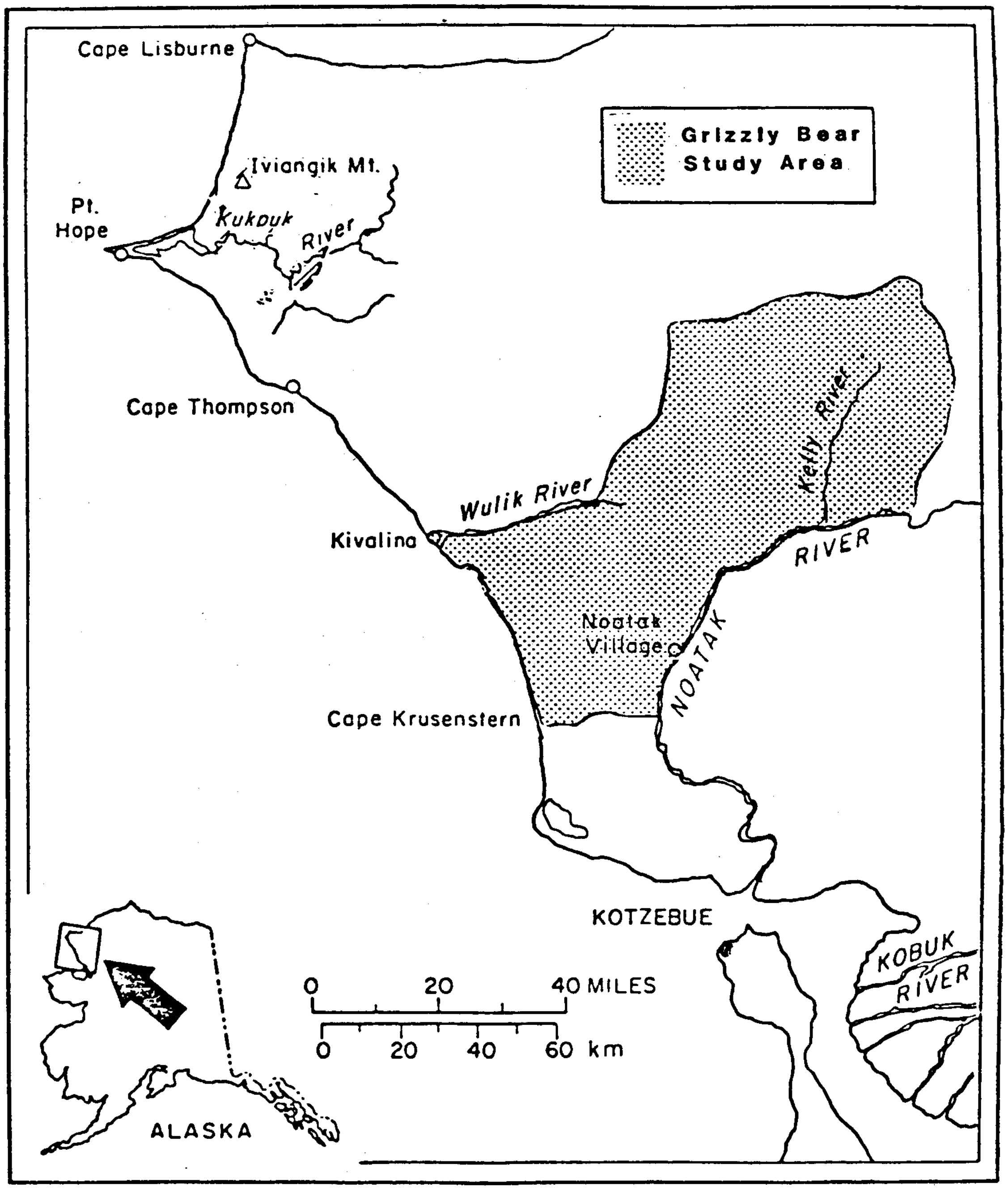

Fig. 1. Location and boundaries of grizzly bear study area in GMU 23 during 1986.

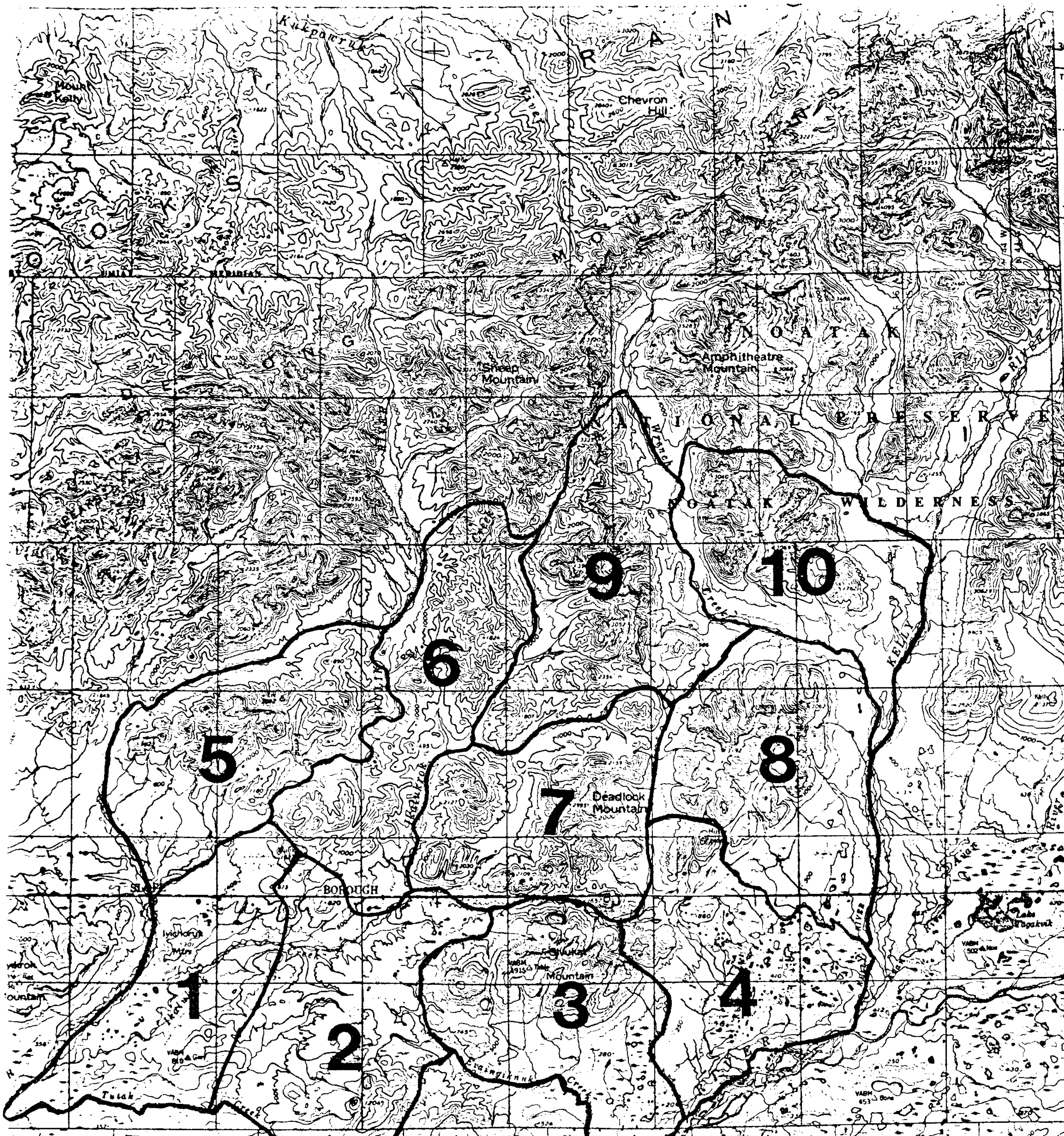

Fig. 2. Location and boundaries of Count Areas used to census grizzly bears within the Red Dog mine census area during 29 May through 4 June 1987.

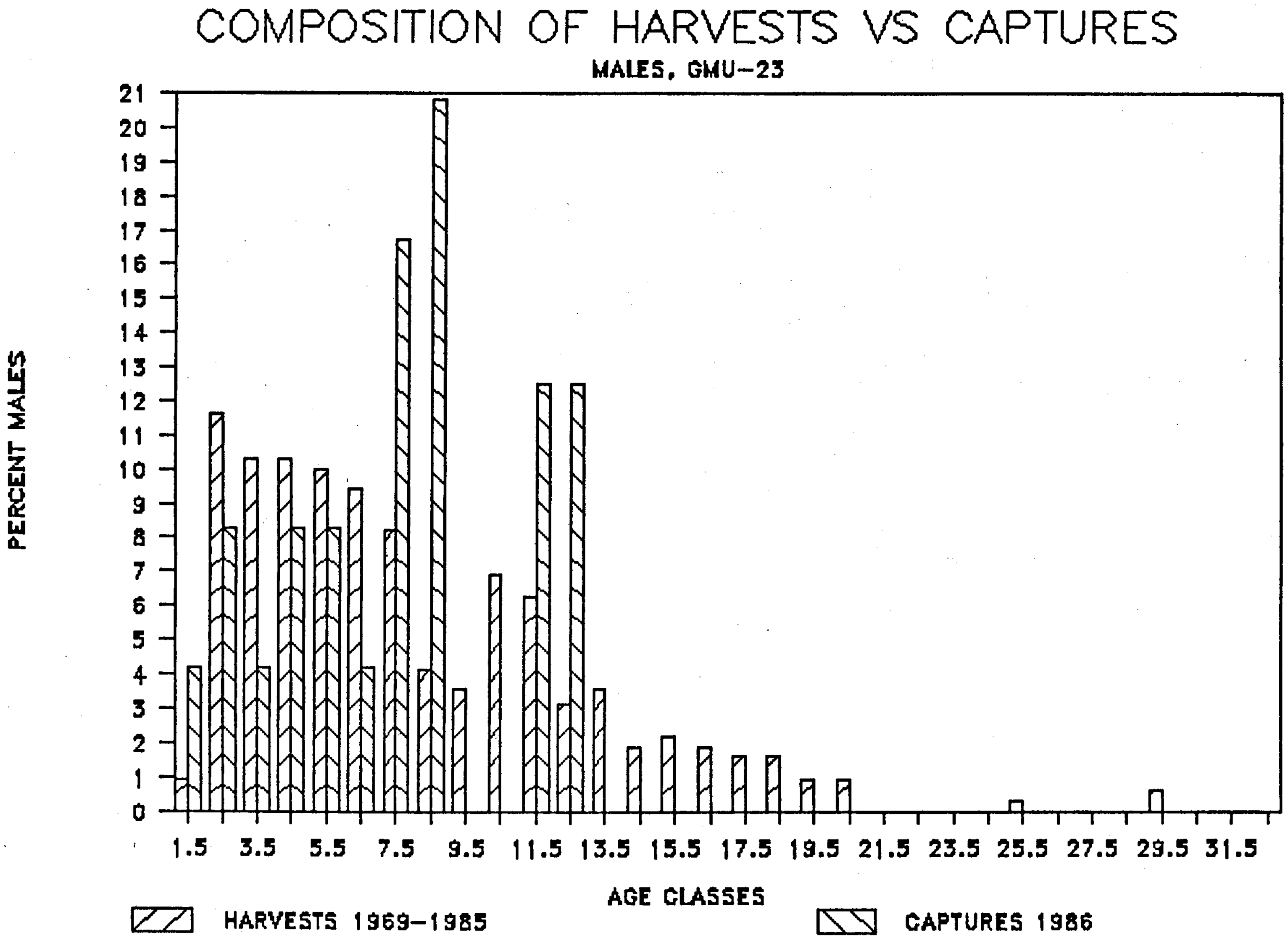

Fig. 3. Age structure of the harvest of male grizzly bears from 1969 through 1985 in comparison to the age structure of males captured within the Noatak River Study Area during 1986 in GMU 23 of northwest Alaska.

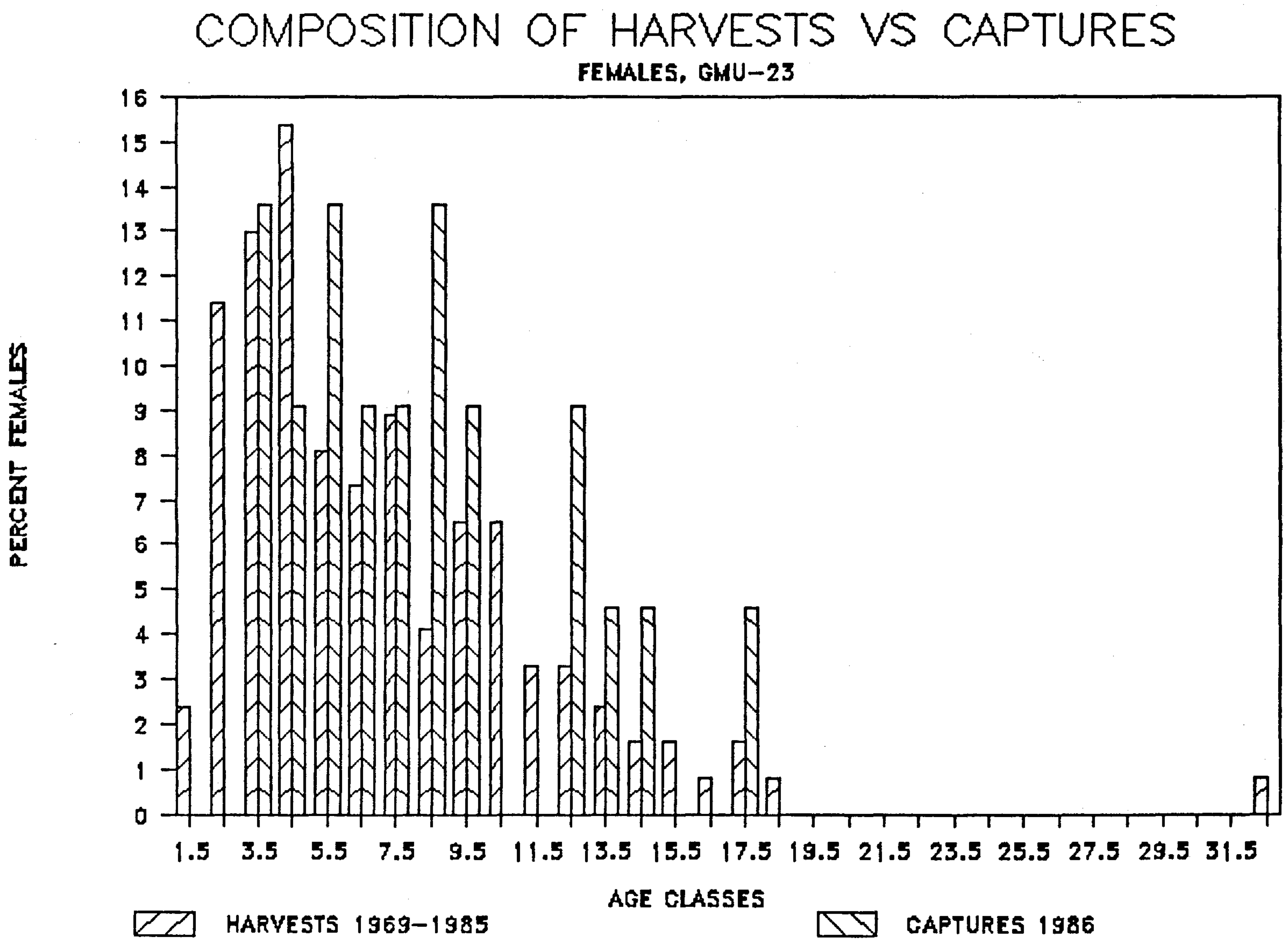

Fig. 4. Age structure of the harvest of female grizzly bears from 1969 through 1985 in comparison to the age structure of females captured within the Noatak River Study Area during 1986 in GMU 23 of northwest Alaska.

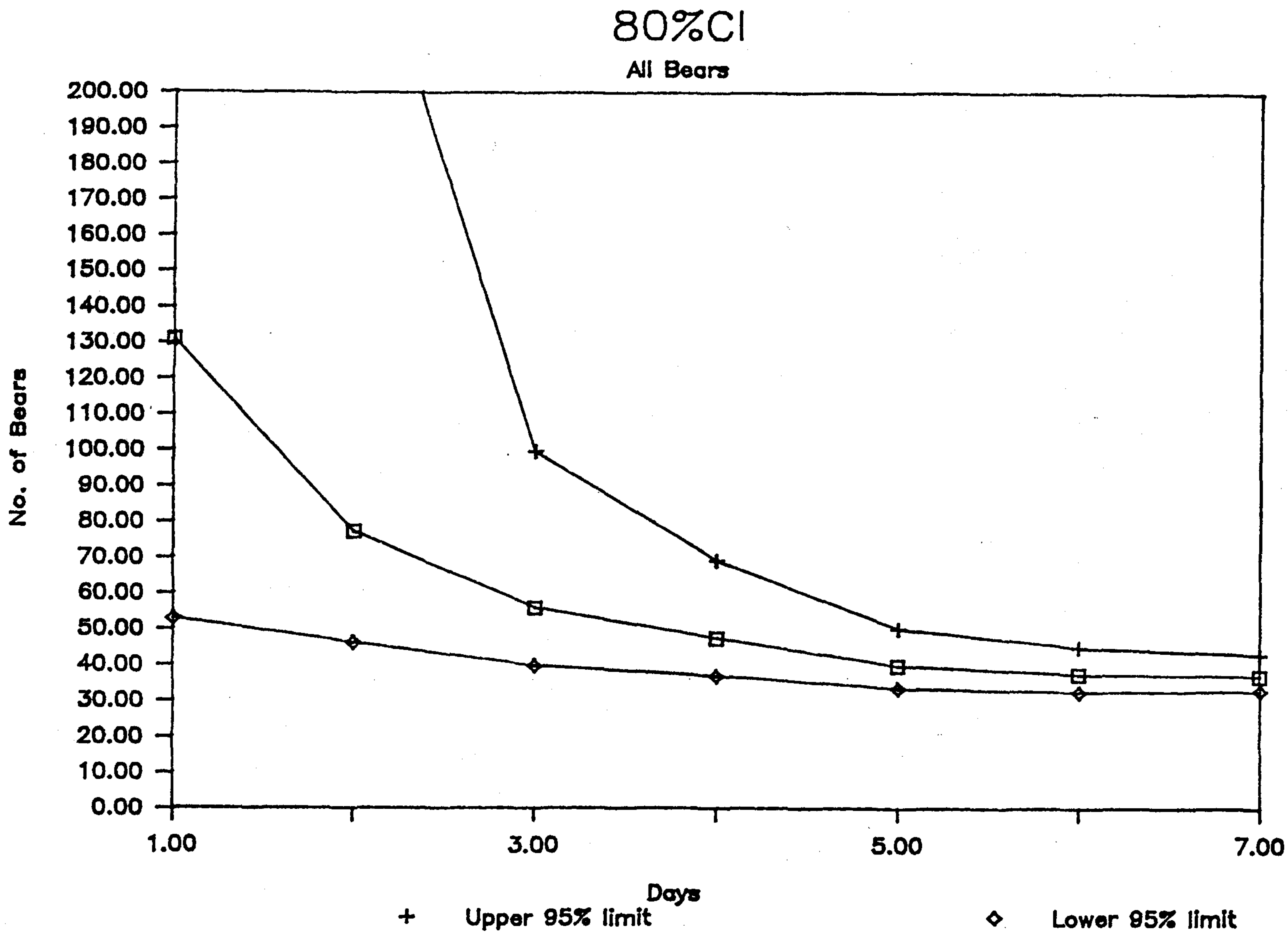

Fig. 5. Changes in population estimates of grizzly bears of all ages, and 80% confidence intervals over time for the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

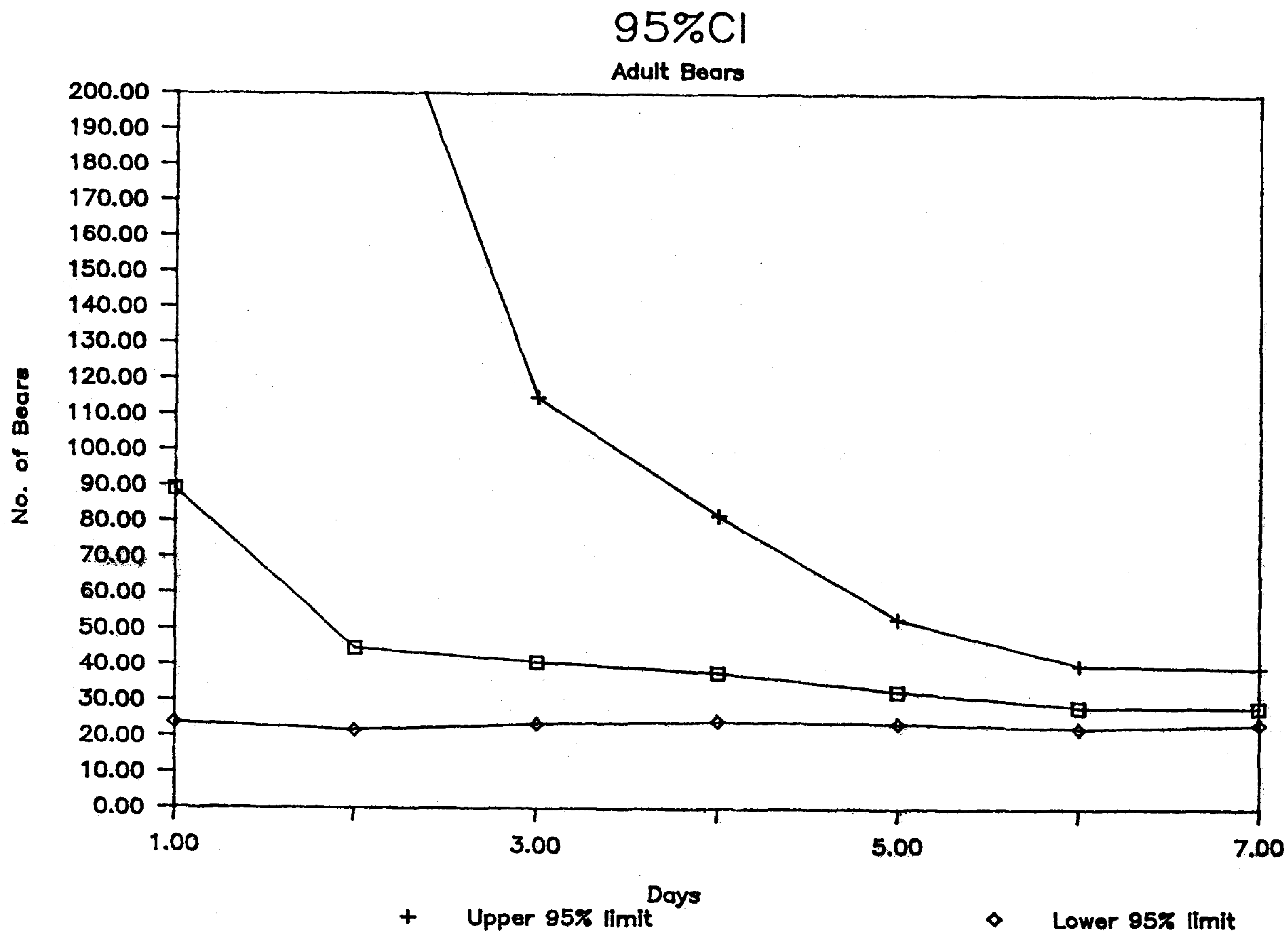

Fig. 6. Changes in population estimates of adult (> 3 yrs. old) grizzly bears and 95% confidence intervals over time for the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

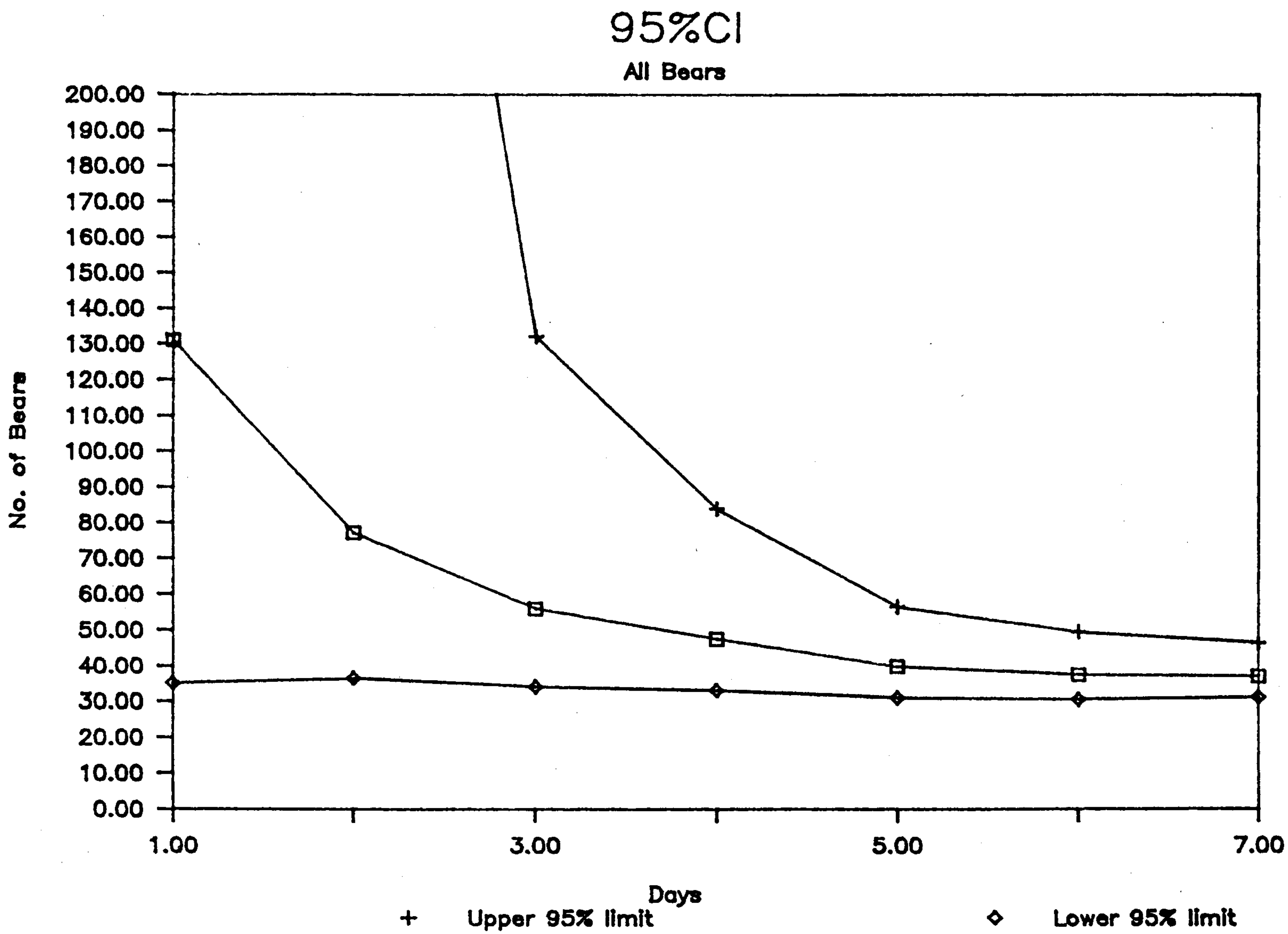

Fig. 7. Changes in population estimates of grizzly bears of all ages and 95% confidence intervals over time for the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

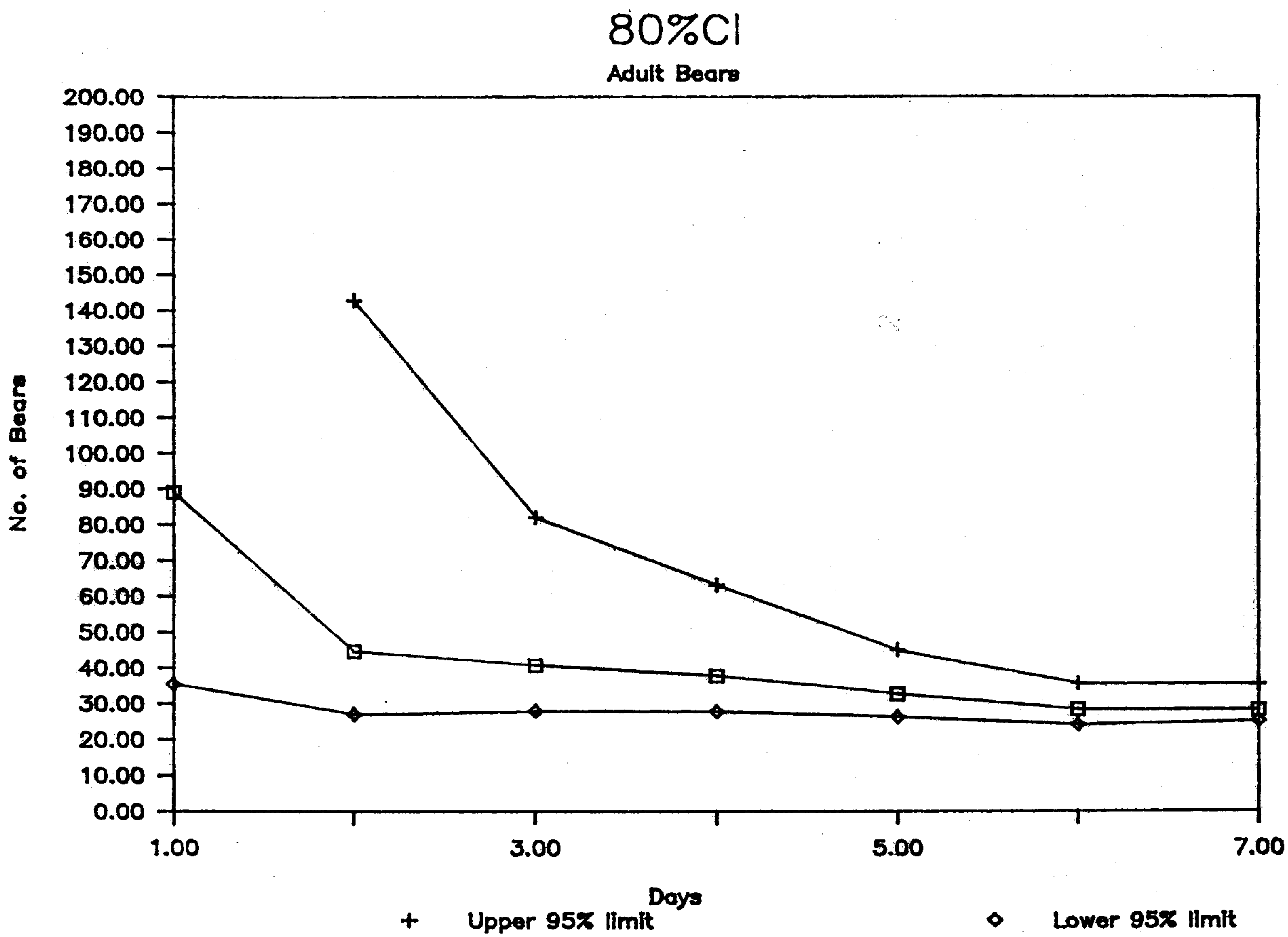

Fig. 8. Changes in population estimates of adult (> 3 yr. olds) grizzly bears and 80% confidence intervals over time for the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

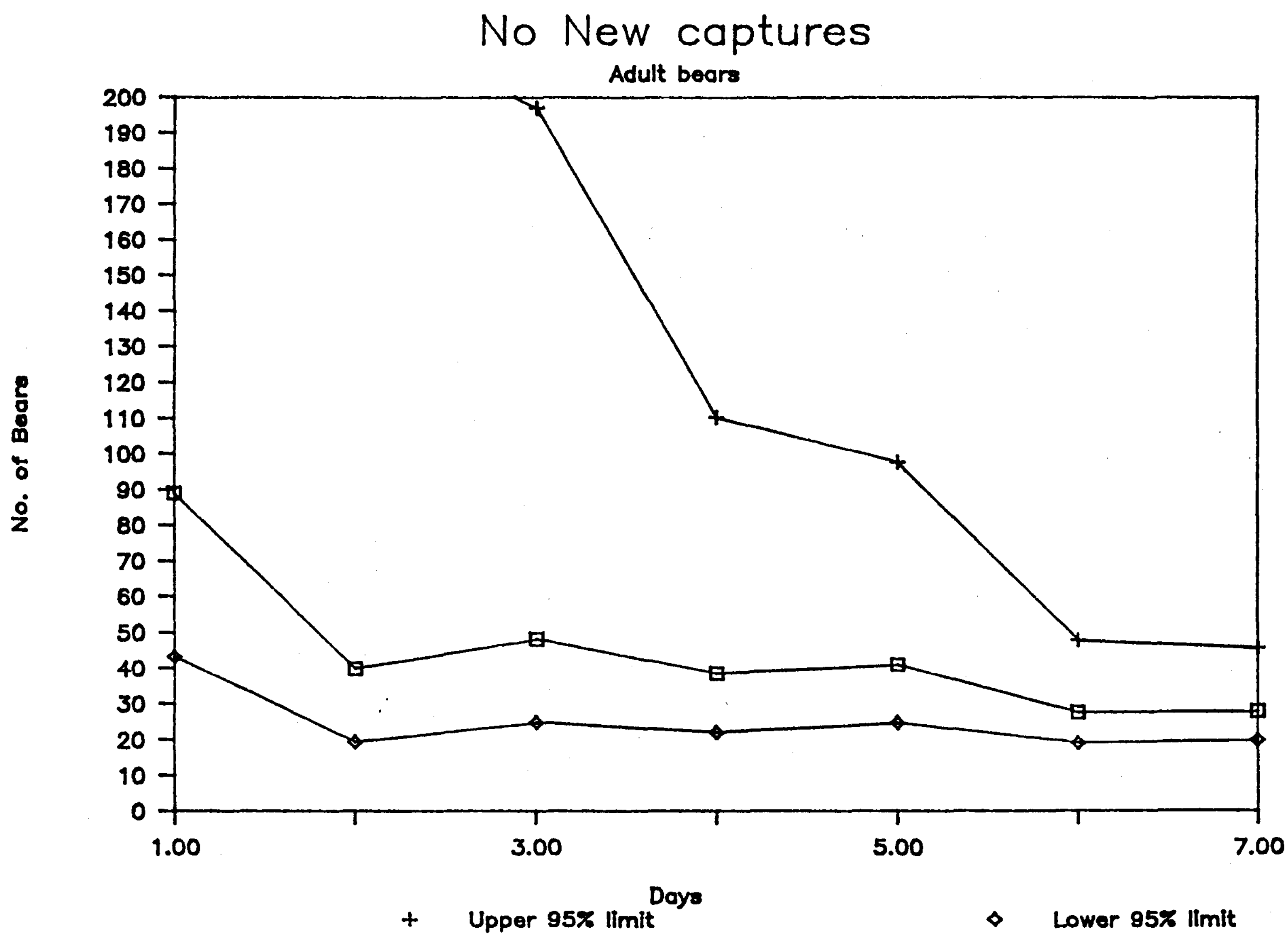

Fig. 9. Changes in population estimates of adult (> 3 yr. olds) grizzly bears and 95% confidence intervals over time had no new bears been captured and marked as part of the census of the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

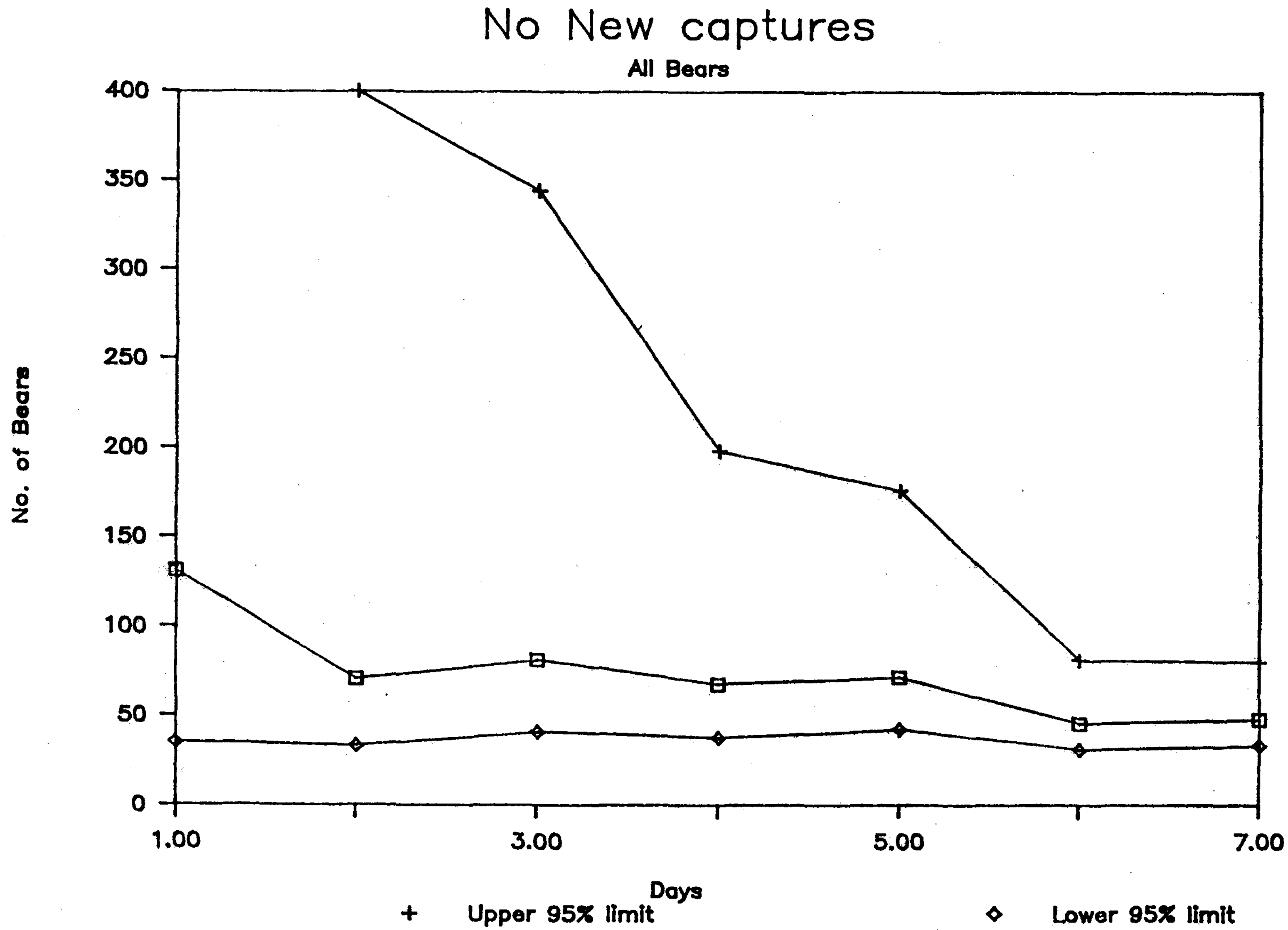

Fig. 10. Changes in population estimates of grizzly bears of all ages and 95% confidence intervals over time had no new bears been captured and marked as part of the census of the Red Dog Mine Study Area in GMU 23 of northwest Alaska in 1987.

Appendix A. Copy of a manuscript concerning predation on moose by grizzly bears presented at the XVIII Congress of the International Union of Game Biologists meeting in Krakow, Poland.

BROWN AND BLACK BEAR PREDATION ON MOOSE IN SOUTHCENTRAL ALASKA

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ABSTRACT: Causes of moose (*Alces alces*) calf mortality were studied during 1984 in an area where brown bear (*Ursus arctos*), black bear (*Ursus americanus*), and gray wolf (*Canis lupus*) populations were sympatric. Predation by brown bears was the greatest cause of mortality. Brown bears averaged 1 calf and 1 adult moose kill/11.7 and 43.7 bear-days, respectively, during late May-late June, while black bears averaged 1 calf moose kill/40 bear-days during the same period. No adult moose were killed by black bears. There were no statistically significant differences in predation rates among sexes, ages, or family

classes of either brown or black bears. Predation rates were highly variable among individual bears.

INTRODUCTION

Predation by brown and black bears has recently been identified as an important cause of ungulate mortality in many areas of North America (Schlegel 1976, Franzmann et al. 1980, Ballard et al. 1981). This is particularly true for moose (Ballard and Larsen 1987, Ballard and Miller 1987). Franzmann et al. (1980) determined that black bears were responsible for 59% of calf moose mortalities on the Kenai Peninsula, Alaska. Ballard et al. (1981) determined that brown bears in southcentral Alaska were responsible for 79% of calf moose mortalities and were an important predator of adult moose. In both studies, the most numerous of the two bear species was responsible for most of the calf moose mortality. Based on these and subsequent studies, we hypothesized that the most numerous predator species would account for the greatest proportion of calf moose mortality.

Other than the estimate provided by Ballard et al. (1981) based on 1 year's data, no estimates of rates of predation by either brown or black bears on ungulates exist in the literature. This paper reports on causes of moose calf mortality and rates of predation on moose during late spring and summer in areas where brown and black bears occur sympatrically in southcentral Alaska.

STUDY AREA

Brown bear predation rates studies and moose calf mortality studies were conducted in 4 areas and black bear studies in 1 area of the upper and middle Susitna River basins of southcentral Alaska. The 1984 calf moose mortality study was conducted in a 1,325 km^2 area where brown bear, black bear, and wolves were sympatric. Boundaries, vegetation, topography, and weather have been previously described (Ballard et al. 1981, Miller 1985). The areas contained the following densities of predators: wolf-2.8/1,000 km^2, brown bear-28/1,000 km^2, and black bear-90/1,000 km^2 (Miller et al. 1986, Ballard et al. 1987; unpubl. data). Caribou (Rangifer tarandus) were available in low numbers as alternate prey but only 1 kill was observed during the study. Of the 1,325 km^2 area where bear densities were studied, 532 km^2 (40%) was classified as black bear habitat. All moose calves were captured within or close to the black bear habitat. Although the average black bear density within the classified black bear habitat was estimated at 90/1,000 km^2, actual density was probably less in terms of distribution of radio-collared moose calves. Black bear densities were greater in forested habitats along the river where relatively few calves were captured in comparison to forest edges where most calves were captured. Regardless, black bear density was at least 1.5-2 times higher than density of brown bears.

METHODS

Equipment and procedures used to determine causes of moose calf mortality in 1984 have been described by Ballard et al. (1979, 1981). Only calves that bonded with the cow following capture were included in calculations. Densities of brown and black bears were estimated using mark-recapture methods described by Miller et al. (1986). Wolf densities were determined by methods described by Ballard et al. (1987).

During late May and June of 1978, 1981, and 1984, an attempt was made to observe radio-collared brown and black bears once daily (usually twice daily during first 2 weeks of 1978 and 1984) from fixed-wing aircraft to determine if they had killed a calf or adult moose. Data used for calculation of predation rates in 1978 (Ballard et al. 1981) were included in these analyses. Black bear predation rates were studied only in 1981 and 1984. Black bear were rare or absent in the 1977 and 1978 moose calf study areas.

During 1984, the same bears monitored during spring were tracked daily between 23 July and 1 August to examine summer predation rates. Individual radio-collared bears observed on ungulate carcasses were assumed to have made the kill unless the carcass exhibited characteristics typical of other causes of death (Stephenson and Johnson 1973, Ballard et al. 1979) or other bears or gray wolves were observed. When more than 1 predator was present, the kill was counted as a partial kill by each predator unless the individual or species which had made the kill could be determined. Although calf kills were not examined in situ, examinations of radio-collared calf moose carcasses revealed predation by brown bears was responsible for 65 to 79% of the deaths (Ballard et al. 1981; this study).

Starvation mortalities of adult moose could have been misidentified from aircraft and kills could have been made by other predators. To the degree this applied, data on cause of death of adult moose are biased in that they overestimate actual kill rates. All wolf packs were monitored on the same flights made for bears and over half of the individuals within those packs were radio-collared. Wolf kills of adult moose were known, which removed wolf predation as an important source of bias (Ballard et al. 1987, unpubl. data). Although ungulates thought to have died from causes other than bear predation were excluded from predation rate calculations, we could not state with 100% certainty that some kills were not scavenged. Bears were considered present on a kill only if they were observed on the carcass or located in close proximity (< 1 km).

Ages of radio-collared bears were estimated by tooth cementum annuli similar to methods described by Mundy and Fuller (1964). Bears were considered sexually mature if 5 years old (Ballard et al. 1982). Only offspring 1.0 year-old are termed "cubs."

Predation rate (i.e., moose killed/bear-day) is defined as the number of days between new kills. Predation rates were calculated separately for calf and adult moose because of differences in length of time bears remained with carcasses. Because bears can kill and consume a calf moose in 25 minutes and generally remain on calf moose kills less than the time between two daily flights (approximately 12 hours), daily flights would underestimate the number of calf moose kills. Bears were not located or observed during each flight due to inclement weather, overstory vegetation, or loss of radio contact. Predation rates on calf moose were calculated by summing the number of days each bear was observed divided by the total number of calf kills and expressed as 1 kill/no. of bear-days. These rates are considered to be minimum estimates of predation on calf moose.

Fuller and Keith (1980) demonstrated that wolf predation rates were overestimated when based on numbers of observation days separated by periods of no contact. This was because wolves remained on kills 1 day, so the probability of detecting a kill based on sporadic monitoring was greater than the actual predation rate. This problem was also true for adult moose killed by bears, and preliminary results reported by Ballard et al. (1981) overestimated the predation rates on adult moose. To reduce this bias, this analysis included only days and adult moose kills that were preceded by 1 day of observation when no kill had been made. When daily monitoring was interrupted for intervals 1 day, the first day observations resumed and any kill observed were excluded. When bears were radio-located but not visually observed for 1 day between visuals, that single day was included in calculations for adult moose because a kill would have been confirmed the following day when visually observed. Days in which bears were located but not observed 1 day between visual observations were excluded.

Differences in rates of bear predation among years, sexes, ages, and family classes were tested by Student's *t*-test (Cochran 1977). Unless stated otherwise differences were not considered significantly different if $P > 0.05$.

RESULTS AND DISCUSSION

Causes of Calf Moose Mortality

Between 25 May and 1 June 1984, 45 moose calves ranging in age from 1-10 days were captured and radio-collared. Only 18% of the radio-collared calves survived from birth to early November. Brown bears killed 53% (*N* = 24) of the calves, while black bears and wolves killed 9 (*N* = 4) and 7% (*N* = 3) of the calves, respectively. Other natural mortality factors such as drownings and coyote (*Canis latrans*) predation accounted for approximately 13% (*N* = 6) of the mortalities. Mortality from all causes was 82%.

Most moose calf mortality occurrs during the 6 weeks following birth (Ballard et al. 1981). Predation accounted for 86% of all mortalities in 1977, 1978, and 1984, with brown bears accounting for 65% of all mortalities in 1984 and 79% of all mortalities in 1977 and 1978. The calves studied in 1977 and 1978 were collared in areas where black bears were rare or absent. Thus, despite being less dense than black bears in 1984, brown bears were the most important cause of calf moose mortality. Black bears were the second most important cause of mortality, followed by wolf predation.

Based on this study, we conclude that the causes of calf moose mortality were not directly proportional to the relative densities of the three predator species. Brown bears appear to prey on moose calves more frequently than do black bears or wolves. Where brown bears are substantially less dense than black bears, such as on the Kenai Peninsula, Alaska (Franzmann et al. 1980), black bears can be frequent predators on calf moose or other ungulates. Elsewhere, wolves can be significant predators on moose calves (Gasaway et al. 1983) but their importance relative to varying levels of bear predation warrants further investigation.

Brown Bear Predation Rates

Forty-four adult radio-collared brown bears were monitored from fixed-wing aircraft either once or twice daily during late May-late June

1978, 1981, and 1984. They were visually observed on 921 (82%) of 1,121 relocations. The 44 bears were observed on 64.5 calf moose kills during 756 bear-days of monitoring and 13 adult moose kills during 590 bear-days of monitoring. Because some carcasses were buried or in a position that could not be adequately examined from fixed-wing aircraft, moose age or ungulate species of an additional 20 kills could not be identified. Overall, adult brown bears preyed on calf and adult moose at rates of 1 kill/11.7 and 43.7 bear-days, respectively.

Male brown bears preyed on calf and adult moose during late May-late June at rates of 1 kill/13.6 and 1 kill/45.3 bear-days, respectively (Table 1). Large differences existed in average predation rates by male bears among study years, sexes and age classes, but these differences were not significant, apparently due to large variability in predation rates among individual bears. Predation rates by individual male bears ranged from 0 kills to 1 kill/5.7 bear-days (Fig. 1), and on adult moose from 0 kills (18 bear-days) to 1 kill/4.0 bear-days (4 bear-days).

We recorded greater predation rates on calf and adult moose by female brown bears (Table 2) than male bears, but these differences were not significant. Females accompanied by offspring 1 year-old also appeared to have greater predation rates on calf moose than single females, but again these differences were not significant. Similar to males, lack of significant differences among all ages and family classes appeared to be due to large variability among individual bears (Fig. 1). Predation rates of individual females with offspring 1 year old ranged from 1 calf moose/3.8-21 bear-days, and on adult moose from 0 kills (23 bear-days) to 1/24 bear-days. Predation rates of single female bears ranged from 0 calf or adult moose kills (0/26 bear-days) to 1/2.8 and 1/9 bear-days, respectively (Fig. 1). Twenty unidentified kills added as either calf or adult moose did not change the outcome of the statistical comparisons for either male or female bears.

Sample sizes of females with cubs were too small for comparisons with other family groups in these studies. However, they appeared to have the lowest predation rate of any of the sex or family groups based on total numbers of visual sightings and numbers of kills observed over an 8-year period (Miller 1987). Because moose parturition occurs at relatively low elevations and females with cubs occupy relatively high elevations for 3-8 week periods after emergence from dens, the two groups are geographically separated.

During late July and early August 1984, 9 of 16 brown bears monitored during spring, plus 8 additional adults, not monitored during that period, were located daily to estimate summer predation rates. Based on numbers of kills observed and bear-days monitored in spring, these 17 bears would have been expected to kill 5 calves and 1.2 adult moose during 52 bear-days of monitoring in mid-summer, if we assume equal prey availability between the two periods. Only 1 moose kill of unidentified age was observed, but the bears were only visually sighted on 44% (71 of 161) of the relocations. Regardless, these data are consistent with the chronology of radio-collared calf mortalities we recorded previously (Ballard et al. 1981): predation by brown bears on calf moose appears to decline substantially after mid-July of each year. Predation rates on adult moose probably also decline after spring-early summer. Boertje et al. (1987) reported a decline in predation rates by brown bears from spring to summer.

The length of time brown bears remained at kill sites was highly variable. The minimum period individual bears remained at calf moose kills ranged from 0.4-38.6 hours (N = 9 kills, X = 13.2 hrs., SE = 3.8). The latter average estimate was biased in favor of bears which remained on kills for 12-hour periods. When we made two flights per day, we found that bears remained on 88% of the calf moose kills (N = 32 kills) less than 12 hours. On a daily basis brown bears remained on calf kills an average of 1.1 days (N = 48 kills, SE = 0.06).

Minimum length of time brown bears remained on adult moose kills averaged 66 hours (N = 12 kills, SE = 12.5 hours, range 7.9-141.2 hours). On a daily basis these bears remained on adult moose kills a minimum of 1-7 days, averaging 2.8 days (N = 18 kills , SE = 0.49 days). Reasons for the relatively short time spent at adult moose carcasses are unknown, but some of the kills were probably usurped by other bears. Because bears remain on adult moose kills 1 day, predation rates based on periodic relocation of radioed bears would tend to overestimate predation rates (Fuller and Keith 1980). Consequently, brown bear predation rates reported by Ballard et al. (1981) based on observation days, overestimated the kill rates of adult moose. Large variation among individual bears prevents development of a correction factor for periodic relocation as proposed by Fuller and Keith (1980) for wolves.

Moose calves are born, and most mortalities occur, from mid-May through mid-July. Adult brown bears killed an average of 5.3 moose calves and 1.4 adult moose during this 60-day period. Estimated predation rates on calf moose were lower than those reported by Boertje et al. (1987) during late spring-early summer for interior Alaska, (1 calf moose kill/8.6 bear-days). However, predation rates on adult moose during late spring were similar between the two studies. Autumn moose densities were about 90% lower in interior Alaska than the estimates developed in this study. Also, the Boertje et al. spring study only extended to 10 June, a period in our study when about half of the calf moose mortality had occurred. We recalculated our calf predation rates to correspond with their earlier time period, but the adjusted rates (1 kill/12.2 days) remained lower than their reported rate.

Black Bear Predation Rates

Radio-collared black bears (7 males, 5 single females, and 5 females with young) were monitored once or twice daily in conjunction with brown bears in late May-late June 1981 and 1984 to determine predation rates. During this period black bears were observed on 79% (452 of 573) of the relocations. Sample sizes were too small to test for differences in predation rates among ages or family classes. None of the radio-collared bears were observed on fresh carcasses of adult moose. Male black bears were monitored for 151 bear-days and were observed on 6 calf moose carcasses for an average predation rate of 1 kill/25.2 bear days (SE = 12.7). Females with cubs were monitored 92 bear-days and 0 kills observed; single females were observed on 3 calf moose kills during 120 bear-days ($\underline{X}$ = 1 calf moose/40 bear-days, SE = 16.5). There were no significant differences in rates of predation on calf moose between male (1 kill/25 bear-days) and female (1 kill/70 bear-days, SE = 35.4) black bears. Similar to brown bears, individual black bears exhibited highly variable predation rates, ranging from 0 kills (0/20-29 bear-days) for most bears (53%) to 1 calf moose kill/5.7 bear-days (3 in 17 bear-days). Overall predation rates by adult black bears on calf moose averaged 1/40 bear-days.

Thirteen of 17 black bears monitored in spring 1984 plus 3 others not monitored in the spring were relocated several days in late July and early August to determine summer predation rates on moose. Observability of radio-collared bears averaged 71% (59 of 83 relocations). No kills of either calf or adult moose were observed during 59 and 38 bear-days, respectively. Similar to brown bears a much lower number of kills (2.3 calves and 0 adult moose) was expected during this time period based on number of kills and days monitored in spring. Rates of predation on calf moose by black bears appeared to decline after mid-July in part due to fewer calves being available as prey. During either season, black bears appear to kill few adult moose.

Black bears were observed remaining with calf moose carcasses an average of 16.8 hours (N = 4 kills, SE = 1.5 hours). Similar to brown bears the figure was biased in favor of bears which remained with kills for relatively long periods. On a daily basis they remained on calf moose kills an average of 1.3 days (N = 8 kills, SE = 0.16 hours). When we monitored black bears twice daily we found the bears remained on 71% of the calf moose kills (N = 7 kills) less than 12 hours.

SUMMARY AND CONCLUSIONS

In a sympatric black and brown bear population where black bear were more numerous than brown bears, brown bears were the largest cause of moose calf mortality. Predation rates by brown bears on calf and adult moose during late spring-early summer averaged 1 kill/11.7 and 1 kill/43.7 bear-days, respectively. Black bears did not prey on adult moose, and their rates of predation on calf moose were substantially less (1 kill/40 bear-days) than those of brown bears. Large variability in kill rates of individual bears of both species was responsible for not detecting significant differences in predation rates by sex, age, or family class. This variability suggests that efforts by managers to increase ungulate survival rates by reducing particular classes of bear (based on sex, age, or family status) is a very imprecise tool for obtaining those objectives. Classes based on family status would be especially imprecise as the same adults would be in different classes in different years.

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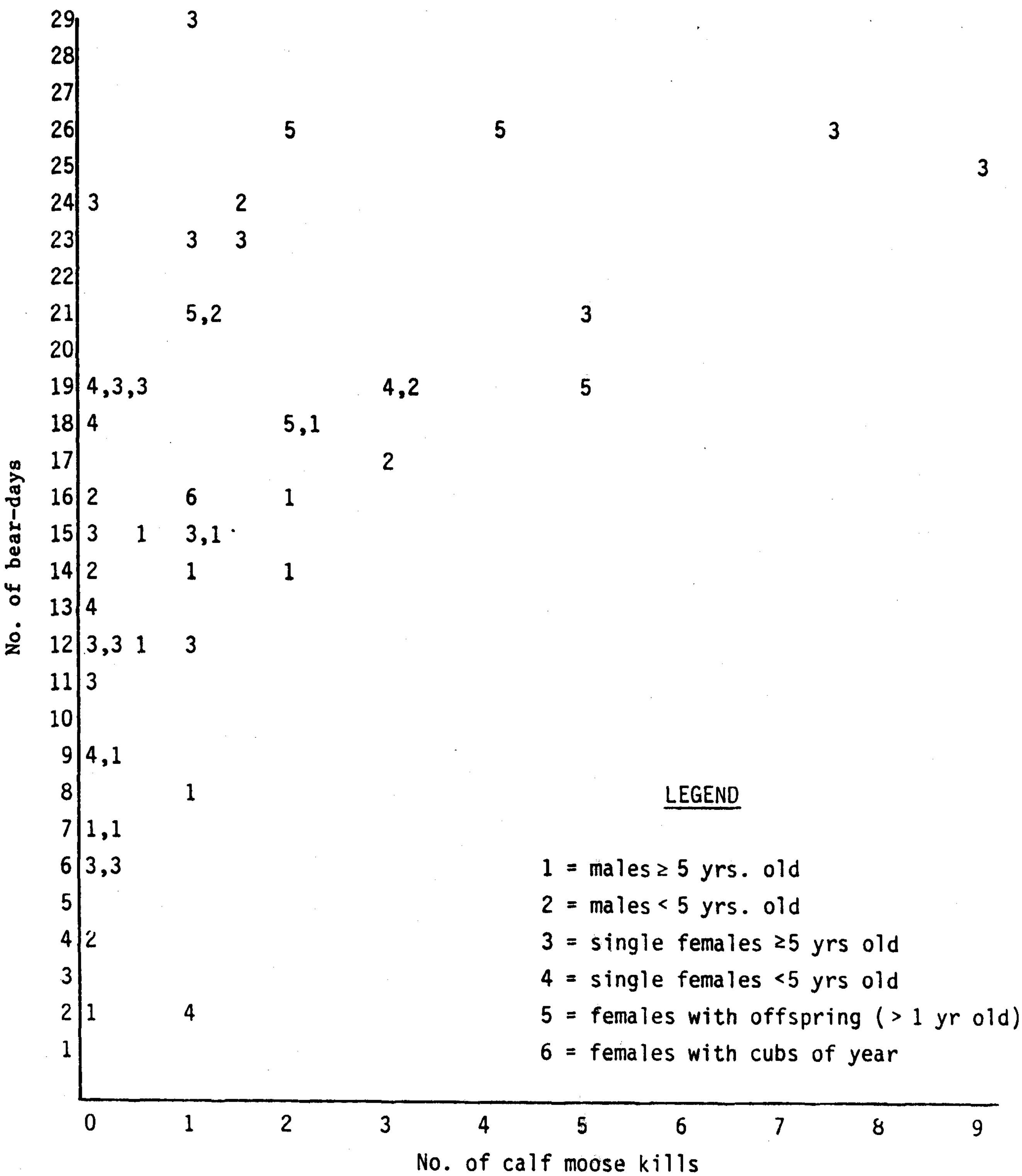

Fig. 1. Number of calf moose kills per number of bear-days monitored for individual adult radio-collared brown bears during late May-late June 1978, 1981 and 1984 in southcentral Alaska.

Table 1. Numbers and rates of calf and adult moose killed by radio-collared male brown bears (>2 yrs age) from approximately 24 May through 30 June 1978, 1981, and 1984 in southcentral Alaska.

				Calf moose[a]			Adult moose[a]		
Age (yrs)	Family status	Year monitored	No. bears	No. killed[b]	No. bear-days monitored	Bear-days/ kill (SE)	No. killed[b]	No. bear-days monitored	Bear-days kill (SE)
5	Alone	1978	6	3.5	52	14.9 (5.9)	1.5	29	19.3 (14.0)
		1981	1	0	9	0 (0.0)	0	2	0 (0.0)
		1984	5	6.5	76	11.7 (2.5)	0	59	0 (0.0)
		Subtotal	12	10.0	137	13.7 (2.8)	1.5	90	60.0 (46.4)
5	Alone	1978	5	4.5	75	16.7 (9.8)	2.5	58	23.2 (6.5)
		1984	2	4.0	40	10.0 (5.5)	0	33	0 (0.0)
		Subtotal	7	8.5	115	13.5 (7.7)	2.5	91	36.4 (16.4)
		Total males	19	18.5	252	13.6 (2.7)	4.0	181	45.3 (5.4)

[a] Prey totals do not include 9 unidentified ungulates which could be either calf or adult moose.

[b] Kills counted as half kill if more than 1 predator was present.

Table 2. Numbers and rates of calf and adult moose killed by radio-collared female brown bears (> 2 yrs age) from approximately 24 May through 1 July 1978, 1981, and 1984 in southcentral Alaska.

				Calf moose[a]			Adult moose[a]		
Age (yrs)	Family status	Year monitored	No. bears	No. killed[b]	No. bear-days monitored	Bear-days/ kill (SE)	No. killed[b]	No. bear-days monitored	Bear-days kill (SE)
5	With cubs	1978	1	1.0	16	16.0 (0.0)	0	10	0 (0.0)
		Subtotal	1	1.0	16	16.0 (0.0)	0	10	0 (0.0)
5	With yrls. or 2-yr. olds	1978	3	8.0	58	7.3 (3.4)	1.0	46	46.0 (43.7)
		1984	2	6.0	52	8.7 (2.9)	1.0	47	47.0 (46.0)
		Subtotal	5	14.0	110	7.9 (4.7)	2.0	93	46.5 (27.0)
5	Alone	1978	6	16.5	107	6.5 (2.8)	3.5	90	25.7 (11.0)
		1981	4	0	43	0 (0.0)	0	25	0 (0.0)
		1984	7	10.5	148	14.1 (9.0)	3.0	129	43.0 (26.4)
		Subtotal	17	27.0	298	11.0 (4.3)	6.5	244	37.5 (13.9)
5	Alone	1978	3	1.0	30	30.0 (42.9)	1.0	24	24.0 (30.0)
		1981	3	3.0	50	16.7 (15.6)	0	38	0 (0.0)
		Subtotal	6	4.0	80	20.0 (14.9)	1.0	62	62.0 (66.6)
		Totals	29	46.0	504	11.0 (3.1)	9.5	409	43.1 (13.0)

[a] Prey totals do not include following = 2 moose of unidentified age and 9 unidentified ungulates of which 2 were possible kills, all of which could either be calf or adult moose.

[b] Kills counted as half kills if more than 1 predator was present.

Appendix B. Copy of Memorandum distributed to census participants prior to initiation of census on 29 May 1987 near the Red Dog Mine in northwest Alaska.

Bear Census Participants

May 18, 1987

Warren Ballard
Game Biologist
Division of Game
Nome

GUIDELINES FOR NOATAK
GRIZZLY BEAR CENSUS
Spring 1987

Participants: L. Ayres, W. Ballard, J. Coady, D. James, D. Larsen, S. Machida, M. McNay, R. Nelson, NPS Pilot, S. Patten, D. Reed, P. Willams (Helicopter), K. Roney, F. Sandegren, J. Schoen.

A total of 6 fixed-wing aircraft and 1 helicopter will be used for the census. Five aircraft will be used as search aircraft while one will be used for radio-tracking and watching bears for immobilization that have been spotted by search aircraft. Activities by type of aircraft are as follows:

(1) Search Aircraft -

Each search aircraft will be assigned quadrats to be searched daily for bears. We will attempt to search adjacent quadrats in rotation. Each plane will spend 8 hours/day searching, half in morning and half in evening. We will spend 1.5-3.5 minutes/mi^2. The lower search effort will be used in flat open areas while the upper limit will be used in mountainous or spruce covered areas. Each aircraft will be equipped with antennas and receiving equipment.

When bears are spotted by the search aircraft the observer will scan all frequencies of radio-collared bears to determine if the bear has been previously radio-collared. If it has a functioning collar this will be recorded and the location plotted in standard fashion and the search will continue. These bears are our <u>marked</u> portion of the sample. When a bear that has no active radio-collar or has not been captured and visually marked earlier in the census period is spotted, the helicopter will be called in and this bear captured and marked in standard fashion. If the helicopter is busy and the spotter will need to circle the bear for a long time (over 15 minutes) until it becomes available, this spotter should call in the radio-tracking plane to watch the bear so the spotter can go back on search. Time spent circling a bear should be subtracted from search effort time. The spotter should obtain the bear ID from the helicopter crew so that he can keep his records straight. These are NEW CAPTURES. If the bear is not captured be sure to record this as well. Spotter planes will be assigned adjacent quadrats to search to avoid long commuter flights by the helicopter. If they get on a hot track they don't need to stay in the quadrat but time over 15 minutes spent in the "wrong" quadrat should be credited to the correct quadrat. Alert other aircraft when you are out of quadrat or switching quadrats for safety. Obviously be careful on borders between quadrats. Biologists in the spotter planes will be switched regularly and rotated with the crews in the helicopter. Do not capture bears out of the search area. If you see these record them but be sure to indicate that they are not in the borders of the search area. If a bear moves from in to out of the search area, capture him.

Do not make an intentional effort to resight all marked bears seen earlier (previous day, for example) by going back to look for him in the same spot. THIS IS IMPORTANT. You can and should look in all spots where there are likely to be unmarked bears but do not make any additional effort to spot a marked bear based on your previous knowledge of where that bear might be.

Cover the entire search area each day, a portion of it by each search plane. Each search plane should alternate areas searched on alternate days--take turns searching different areas.

(2) Radio-tracking plan (C-185-Coady-Nelson):

The primary purpose of the radio-tracking plane (C-185) will be to document the degree of closure of the search area. Marked bears that are outside of the search area during 30% of radio-locations made by this plane, for example, will be counted as 0.7 marked bears in the calculations. This eliminates the need to correct the area of the search area for periphery effect.

Radio-tracking will be done daily, excluding weather days when the spotters are not working. A secondary objective will be to determine rate of predation and scavenging by bears on ungulates.

This plane, when not radio-tracking, will stand-by where it can respond to the needs of the spotter planes to have someone watch a bear until the chopper can get there. This is a priority activity over radio-tracking since they can always go back to radio-tracking after the bear is captured.

This crew will be quiet about any bears they observe when radio-tracking, marked or unmarked. The spotter planes, if it sees this plane circling will not alter the search pattern based on this sighting. To assure this and for safety, this plane will attempt most of its radio-tracking at times or in areas that are not being actively searched by spotter planes. The tracking plane will periodically broadcast its location when flying at the same time as the spotter planes. If practical I would like to keep the same pilot-biologist crew as the radio-tracking team.

(3) Helicopter - Chopper Crew:

The capture crew in the helicopter will be rotated daily except for 1 biologist who will remain as a permanent member. Mark all bears captured. White for females, red for males.

When you get a bear down, check first to see if it has been previously marked (tattoos, eartags). If you can't read the tattoo determine the ID by the eartag number (scan this column in the capture records table in your tagging kit).

Get information on excitability of bear prior to capture from spotter plane. Record how long it was under observation prior to darting and whether it was active during this period. Also how much you harassed it from the chopper.

High priority items on downed bears are sex, tooth, and marks. Measurements and blood can be neglected if you are needed on another bear. Take photos of teeth of all bears when practical (except newborn cubs). Bear ID and date should be in the photo and give me these slides.

Follow standard safety procedures when approaching bear, two people together, one with rifle, not in single file. Please review CPR.

BROWN BEAR TAGGING PROCEDURES

Approaching the Bear

1. Be sure bear is down before landing near it. If bear can still lift head or exhibits any mobility, it isn't safe to approach.

2. ALWAYS assume that the bear may recover its FULL MOBILITY at ANYTIME during the operation.

3. Team member with rifle should approach the bear first. Rifle should be ready to fire, but all rules of firearms safety must be observed. A CLEAR LINE OF FIRE SHOULD BE MAINTAINED between team members and the bear.

4. Shout, clap hands, etc., and watch for signs of awareness in bear as you approach. Toss rocks, sticks, etc., at bears to checks its reaction.

5. If bear appears immobile but is still able to lift its head, wait a few more minutes before approaching again.

6. A supplemental dose of drug should be administered IM if the bear continues to show some signs of awareness.

   One team member should have rifle trained on bear while this procedure is done.

Processing the Bear

1. Remove dart from bear; check for complete injection, removing tailpiece first with dart held in safe direction. Place dart in plastic bottle.

   Inject antibiotic in wound.

2. Be EXTREMELY CAUTIOUS in removing the dart taking care not to nick yourself with the needle which may still contain drug or the internal charge may still be "live".

3. Immediately begin monitoring TEMPERATURE, RESPIRATION and PULSE RATE of the bear. This should be done continuously during the tagging process.

4. If the bear begins to show serious signs of stress such as: a) RAPID, SHALLOW BREATHING/or DEPRESSED RESPIRATION (fewer than 2/min); b) ERRATIC PULSE: c) RISING TEMPERATURE (above 105°F should cause concern), the operation should be closely monitored, and if appropriate, the antagonist (M 50/50) administered. (If the basal area of the tongue turns blue, it's a good indication that respiration is inadequate and bear should be revived.) In the case of excessive temperature, placement of snow on pads and under arm pits will quickly reduce it. If snow not available cold water helps.

5. Verify sex and reproductive condition of bear and record.

6. Attach radio collar and record serial number, frequency, and collar circumference. BE SURE MAGNET HAS BEEN REMOVED!!!! Attachment of radio-collar is highest priority - all other items secondary.

7. Pull both first lower premolars and place in separate envelopes labeled with bear number. If only one or none available take uppers. Be sure to record on envelope which tooth is pulled. When pulling teeth be careful not to gouge the root. The elevator should not be in that area anyway.

8. Punch holes in ears and inject Betadine.

9. Attach numbered Duflex eartags (ORANGE/males, WHITE/females) noting numbers. Keep hair clean of holes when attaching tags, clipping hair if necessary.

10. Apply tattoos as follows:

    Lower lip: Wipe lips dry before applying tattoos. Use punch tattoo with top of number toward inner gum line. Rub ink in well with thumb and apply more ink if necessary.

    Upper lips: Top of number toward inner gum line. Wipe lips (not your's Nelson, the bear's!!!) frequently to check tattoo quality. Use plenty of ink.

11. Take measurements in following order of priority: skull length and width, heart girth, total length, neck, teeth.

12. Draw blood from femoral vein: two (2) heparinized vacutainers 1/4-1/5 full (green cap); three to five (3-5) plain vacutainers 3/4 full (red cap). Place all vacutainers in a whirl-pak labeled with bear number. Try not to aggitate blood. Put in back of helicopter.

13. Inject bear with 5 cc Flocillin or bicillin (deep IM, rump).

14. Re-check tagging form to assure that all information has been recorded.

15. If appropriate, prepare syringe with antagonist (dose equal to amount M-99).

16. Double-check to see that: MAGNET IS OFF, THERMOMETER IS OUT, and all items are packed in tagging kit.

17. Take weight.

    THE TAGGING FORM IS THE RESPONSIBILITY OF THE TEAM LEADER (Help him remember it!!!)

Leaving the Scene

1. Move tagging gear to helicopter landing site and signal helicopter; RIFLE STAYS WITH TEAM MEMBER CLOSEST TO BEAR!

2. Load tagging gear into helicopter.

3. If appropriate, inject antagonist into bear. Intramuscular (IM) injection into rump is preferred. Intravenous (IU) injection should be used only if a bear is experiencing serious stress and must be gotten up immediately. USE EXTREME CAUTION with IV injection as the bear may come up within a few seconds. If a bear is severely stressed or may have received a double dose (dart bounced off or lost and amount injected unknown).

4. For a sow with cubs, the cubs should be gotten up before the sow and left laying up against the sow in most cases.

5. Mentally note the TIME OF INJECTION (record when aboard helicopter) and return to the helicopter.

6. Don't climb into the helicopter with a cocked and loaded rifle. Take time to clear the round from the chamber. BE SURE!!!

7. Move to a location where bear can be observed safely and note time of recovery.

Safety Notes:

The safety of the bear is SECOND only to the safety of the tagging crew. If at any stage the bear appears to be coming out of anesthesia, cut the operation short, administer the antagonist and retreat.

If the bear becomes too severely stressed, terminate the operation, administer the antagonist and retreat.

Firearms Handling:

NEVER point dartguns or other firearms at another person. That means the muzzle should never be aligned even momentarily with any part of the human anatomy, yours or someone elses.

In the helicopter guns should be transported with muzzles pointed at floor.

NEVER close breech on loaded dart gun until muzzle is pointed in a safe direction OUTSIDE the helicopter.

Photographs:

Photos should be taken throughout the tagging operation when convenient.

WILDLIFE RESTORATION

Federal Aid Project

funded by your purchase of
hunting equipment

DEMOGRAPHY OF NOATAK GRIZZLY BEARS IN RELATION TO HUMAN EXPLOITATION AND M
DEVELOPMENT