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Demography of Noatak Grizzly Bears in Relation to Human Exploitation and Mining Development

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SUMMARY

During 1986 through 1990, 146 grizzly bears were permanently marked with tattoos and ear tags; 67 were radio collared within or adjacent to the 6,700-km^2 Noatak River Study Area. Sex ratios of captured bears were not significantly different from 50:50. Average litter size at first observation was 2.17 (n = 35). Age of first reproduction ranged from 5 to 9 years of age. Fifty percent of first litters occurred at 5 years of age. Seventy-seven percent of the litters were weaned as 2.5-year-olds. Average interval between weaning was 3.92 years. Relationships between sex and age and numerous physical measurements were examined to determine if age and sex could be estimated from measurements. Although all of the measurements were significantly correlated ($P < 0.05$) with age, variances were so large that age estimates overlapped many age classes.

Sixty-seven radio-collared bears were relocated from fixed-wing aircraft on 1,625 occasions. Sows with COY occupied higher elevation sites than other sex and age classes. Movements of bears were described. Use of slopes, aspects, and habitat types varied by sex and age class. Sows with COY used steep slopes more than other sex and family groups. Home range sizes of males and females averaged 1,437 km^2 and 993 Km^2, respectively. Adult bears had high fidelity to the same area for denning, but the same dens were not used because they collapsed each spring.

Six adult female bears were equipped with satellite transmitters in 1988. Error associated with relocations provided by the satellite transmitters averaged 1,110 m. Average error varied by transmitter, ranging from 664 to 2,221 m. During 1988 the 6 transmitters provided 1,865 relocations. Use of the mine garbage dump was documented with the transmitters. One year of data from satellite transmitters provided estimates of movements and home range sizes equivalent to that acquired over a 3- to 5-year period with conventional methods. All 6 transmitters prematurely failed after one season.

An intensive mark-recapture census of grizzly bears was conducted in 1987. Densities of adults (>3 years old) and bears of all ages were estimated at 1/67 km^2 and 1/50 km^2, respectively. The estimates were representative of high-quality denning habitat and not year-round habitat, whose densities were much lower.

Age structure of harvested bears in relation to those captured during 1986 through 1990 indicated that the standing population of males was more skewed towards younger age classes, suggesting that the population was being heavily harvested. In contrast, the female age structure was similar between harvested and captured sows. Annual survival rates of COY and yearlings averaged 0.874 and 0.887, respectively. Adult (>5 years old) survival rates of radio collared males and females averaged 0.906 and 0.940, respectively. If 8 missing females were shot and not reported, average adult female survival rates could be as low as 0.879. A large portion of the subsistence harvest (i.e., equally or exceeding the sport harvest) is not reported; effectively negating the usefulness of attempting to determine the status of the bear population by analyzing harvest data.

Annual harvest rates were estimated by extrapolating density estimates to a larger study area and comparing the population estimate with known and suspected harvests. Assuming a stable bear population, annual harvest rates ranged from 3.7% to 15.7% of the population from 1983 to 1989. Based on reported estimates of productivity and mortality, population modeling suggested a sustainable harvest of about 8%; whereas, the literature suggested sustainable rates ranging from 2% to 6% annually. The bear population may be overexploited at existing harvest levels.

Subsistence users have requested that hunting regulations be changed to accommodate their traditional practices and values. Some changes in regulations may be possible, if harvest reporting were greatly improved; however, the bear population is being harvested at or above sustained-yield levels and harvests can not be increased without causing a population decline. Potential changes in regulations are discussed, and recommendations for continuation of the study in relation to mining development and harvest assessment are made.

Key Words: grizzly bear, *Ursus arctos*, harvest rates, density, population estimates, mining development, subsistence, productivity, mortality, satellite telemetry.

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. Historically, managers have primarily relied on gross analysis of harvest data and miscellaneous observations to assess bear population trends and harvest effects; however, the basis for use of harvest statistics for monitoring population status is not well documented and appears to be imprecise and unreliable (Harris 1984, Harris and Metzgar 1987*a*, 1987*b*). In areas where unreported harvests are potentially large, reported harvests may not adequately represent trends in total mortality; consequently, problems associated with analysis of harvest data for assessing population trend may be insurmountable. Fortunately, bear populations appear healthy and abundant in many areas of Alaska (Peterson 1987). If the status quo is to be maintained, however, appropriate methods must be developed and tested so that managers can accurately identify and remedy population declines as well as allow opportunities for additional harvest.

Increasing human populations have significantly reduced the abundance and distribution of grizzly bears in North America (Cowan 1972). Although abundance and distribution of bears in

Alaska have changed little from historical times, significant changes in the environment could permanently alter the productivity and survival of some populations. Current understanding of the effects of resource development activities on grizzly bear population dynamics is considered inadequate for providing effective guidelines to agencies and private companies for minimizing and mitigating impacts to bear populations. This inadequacy exists because such impacts are usually long term, research is usually of short duration, and many impacts have occurred relatively recently (Peek et al. 1987).

The present study was conceived because of conflicting testimony received from the public concerning bear abundance and potential adverse impacts from development and operation of the Red Dog Mine in Northwest Alaska. Background for the study was provided by Ballard (1987). Briefly, this study was designed to evaluate effects of human harvests by comparing bear densities with known reported harvests and provide baseline data on population density, sex and age structure, movements, and reproductive parameters prior to large-scale development of the Red Dog Mine. Actual impacts from the mine and other associated developments were to be assessed at a later date by repeating the study using identical methods. Obtaining an accurate and precise estimate of the bear density in the potential impact area was a high priority and key objective of this research effort.

OBJECTIVES

Overall objectives of this study are to estimate density, sex and age structure, movements, and reproductive parameters of a grizzly bear population in the southwest Brooks Range. The original study design was provided by Ballard (1987). During 1988 this study was modified to include the following objectives:

To estimate reproductive and mortality rates of grizzly bears within a selected study area in and adjacent to the Noatak National Preserve.

To determine daily and seasonal-use patterns of adult grizzly bears in relation to development of the Red Dog Mine.

To determine short-term changes in behavior and habitat use of bears as a result of development and operation of the Red Dog Mine and associated roads.

To compare the utility of conventional telemetry with satellite telemetry for determining seasonal habitat use and home range sizes.

STUDY AREA

During 1986 through 1990 we studied demography and movements of grizzly bears in a 2,600-mi^2 (6,700 km^2) area that encompassed the Red Dog Mine Project (Fig. 1). This large area is herein referred to as the Noatak River Study Area (NRSA). The Red Dog Mine Project is a joint venture between NANA Regional Corporation (a local private native Corporation) and Cominco Alaska, Inc. The project includes an open pit lead/zinc mine located on Red Dog Creek 82 miles (131 km) north of Kotzebue (Fig. 2). In addition to the mine the project includes tailings ponds, a mill, power plant, worker housing, water reservoir, at least 90 kms (56 miles) of gravel road, a saltwater port, and several gravel borrow sites (U. S. Environmental Protection Agency [EPA} and Dep. of Interior [DI] 1984). At normal production levels, a minimum of one large truck will pass on the road to the port at least once every 45 minutes. The project is expected to last at least 40 years, and 225-250 employees will occupy the site at any one time. The transportation corridor may accommodate a railroad in future years. Easier human access to remote areas is expected to result in an increase in human use and additional "long-term increase in natural resource productivity in the western Brooks Range (e.g., hard rock minerals, coal, oil, and gas)" (EPA and DI 1984). Over 18,000 mining claims exist within the area. Ore production began during the winter of 1989 but full production did not begin until late autumn 1990.

The NRSA is characterized by a polar maritime climate along the coast and a continental type climate inland. Summer temperatures range from 36 to 90 degrees F and winter temperatures have been as low as -53 degrees F. Extremely low winter temperatures occur less frequently in the mountains because of temperature inversions. Annual precipitation averages from 10 inches (25 cm) along the coast to 20-30 inches (51-76 cm) in the mountains; half of it occurs during July through September. Snow cover usually occurs from mid-October through mid-May. Elevation ranges from sea level to over 4,000 ft (1,212 m). Topography ranges from flat lowlands near saltwater and major river systems at the southern end of the study area, grading into moderately sloping foothills, to steep, rocky mountains separated by narrow valleys in the north. Much of the area is underlain by permafrost. The area is largely treeless except along the Noatak and Kelly River floodplains. Caribou (Rangifer tarandus), moose (Alces alces), and Dall sheep (Ovis dalli) all 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 tributaries provide habitat for fish that are an important seasonal source of food for bears. Arctic char (Salvelinus alpinus), grayling (Thymallus arcticus), pink salmon (Oncorhynchus gorbuscha), and chum salmon (O. 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 some of the latest in North America (C. Lean, pers. commun.), may have some relevance to bear densities mentioned later in this report. Also a number of bears appeared to take advantage of dead marine mammal carcasses such as beluga whales (Dolphinaaterus leucas), walrus (Odebenus rosmarus), and several species of seals (Phoca spp.) that wash upon to the beach each spring and summer along the Chukchi Sea coast.

The NRSA boundaries were also selected to encompass an area receiving a moderate amount of harvest pressure. Because the NRSA was much too large for effectively conducting 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. 3). This smaller area is referred to as the Red Dog Mine Census Area or just census area.

The census area was initially divided into 12 sample units (i.e., count areas [CA's]), ranging in size from 62 to 78 mi^2 (161-202 km^2) and totalling 852 mi^2 (2,207 km^2) (Fig. 3). Natural landmarks such as streams and ridgetops were used as boundaries between CA's. After the first survey day, CA's 11 and 12 were eliminated; they were not surveyed because we didn't know whether the entire census area could be adequately covered each day with available personnel and aircraft.

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, grading into closed and tall shrub, low shrub, open low shrub, tundra, and then bare rock and ice as elevations increased. Relatively thick stands of white spruce (Picea mariana) occurred within the southern half of CA's 3, 4, and 8 along the Noatak River, and near the mouths of Wrench and an unnamed creek (i.e., No Name Creek) in CA 10. Elevations within the census area ranged from approximately 200 feet along the southern boundary to 3,904 feet along the northern boundary. The census area (CA's 1-10) included the den sites of 7 radio-collared bears. All of the census area was considered useable bear habitat, although the northern half of the area was probably more representative of high-quality denning habitat rather than habitat used on a year-round basis. Only relatively small portion of the census area contained areas over elevation of 3,000 ft, which were considered to be poor bear habitat in this portion of Alaska. Consequently, the entire area was used for calculations of density estimates.

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 either phencyclidine hydrochloride (Sernylan, Bio-Ceutic Laboratory, St. Joseph, MO) or etorphine hydrochloride (M-99, Lemmon Co., Sellersville, PA) during 1986. After 1986 all bears were immobilized with a mixture of tiletamine hydrochloride and zolazepam hydrochloride (Zoletil 100, Wildlife Laboratories, P. O. Box 8938, Fort Collins, Colorado 80525), referred to herein by the trade name Telazol. Drugs were delivered from either a dart projectile fired from a Cap-Chur gun (Palmer Chemical Equipment Co., Douglasville, Georgia 30134) or by hand injection. 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, and individually marked with 1 to 3 lip tattoos and duflex or roto ear tags; they were also radio-collared if judged to be ≥ 5 years of age with radios manufactured by Telonics (Mesa, Arizona). Several subadult (probably 3-5 year olds) bears were radio-collared during the census with collars designed to fall off after several weeks. These collars were of the same design as standard Telonics collars, except the attachment was modified to allow the collar to fall off. Instead of one standard hardware attachment, 2 sets were used with one 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.

All bears, except cubs-of-the-year (COY), had ≥ 1 premolars extracted for age determination. Teeth obtained from 1986-88 were cut, stained, and read by staff at the Division of Wildlife Conservation laboratory in Anchorage using methods described by Goodwin and Ballard (1985). Beginning in 1989 all teeth were sectioned, stained with a Giemsa stain, and aged commercially by Matson's Laboratory (Milltown, Montana). Several vials of blood were collected from each adult bear. One 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 capturing 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.

We attempted to capture all members of family groups including COY. We lightly immobilized COY by hand injection with a syringe. Immobilized COY were easier to process, and abandonment rates were lower when both sows and COY were immobilized.

During 1987 select radio-collared bears were relocated on a weekly basis. We subjectively selected bears from 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 the summer to monitor status and survival of young and twice in late autumn to determine location of den sites. At each relocation, the date, time, number, sex and age of associates, activity, and type of habitat were recorded on standard forms. Habitat types were based on overstory vegetation that could be identified from aircraft. Generally, vegetation was classified within one full 360-degree turn of the aircraft, using classifications of vegetation described by Viereck and Dyrness (1980). Prey and carrion observed while relocating bears were recorded. Prey that were observed at the location of radio-collared bears were considered to have been made by that bear if freshly killed, as evidenced by fresh blood, an intact carcass, and absence of other bears or predators.

Slope, aspect, and elevation use by radio-collared grizzly bears were determined from map relocations on 1:63,360-scale topographic maps after each flight. Elevations were determined by extrapolating between contour lines to the nearest 15-m interval. Slopes were classified into the following categories using contour line intervals: (1) flat, ≤10 degrees, (2) gentle, 11-30 degrees, and (3) moderate, > 30degrees. Aspect was classified as 1 of 8 compass directions from a line perpendicular to the contour lines through the bear relocation point.

Survival rates of radio-collared adults and uncollared COY and yearlings accompanying radio-collared sows were determined by Kaplan-Meir procedures described by Pollock et al. (1989). The McPAAL microcomputer program was used to estimate home range sizes by the following methods: convex polygon, concave polygon, 95% ellipse, and harmonic mean transformation (Dixon and Chapman 1980). For the latter we calculated home range sizes based on 80%, 90%, and 95% of the relocations. Home range sizes were only calculated for bears that had ≥10 total relocations.

Density and Population Estimates

Except where stated, the methods for censusing bears were identical to those described by Miller et al. (1987); i.e., mark-recapture using radiotelemetry to correct for population closure. This procedure uses fixed-wing aircraft to thoroughly search (without aid of telemetry) individual CA's until a bear or bears are spotted. Once spotted, radio telemetry is used to determine whether the animal(s) is "marked" (i.e., radio-collared). Only sightings of bears with functioning radio-collars were considered as resightings of marked individuals; however, for some sets of population and density estimates that are identified later, we considered young accompanied by their mothers to have the same status as their mothers. If the bear did not possess a functioning radio-collar, it was considered unmarked. If unmarked, the location of the bear was transmitted to staff in a nearby helicopter who immobilized it. Once immobilized and radio-collared, the bear was potentially available as a recapture in subsequent searches. Effort was made to capture all unmarked adult bears, but not subadults accompanying their mothers. All unmarked adults were captured, with exception of one adult female accompanied by one 2.5-year-old (estimated based on size) that escaped. Because the census occurred during the breeding season, adults were sometimes observed together. These sightings were treated as independent observations.

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

> "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 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 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:

$$N_d{*}_u = n_1/p{*}_u \qquad \text{and,} \qquad N_d{*}_1 = n_1/p{*}_1$$

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 (ADFG, Fairbanks) developed a DBASE microcomputer program that calculates the binomial confidence intervals for the 80%, 90%, 95%, and 99% levels. These values were then entered into the Lotus worksheet developed by Sterling Miller (ADFG, Anchorage), and the confidence intervals for bear-days, numbers of bears, and density were calculated automatically.

Twenty individuals from 3 agencies, 2 private companies, and Noatak participated in the census, which was conducted from 29 May through 4 June 1987. Six fixed-wing aircraft and 1 helicopter (Bell Jet Ranger 206B, Bell Helicopter, Fort Worth, Texas 76101) were used during the census. Fixed-wing aircraft used for surveying were composed of 3 Piper PA-18's, 1 Piper PA-12, and 1 Arctic Tern. A Cessna 185, herein referenced as the tracking aircraft, was used primarily for radio-tracking to determine degree of population closure (number and identification of individual radio-collared bears that were either in or out of individual CA's), but it was also used for surveying. In both instances, population closure was assessed after it had searched the assigned CA's. During other days, radio-tracking occurred simultaneously with surveys. Depending on location of survey aircraft and availability of the helicopter, the tracking aircraft also monitored unmarked bears spotted by survey aircraft that needed to be captured and radio-collared. This relieved staff on the survey aircraft from the tedious task of watching bears until the helicopter became available, allowing them to continue surveying with minimum delay. The tracking aircraft was careful not to transmit the identity or whereabouts of any radio-collared bears.

Survey aircraft, pilot-observer teams, and assigned CA's were rotated daily. In some cases, individuals who were pilot/biologists were also rotated into spotting and assisting with bear tagging. Pilot-observer teams were careful not to discuss the location of sighted bears during the census or afterwards to prevent bias in search efforts in succeeding days. Personnel in the tracking aircraft were not rotated. One biologist was assigned permanently to the helicopter to insure consistency in immobilization and handling procedures. All survey aircraft personnel, except professional pilots and tracking personnel, were rotated into the tagging team to provide a break from spotting and allow everyone the opportunity to gain experience with handling bears.

A total of 40 hours and 3 minutes were spent surveying on the first day, of which 10 hours and 33 minutes were allocated to CA's 11 and 12. With CA's 11 and 12 eliminated the total size of the census area was reduced to 719 mi^2 (1,862 km^2). All relocations were digitized and, along with associated descriptive data, entered into DBASE computer files to facilitate future analyses.

Statistical Tests

Differences among means, medians, ranks, and survival rates were determined by t-test, one-way ANOVA, Kruskal-Wallis, or Mann-Whitney test (Sokal and Rolf 1981). Residual and normal plots were examined with MINITAB to determine if assumptions of equality of variances and normality had been met. Ratio and proportion data were tested by Chi-square analysis. We used quadratic equations in a LOTUS worksheet to examine relationships among physical measurements. In some cases equations other than quadratic equations may have provided better fits, but we chose to stay with quadratic equations because of the ease and speed of calculation. Unless stated otherwise $P < 0.05$ was necessary for differences to be considered significant.

RESULTS AND DISCUSSION

During 1986 through 1990, 146 grizzly bears of all ages were immobilized on 205 occasions within the NRSA (Tables 1-4). Of that total 78 were females and 68 were males. Forty-nine females were captured once, 16 twice, 12 three times, and 1 four times. Of the 68 males, 53 were captured once, 13 twice, and 2 four times.

During the first year of study (1986) 47 bears were immobilized with either phencyclidine hydrochloride or etorphine hydrochloride. Of 27 bears immobilized with phencyclidine in 1986, 1 died (3.7% mortality), while 1 of 20 (5.0% mortality) immobilized with etorphine died. Both mortalities were adult females, and exact cause of death was not determined.

During 1987 we tested Telazol (combination of tiletamine hydrochloride and zolazepam hydrochloride) for immobilizing bears and found that it had a number of advantages over other drug combinations, in addition to being less toxic to humans. Data from 1987 were combined with those from several other Alaska studies, and concluded that Telazol was an excellent drug for immobilizing grizzly bears because of rapid induction times, timely and predictable recovery times, wide margin of safety, and few adverse side effects. The abstract of the manuscript published in The Journal of Wildlife Management is presented in Appendix A.

A total of 158 immobilizations have been made with Telazol during this study. We used approximately 9-11 mgs of Telazol per kilogram of body mass. Two concentrations of Telazol were used: 200 mg/ml and 300 mg/ml. The higher concentrations were used on larger adult males to reduce the volume of drug needed for immobilization. Only 1 mortality (0.6%) out of the 158 immobilizations. The one mortality was a 3.5-year-old emaciated female probably would have died, regardless of the drug used for immobilization. It appears that bears immobilized with Telazol have very low rates of capture mortality. Other details of immobilizations were discussed by Taylor et al. (1989, Appendix A).

Reproductive Parameters

A total of 146 grizzly bears (78 females and 68 males) were captured and handled during 1986 through 1990 (Tables 1-4). Of that total, 67 (43 females and 24 males) were radio-collared. Although sex ratios at capture by age class were not significantly different ($P > 0.05$) from 50:50, sex ratios of COY through 2.5-year-olds appeared skewed in favor of males; for bears aged ≥ 3.5 years, sex ratios appeared skewed in favor of females (Table 5).

Physical characteristics, ages, ear tag numbers, and other important identifying criteria for individual bears are summarized in Tables 1 through 4. During 1987 we discontinued the use of duflex ear tags because of a high incidence of infection related to these tags; H. Reynolds (pers. commun. ADFG, Fairbanks) encountered a similar problem with duflex tags in an arctic study area. We suspect the tag may be too wide to allow the wound to properly heal. To reduce this problem, we began using large roto-tags, which do not cover the wound. Reynolds came to an identical conclusion and began using roto tags to reduce risk of infection.

Of 81 adult (age ≥ 5.5 years) females captured during 1986 through 1990, 36 (44.4%) were not accompanied by young at the time of capture; however, 66.7% (n = 24) were lactating at the time of capture suggesting they had given birth to COY but had lost them just prior to den emergence or between emergence and time of capture. Also, based upon physical examination of 29 females in estrus at the time of capture, only 11 (37.9%) were observed with COY the following spring. High cub mortality early in life has been observed in several other Alaska studies; predation by boars is suspected as the major cause of death (Miller 1985, Reynolds 1985).

Average size of 35 litters observed at den emergence during 1986 through 1990 was 2.17 (Table 6). There were no significant differences in numbers of COY per litter among years ($F = 1.28$, $\underline{P} = 0.30$), but there were differences in proportions of sows producing COY ($\underline{X}^2 = 10.1$, $\underline{P} < 0.05$) among different years. There appeared to be proportionately fewer litters than expected in 1986, 1987, and 1988 and more than expected in 1989 and 1990. Reasons for these differences cannot be explained. The largest observed initial litter size was three. One uncollared sow was observed with 4 COY during autumn 1990 (J. Dau, ADFG, Kotzebue, pers. commun.). Upon den entrance average litter size had declined to 2.06, reflecting mortality of COY from predation by boars. Litter size continued to decline to 1.93 per litter upon den emergence as yearlings to 1.88 at den entrance. Losses observed after emergence as 2.5-year-olds were considered to be the result of weaning rather than actual mortality.

Minimum age of first reproduction ranged from 5 to 9 years. Fifty percent of the first litters occurred at 5 years (Sow Nos. 001, 055, 058, 067, and 070), 20% at 6 years (Sow Nos. 004 and 053), and 10% each at 7, 8, and 9 years (Sow Nos. 020, 041, and 002, respectively). Seventy-seven percent ($\underline{n} = 24$) of the young were successfully weaned as 2.5-year-olds, and 23% were weaned as 3.5-year-olds. Known interval among COY litters, regardless if COY survived and were weaned, averaged 3.3 years; 4 litters had 3-year intervals and two had 4-year intervals. Although the latter statistic may be interesting, it is more biologically meaningful to report the interval between successful recruitments into the population. The average minimum interval between successful weaning of 2.5-year-olds was 3.92 years (range = 3 to 8 yrs [Table 7]).

<u>Morphometrics</u>

Average weights of female COY, yearlings, and 2.5-year-olds were 7.4, 30.9, and 47.5 kgs, respectively, while males weighed an average of 9.0, 36.1, and 60.6 kgs, respectively (Table 8). Males were heavier than females for all age classes. Weight of females appeared to level off at about 12 years of age (Fig 4.). The same may also have been true for males, but we obtained a better fit with a linear equation that depicted increasing weights through 15 years of age (i.e., oldest male examined, Fig. 5). Unfortunately the scales used in this project could only weigh bears up to 227 kgs. None of the females exceeded that weight, and at least 4 males appeared to exceed it. We estimated the maximum weight of bears in the Noatak area may range up to about 275 kgs.

As part of our physical examination of each bear, we routinely estimated each bear's age by tooth wear, size, and general appearance. This practice allowed us to compare our estimates against those provided by cementum analysis. We also took a number of tooth measurements that we hoped might provide some objective criteria for estimating ages. Our estimates of age were generally correlated with cementum ages (Figs. 6 and 7), but there was a large amount of error associated with those estimates. Analysis of tooth measurements in relation to cementum ages suggested that so much overlapping occurs among age classes that only COY and yearlings could be reliably distinguished from other age classes (Figs. 8 and 9).

While this study was being conducted, concerns were raised that local subsistence hunters in northwest Alaska do not salvage skulls or hides because this practise conflicts with their culture and tradition (Loon and Georgette 1989). Currently, state regulations require all successful bear hunters to present the hide and skull to a Department official for sealing. At that time a premolar tooth is extracted for age determination, the skull measured, and other biological specimens collected. When subsistence users do not retrieve the skull or hide, they are in violation of those regulations, and more importantly, biologists fail to receive information needed to manage a bear population. As a result, there has been informal discussion concerning advantages and disadvantages of abolishing sealing requirements for subsistence users. If this were to occur, biologists might obtain more accurate data on total harvest, but they would lose data on sex and age structure of the harvest (<u>see</u> harvest assessment section for more detailed discussion). Because of this discussion we examined the relationship between age and a number of physical measurements to determine if some other types of measurements could be taken by hunters in the field that might provide an indication of sex and age structure. If possible it might negate the need for subsistence hunters to retrieve hides and skulls.

We examined the relationships between age and skull width (Figs 10 and 11), skull length (Figs. 12 and 13), length plus width of skull (Figs 14 and 15), neck circumference (Figs 16 and 17), heart girth (Figs. 18 and 19), and total body length sex (Figs. 20 and 21). We also examined the relationships between weight and neck circumference (Figs. 22 and 23), heart girth (Figs. 24 and 25), and total body length (Figs. 26 and 27). Although all of these comparisons were significantly correlated with age, all had significant overlapping among age classes so that only COY and yearlings could be reliably identified. Separation by age class appeared more pronounced for males than females, but it is not enough to allow reliable identification of ages. We concluded that there are no measurements hunters could take in the field that would substitute for the cementum age data obtained by sealing.

<u>Movements and Habitat Use</u>

During 1986 through 1990, 1,6257 relocations were obtained on 67 (43 females and 24 males) radio-collared grizzly bears (Tables 9 and 10). Annually, each adult female was relocated an average of from 5.3 relocations per season in 1990 to 14.3 in 1987 ($\underline{X}$ = 9.0). Each adult male was relocated an average of from 6.5 to 11.6 occasions annually ($\underline{X}$ = 8.8). Radio collars were removed from all boars in 1988 to prevent lacerations caused by growth. All of the boars that still wore collars in 1988 were less than 11 years of age (7 of 8 were less than 10 yrs of age).

Grizzly bears emerged from relatively high-elevation den sites during April and May; boars emerged before other sex and family classes. Sows with COY were the last to emerge. Bears used progressively lower elevations throughout the summer; the lowest elevations were used in early to late September. This appeared to be related to the appearance of salmon in the Noatak River near Kelly River (Fig 28). After mid-September, bears gradually began moving to higher elevations in preparation for denning. Den entry occurred between mid-October and late November. There were no significant differences in average elevation use by sex or family class at 2-week intervals (Table 11). However, sows accompanied by COY occupied higher elevations than males throughout the spring and most of summer until early to mid-September, although the differences were not statistically significant (Fig. 28). In each year they occupied higher elevations than single females or sows accompanied by yearlings through mid-June; again these differences were not statistically significant. These differences may be related to sows with COY avoiding habitats frequented by adult males that may prey frequently on them.

Movements of individual adult grizzly bears (i.e., radio-tracking from fixed-wing aircraft during 1986 to 1990) are shown in Appendix C. Several distinct movement patterns were discernable from examination of these plots. At least 3 adult females (Nos. 021, 052, and 059) denned in the vicinity of Amphitheater Mountain each year. After den emergence they moved to the North Slope and remained there through summer and autumn. These were the only radio-collared bears that spent any appreciable time there.

Eleven radio-collared bears had home ranges that included or came within several kilometers of the Chukchi Sea. At least 2 bears traveled to the coast from as far as the upper Avan River and Wrench Creek. Both collared and uncollared bears were observed along the coastline of the Chukchi Sea during late May through August. We suspected the late-spring use of coastline habitats was related to scavenging the numerous marine mammal carcasses that wash up each year. Movements to the coast during mid- to late summer coincided with the appearance of fish at the lower stretches of major creeks and rivers. Several bears also made distinct movements to sloughs that contained spawning salmon; the most noticeable of which were along the lower Eli River and along the Noatak River near its confluence with both the Kelly River and Kuchak Creeks.

At least 13 radio-collared bears had home ranges that included the Red Dog Mine site (Appendix C). Several others had home ranges adjacent to the mine site. We were unable to detect any apparent changes in movement patterns because of mine development using conventional telemetry methods. This was not entirely unexpected because large-scale development of the camp did not begin until 1987, actual development of the mine did not begin until 1989, and full-scale production did not begin until 1990. Perhaps more importantly, the relatively low intensity of monitoring that occurred during much of the study was not sufficient to detect anything less than drastic changes in movement patterns resulting from mining development; however, in 1988, we detected (<u>see</u> satellite radio telemetry section) movements of 3 bears to a temporary garbage dump adjacent to the airport.

There were significant differences in use of slopes, aspects, and habitat types by sex and family class (Tables 12-14). Sows with COY used steep slopes proportionately more and flat slopes less ($P < 0.0001$) than males and single sows. This coincided with the differences in elevation use and may be related to avoidance of boars and single sows. There were no significant differences in use of slope aspects between single sows and boars ($X^2 = 3.29$, $P = 0.27$). Sows with COY used north-facing slopes more and flat slopes less than other classes of bears. Males used flat areas more than expected.

Use of vegetation types reflected the same pattern as would have been predicted by usage of elevations and slopes. Females with COY used riparian habitats less and rock-snow and alpine herbaceous vegetation types more than males and single sows (Table 14). Other vegetation types were used in approximate equal proportions.

Home range sizes of radio-collared bears were determined by 4 methods (Tables 15 and 16). Males had larger home ranges than females by 3 of 4 methods of calculation, but only the differences for convex polygon ($W = 722$, $P = 0.028$) and 95% ellipse ($W = 686$, $P = 0.003$) were significant. Male convex polygons averaged 1,437 km^2; females averaged 993 km^2.

During this study 30 radio-collared bears were observed feeding on 38 ungulate carcasses (17 moose, 9 caribou, and 12 unidentified). Several of the carcasses were relatively old and probably represented scavenging activity, particularly after den emergence. At least 6 of the 17 moose carcasses were neonate moose that had been killed by bears. Caribou appear to be utilized by bears on an opportunistic basis.

Den Site Characteristics

Den site characteristics were documented for 86 dens located by tracking 43 radio-collared bears (31 females and 11 males) from fixed-wing aircraft during 1986-1990. Numbers of consecutive den sites located for each bear ranged from 1 to 4 dens. Den sites were found on moderately (>30 degree) inclined slopes averaging elevations of 500 m (SD = 139.4, median = 457 m). Seventy-two percent of the dens had orientations between 90 and 270 degrees. All dens were excavated by bears and no reuse in successive years was observed, because nearly all, if not all, dens collapsed. Although monitoring intensity was not sufficient to precisely document entrance dates, bears (i.e., both sexes) usually entered dens between 15 and 30 October each year ($\underline{n}$ = 71). Earliest den entrance occurred in 1986, when 5 bears entered dens between 2 and 4 October. Latest den entrance ($\underline{n}$ = 8 bears) occurred between 15 and 29 November each year. Six of 8 bears still active after 15 November were associated with open water along rivers that contained spawning salmon. In these cases, accessible food appeared to be a more important factor affecting timing of den entrance than either snow cover, temperatures, or amount of daylight.

First observations of radio-collared bears emerging from dens occurred between 15 April and 2 May ($\underline{n}$ = 18). Several uncollared boars were observed outside their den sites as early as 18 March. Most bears were first observed away from dens between 19 May and 1 June ($\underline{n}$ = 64). This later category included 15 bears that were still located within their dens as late as 29 April. The latest dates bears were first documented emerging from dens were between 18 and 21 May ($\underline{n}$ = 5). As expected, all were females accompanied by COY. Of 18 observations of early emerging bears, seven were males, 10 were barren females, and two had offspring (one yearling and one 2.5-year-old). Males emerged from dens earlier than females, especially females accompanied by COY.

Fidelity to den sites was determined by comparing straight-line distances between dens used in consecutive years ($\underline{n}$ = 69) and in nonconsecutive years ($\underline{n}$ = 69) for 31 bears. Mean distance between consecutive den sites was 4.4 km (SD = 6.2), and mean distance between all dens for individual bears was 5.1 km (SD = 6.4, $\underline{n}$ = 138), suggesting strong fidelity to the same area each year. Only 5 bears (Nos. 004, 028, 042, 070, and 098) exhibited distances >20 km between annual den sites. Bear No. 070 moved 20.9 km from her 1987 den site in Wrench Creek drainage to a den site within 6 km of the Red Dog Mine in 1988. Perhaps this bear was attracted to the temporary garbage dump, as were 3 satellite-equipped bears (<u>see</u> satellite telemetry section). Bear No. 098 denned 36.8 km away from her 1988 site in 1989. Bear No. 028 maintained a high fidelity to her den sites located 12 km northwest of the mine from 1986 through 1989 and then in 1990 moved 25 km south to a den located 20 km southwest of the mine. The 1990 den site was located near a portion of the Noatak River that was a fishing site that had been used by this bear each autumn. In 1988 bear No. 004 selected a den site 25.1 km south of sites used in 1986 and 1987 and then returned to within 7.0 km of those sites in 1990. We wondered if some of these changes in den site useage were related to mine development or operation activities. Perhaps changes in denning activity may be one indicator of responses by grizzly bears to industrial development. Continued monitoring of radio-collared bears is necessary to adequately test this hypothesis.

Satellite Radio Telemetry

During early June 1988, 6 adult females that had been previously radio-collared and monitored for 1-2 years were recaptured and fitted with satellite collars manufactured by Telonics (Mesa, Arizona). Each satellite collar also contained a separately packaged conventional VHF transmitter that allowed each one to be located by conventional tracking methods. The Argos Data Collection and Location System (DCLS) has been used for receiving signals from the satellite collars and for processing data. The Argos system is a cooperative effort among the French Centre National d'Etudes Spatiales (CNES), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA). History and current use of satellite transmitters on wildlife in Alaska has been described by Fancy et al. (1988) and Harris et al. (1990).

Satellite transmitters used in this study, herein referred to as platform transmitter terminals (PTT), were programmed to transmit for 6 hours per day from 25 May through 10 October and then cease transmission during the denning period. At den emergence the subsequent year, they were to repeat the above cycle. These PTT's were expected to operate through 2 field seasons. Each PTT can be programmed to transmit at varying intervals for up to 4 different transmission schedules. A 6-hour transmission period is thought to be an optimum length to allow the satellite sufficient opportunity to consistently fix at least 1 accurate relocation while maximizing battery life (B. Berger, Telonics, Inc., pers. commun.). Users are provided microcomputer diskettes on a monthly basis that contain all of the relocations, including several types of sensory data. Users can usually obtain relocations by telephone modem within 6 hours following a satellite overpass.

Argos provides several types of data processing. These include accurate, standard, nonguaranteed, and special processing (Table 17). Argos routinely provides users with accurate and standard processing, but nonguaranteed processing must be requested, even though there is no additional cost. The latter type of processing is essential for PTT's used on animals, because significantly fewer relocations are obtained without it. The accurate (Nl or LQ = 3 or QQ = 9) processing reportedly has 68% of its relocations within 150 m of the true value, while standard processing has 68% within 350 m (Harris et al. 1990). Nonguaranteed relocations reportedly have 68% of their relocations within 1 km of the true value.

We attempted to evaluate the accuracy of satellite PTT's used in this study and found the accuracy to be much less than that reported by Fancy et al. (1988) and Harris et al. (1990). Prior to deployment in 1988 we activated all 6 PTT's on 27 May 1988 (Julian day = 147) in Nome and placed them at a known fixed location for 6 days. We were able to map this location to within several hundred meters. A total of 109 relocations were obtained during this period. LQ = 2 relocations composed 73.4% of the relocations and LQ = 3 relocations composed the remainder. Unfortunately, no LQ = 1 or LQ = 0 relocations were obtained and consequently their accuracy could not be assessed. The average error for LQ 2's and 3's associated with the 6 PTT's during this period was 1110.3 m (Table 20, median = 939.6). About 60% of the relocations were equal to or less than 1,200 m, and 90% of the relocations were within 2,000 m (Fig. 29).

Fancy et al. (1988) reported that there was variation in accuracy of relocations among individual PTT's. The same was true in this study (Table 20). Average location error per PTT ranged from 663.5 m for B902 to 2,220.8 m for B903. Range of relocations within 60 and 90% of total number of relocations was 800 to 1,600 m and 1,400 to 4,000 m, respectively (Fig. 30).

Argos also provides special processing of data received which costs an additional $1.25 PTT-day. Although this latter category provides the greatest number of relocations, the accuracy of most relocations may be poor, given that the average accuracy of LQ 2's and LQ 3's was only 1,110 m. Although we used this service in 1988, we chose not to use these relocations in many of our analyses until we can assess their error. Data collected using special processing on several PTT's deployed on wolves in northwest Alaska contained many inaccurate relocations, and we suspect the same may be true for the bear PTT's (W. B. Ballard, ADF&G files).

Aside from relocations, PTT's also provide other types of data, depending on the user's needs (Fancy et al. 1988). PTT's used in this study provided canister temperature that is correlated with ambient air temperature, and short and long-term activity patterns (i.e., reflected by activation of mercury tip switches). However, Fancy et al. (1988) pointed out that the usefulness of these data varies by species and is dependent on the orientation of the switches and the counting interval selected. No attempts have been made to correlate any of these parameters with grizzly bear behavior.

Each PTT costs approximately $3,500. Data received from each PTT is processed by Service Argos and distributed to users on microcomputer diskettes. Data processing in 1990 cost $4,000 per PTT-year (equivalent to 365 days of transmission by 1 PTT). Assuming that each bear PTT functioned as expected, we required 2.27 PTT-years of data processing annually at a cost of $9,074. Each PTT was expected to transmit 138 days per season. Special data processing costs $1.25 per day per PTT or for this study $1,035 per year. Total projected costs including the cost of 6 PTT's over 2 summer seasons was $41,218.

Five PTT's were deployed on 5 June 1988 (Julian date [JD]=157) and 1 on 6 June. During 1988 these 6 PTT's provided 1,865 relocations and 14,220 sets of behavioral data with an average of 0.5 relocations and 3.8 sets of behavioral data per satellite overpass (Table 18). Behavioral data were not analyzed for this report. Approximately 40% of the relocations were classified as location class (LQ) zero, which are often highly inaccurate; only 1.4% of the relocations were of the highest quality (LQ 3, Table 19). Most of the relocations were of intermediate quality (LQ 1 or 2). Prior to deployment on bears the PTT's were tested; 26.6% of the relocations at known locations were high-quality relocations. Apparently when PTT's are placed on animals, the closeness of the antenna to the animals body affects the voltage:standing wave ratio that results in a reduction of the effective radiated power from the antenna (Fancy et al. 1988, Harris et al. 1990). This results in a higher proportion of lower-quality relocations.

Disproportionately fewer relocations and sets of behavioral data were obtained during August 1988 (Tables 18 and 19). A similar discrepancy was observed for several wolf PTT's in northwest Alaska (Ballard et al. 1990a). Reasons for the smaller amount of data are unknown, but they may be related to errors in processing the raw data provided by Argos or errors made in transferring data from Argos format to DBASE files.

Movements of the 6 PTT-equipped grizzly bears during June through October 1988 are depicted in Figures 31 through 36. Although we had several reasons for using satellite telemetry during this study, a primary objective was to monitor how bears reacted to construction and operation of the Red Dog Mine. We also used the relocations to evaluate how often some bears may have frequented the garbage dump at the mine site during 1988.

During 1987 through 1989 we documented that several species of wildlife, including grizzly bears, were attracted to the Red Dog Mine and port site garbage dumps (Ballard et al. 1990b, Appendix [letter to Dep. Environmental Conservation]). We assessed the frequency of use of the mine garbage dump by 6 grizzly bears during 1988, assuming that if a satellite PTT was relocated at or within 3.2 km of the dump site there was a strong probability that the bear was attracted to the area. Three of 6 PTT-equipped grizzly bears were relocated at the Red Dog Mine garbage dump on 144 (15%) of 946 relocations during 6 June through 15 October 1988. One bear visited the dump site regularly throughout the summer and autumn (73 of 291 relocations); the other 2 bears visited the area only during June and July. We therefore concluded that several bears were attracted to the dump site. This was confirmed by anonymous informants at the camp, who indicated that several bears were regularly using the area. As a result of this finding, we requested that the permanent dump site be fenced; however, this request was rejected by the mine owners, because no problems with bears had been documented and they believed that once they began incinerating their trash there would be no food available to attract bears and other wildlife.

Home range sizes of the 6 Ptt-equipped bears were computed by the same 4 methods used for conventional telemetry data and compared by date and method of data collection (Tables 21 through 24). For conventional VHF-transmitter data we calculated total home range sizes for the entire study period (see Tables 15 and 16 for dates) and for relocations obtained only in 1988. All estimated home range sizes based on 1988 conventional data (except those based upon the 95% ellipse) were significantly smaller (Kruskal-Wallis test, $\underline{P} < 0.05$) than those obtained by conventional telemetry over a 3- to 5-year period or by satellite telemetry. This probably occurred because of the relatively small numbers of relocations obtained from fixed-wing aircraft during 1988.

There were no significant differences in average home range sizes for convex polygons, concave polygons, and 95% ellipse between PTT-equipped bears in 1988 and the same bears relocated from fixed-wing aircraft during a 3- to 5-year period, suggesting satellite telemetry in this study provided similar estimates of home range sizes and movement patterns in 1 year that took 3 to 5 years to estimate with conventional telemetry. Average home range size of females equipped with PTT's using convex polygons was 1,453 km^2 (SD = 1,340); for the same bears using conventional methods, home range size averaged 1,395 km^2 (SD = 706). The variation among individual bear home range sizes, regardless of method of calculation or data collection, was so large that average home range sizes may have little value for understanding biological relationships.

The average time interval between relocations with quality indices of LQ 1-3 ranged from 10.6 to 26.0 hours, and the average distance traveled per relocation ranged from 2.8 to 8.3 kms (Table 25). Average rates of travel per relocation ranged from 2.7 to 5.2 km/hour. Minimum and maximum distances traveled between relocations were 0.04 and 80.5 kms, respectively.

We also determined average movements and rate of movement per day by using only 1 (highest quality) relocation per day provided by satellite telemetry (Table 26). Average interval between daily relocations per female bear ranged from 18.8 to 24.3 hours. Average movement per day ranged from 3.7 to 9.8 km per day at a rate of speed ranging from 0.16 to 0.68 km/hour.

Most PTT's functioned as programmed during the first season of use. One transmitter ceased transmission in autumn 1988 on exactly the date it was programmed (10 Oct); three ceased within 1 day of the programmed date, one within 8 days, and one within 10 days (Table 18). The latter 2 PTT's quit transmitting earlier than expected. During late May of the following year (1989), when the PTT's were programmed to resume transmission, 3 of 6 PTT's failed and no signals were received for the remainder of the year. PTT No. 902 resumed transmission on 27 May (JD 147) for 1 day and then quit transmitting. PTT No. 904 failed after providing 1 set of activity data on 22 May 1989. The only PTT that functioned more than 1 day was No. 905, which resumed transmission on 5 June (JD 156) and apparently transmitted daily through about 30 June 1989 (JD 181) before failing. During late 1988 or late spring of 1989 all PTT's that were deployed on grizzly bears failed prematurely.

Unfortunately, by the time we discovered the failures we were unable to locate a helicopter within a reasonable distance of the study area to attempt retrieval of the collars. The closest available helicopter was located in Fairbanks, Alaska. The estimated cost for retrieving the 6 PTT's was prohibitively high: in excess of $10,000.

High failure rates of PTT's deployed on brown bears have been reported elsewhere in Alaska. Harris et al. (1990) reported that of the 11 PTT's deployed on brown bears in 1987, eight had been programmed to transmit through the denning season into May and the remaining three similar to the ones in this study; i.e., so they would cease transmission while in the den and resume transmission at den emergence the following spring. Of those 11 collars, 1 bear shed its collar, and 9 of 10 of the remaining collars failed. The one remaining functioning collar transmitted for 3 weeks and subsequently failed as well. The 3 collars that had been programmed similar to the ones in this study were not programmed properly and did not resume transmission. We wondered if our PTT's may have been incorrectly programmed as well, but the manufacturer indicated that their records showed our PTT's had been programmed properly.

Aside from essentially receiving no data from the bear PTT's during the second summer, the study also lost $9,100 in data processing costs that were paid in advance at the beginning of each year. The policy of the manufacturer regarding satellite PTT's is that they have no liability, unless it can be shown that the failures were related to flaws in design or manufacturing. Since 1987 and 1988 several additional PTT's were deployed on grizzly bears with transmission programming similar to that attempted in this study. Unfortunately, these units had the same failure rates as those reported here. It appears that PTT's undergo severe stresses either during denning or immediately after den emergence that results in complete failure of the PTT. Thus far, these stresses have not effected the VHF units. In spite of nearly complete failure of the PTT's during the second season, it may still be more cost-effective to use PTT's instead of conventional radio collars, depending on project objectives.

During the spring of 1990 we were able to retrieve 4 of 6 of the satellite PTTs deployed in 1988. Unfortunately, for unkown reasons the VHF transmitter on two of the PTT's failed sometime prior to den emergence. Externally, the 4 retrieved PTT's appeared in excellent physical condition. Because the batteries were totally depleted, the cause of the failure could not be determined (B. Berger, Telonics, pers. commun.). Their hypothesis was that for some unknown reason the PTT's reset their duty cycles prior to or immediately after den entrance in 1988. This caused the units to transmit while the bears were inside their dens. Signals transmitted while in the den would probably not be received by the satellite, and thus the problem would go undetected until the following spring. At den emergence the batteries in each unit would be largely or totally expended, accounting for the few or no relocations experienced in this study.

During the past 2 years we have maintained between 30 and 40 conventional VHF transmitters on grizzly bears. Including commute time from Kotzebue to the study area, we were able to locate about 2 radio-collared bears per hour of flight time in a PA-18 Supercub aircraft. At current commercial charter rates of $135 per hour, each bear relocation costs about $68, excluding costs of radio collars and personnel. In comparison, including costs of the PTT's and data processing for the second season and using only relocations with LQ's $\geq$ 1, the average cost of each PTT relocation was about $37. If we had not paid for data processing costs for the second year when there were no data and dropped special processing, the average cost per relocation would have been about $27. Therefore, on a basis of cost per relocation, satellite telemetry for this study was much more cost-effective than conventional telemetry. More importantly, relocations are obtained consistently on a daily basis, regardless of inclement weather that determines how frequently conventional collars can be relocated. These factors suggest that if the principal objectives of a project were to estimate home range sizes, movement patterns, and perhaps habitat utilization, then satellite telemetry is far superior to conventional telemetry. The primary limitations would be the numbers of bears that could be sampled because of the high cost of PTT's; however, most studies that use conventional telemetry methods do not obtain enough relocations per season for each animal to properly measure home range sizes or movement patterns. For example, in this study, the greatest number of relocations obtained for any bear using conventional telemetry was 22, an inadequate sample for most analyses. If other types of data such as productivity and predation rates were important project objectives, then use of conventional methods would be necessary. Even in these cases, however, the VHF unit on the satellite collar could be used to collect this information through conventional telemetry techniques.

Population Estimates and Density

One of the primary objectives of this study was to derive an objective estimate of bear density in an area that included the Red Dog Mine prior to development. During 29 May through 4 June 1987, 196.7 hours were flown by 6 fixed-wing aircraft searching for grizzly bears within the 712-mi^2 (1,862 km^2) Red Dog mine census area (Table 27). Search effort averaged 2.35 min/mi^2/day.

Search effort per count area (CA) varied from 2.08 min/mi^2/day, for a CA characterized by relatively flat terrain and low elevation relief where sightability should have been optimum (CA 2), to 2.53 min/mi^2/day, for a rugged, mountainous area in the north (CA 9) where observability was difficult. The census area had originally included 2 additional CA's totaling 133 mi^2, but these were eliminated after the first day because they required disproportionate survey effort totaling an additional 10 hours 33 min/day. A total of 40.1 hours of search effort was expended on the first day of survey by 5 aircraft, not including commute time or time spent watching bears to be marked, and 6 bears were captured and marked day within or along the borders of the 2 CA's that had been eliminated from the census. Search efficiency declined with fatigue, and we decided not to extend search effort beyond 4-5 hours without several breaks. Average search effort per aircraft was 5.62 hours/day, excluding time used for commuting or watching bears during immobilization. Participants indicated this was close to the maximum effort that should be attempted. If a larger area needs to be censused, we suggest additional aircraft and personnel be used.

Prior to the census, 12 radio-collared bears (i.e., 8 females [Nos. 02, 08, 09, 20, 22, 28, 41, and 43] and 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 the census area boundaries, and 8 bears denned within the census area boundaries (Appendix C). Sow 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 re-sighted at least once during survey days 2 through 7 (Tables 28 through 34). No marked (radio-collared) bears were observed during the first day of the census (Table 28).
Twenty-nine individual radio-collared adult grizzly bears were observed within the census area on one or more occasions while the census was in progress (Table 35).

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 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. 1987). Although we did not statistically test differences in sightability observed among the various sex and age classes because of small sample sizes, there appeared to be a sightability bias against 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: all males (10 individuals, 37 occasions within, 12 occasions seen), 32.4%; all females (19 individuals, 72 occasions within, 22 occasions seen), 30.6%;

single females (14 individuals, 47 occasions within, 16 occasions seen), 34.0%; females accompanied by young >1 year-old (3 individuals, 14 occasions within, 4 occasions seen), 28.6%; and 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 may have been some differences in sightability between bears radio-collared prior to the census versus those captured during the census. Sightability of males was 28.6% before the census versus 36.4% during the census; for single females sigtabililty averaged 40.0% before the census versus 23.5% during the census.

Data from this study will be combined with several other Alaska studies where mark-recapture techniques have been utilized. With larger sample sizes, statistically significant differences among sex, age, and family groups can be properly tested (ADF&G files). A recent preliminary analysis indicated that there were no significant differences ($\underline{P} > 0.05$) in capture sightability of marked bears by family class, age class, or area (Becker 1988); Becker, who also tested for capture homogeneity by day and individual, was unable to detect any differences for the Noatak area ($\underline{P} = 0.316$) or among 4 study areas ($\underline{P} = 0.449$) where mark-recapture estimates had been made (Units 13, 23, 4, and 8 [Karluk Lake]). The Terror Lake study area (Unit 8), was significantly different ($\underline{P} = 0.005$); reasons for that difference have not yet been examined. These results suggest that bear sightability is constant among areas and bear classes.

Two population estimates based on sex and age class of bears were generated in this study: total numbers of adult bears >3 years old and total numbers of bears including COY and other offspring. The most statistically valid estimate was for adult bears >3years old, because it violated fewer crucial assumptions. The adult (>3-year-olds) population estimate within the 1,862-km^2 area was 28; the total population estimate was 37. The 80% confidence interval for the adult estimate was 25 to 35: for the total estimate, it was 33 to 43 (Table 36). 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 that included young treated with the same status as their sows (marked or unmarked). The adult estimate was quite similar to the total number of individual radio-collared bears (29) that were known to have been present on one or more occasions within the census area during the 7-day census effort. The estimate for all bears was slightly lower than the number that we observed in the area on 1 or more days (37 vs 40). Binomial confidence intervals (CI) at the 95% levels for total and adult population estimates are contained in Table 37. Terminology used in Tables 36 and 37 include the following: sightability--percentage of radio-collared bears known to be present within the census area and actually observed on a particular day; Cum. n1--cumulative number of marked bears present in the census area; Cum. n2--cumulative number of marked bears seen; and Cum n2--cumulative number of all bears seen.

Population estimates for adult and total bears, along with their 95% binomial confidence intervals by survey day, are depicted in Figures 37 and 38. As reported for other bear population estimates (Miller et al. 1987), confidence intervals converged as the census progressed. Population estimates and associated CI's leveled off by day 6. We surveyed one 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 continental population (Peek et al. 1987), particular care should be taken to reduce and minimize development impacts on grizzly bear populations. Historically, declining or low 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 their status in a timely and cost-effective manner. Typically, by the time an adverse change in status has been identified, 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 to partially prevent making a Type II error of falsely concluding that there has been no changes in the population (Snedecor and Cochran 1973) as a result of development. The risk of this approach is that remedial actions to protect bears may be taken when no change in their population status has occurred; however, if errors are made in the other direction, a valuable renewable resource may be irretrievably sacrificed.

A large portion of the expense of conducting a mark-recapture study on grizzly bears is the cost of marking new individuals during the census. We compared the differences in adult and total bear population estimates and respective CI's had no new individuals been radio-collared (Table 38 and Figs. 39 and 40) with those obtained in this study, which included new marked individuals (Table 37, Figs. 37 and 38). 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 population estimate of all bears, if no new bears had been captured and marked, would have been 29.8% larger than the estimate obtained. Differences in CI's for the estimate of all bears were similar to that obtained for adult bears; i.e., the CI would have been much wider had no new bears been captured and marked (-31% to +67% of estimate in comparison to -16% to +26% of the estimate obtained during this study). We concluded that the primary benefit of capturing and marking new bears as encountered is the attainment of narrower CI's and perhaps a more accurate population estimate.

Total cost of the Noatak bear census was $64,713 (Table 39). Approximately half of that cost was attributed to the capture and radio-collaring of 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 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 once they had fallen off. Expenses for this census procedure would have been substantially higher without the benefit of a contract for helicopter costs and use of government-owned or leased aircraft. Using chartered aircraft at commercial rates, the projected cost of the census could have been as high as $108,000 (Table 39). Considering the remoteness and size of our census area, total cost of $64,000 was comparable 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: (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 and equal probability of capture on each trapping occasion; this also implies that capture and marking do not affect the catchability of the animal.

We suggest that the above assumptions are either met or substantially reduced enough to provide for reasonable use of mark-recapture methods for estimation of grizzly bear population size in small areas. Use of radio collars to monitor which individual bears (bear-days estimate) are present or absent from the census area satisfies the assumption of population closure, or at least substantially reduces violation of the assumption. Assumption No. 2 is met even if 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. For example, during this study 1 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 concerns possible 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 valid and accurate, they have significant ramifications concerning use of this method for estimating bear numbers if substantiated by future replications.

One additional assumption 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 sows (marked or unmarked), the total population estimate, which includes bears of all ages, must be used with caution. Because of the first observation, similar problems could also occur during the mating season when a second adult is sighted. 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. commun.). However, this problem does not appear to cause problems with the point estimate.

Use of mark-recapture procedures in this study was successful partly because a relatively high (>50%) proportion of the population has been 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 1990b). 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, time consuming, and imprecise.

Eberhardt (1989) recently evaluated use of mark-recapture methods for estimating grizzly bear densities. He concluded that the mean of the daily Petersen estimates was preferable to the bear-days estimator that we used in this study. Using his method of calculation on our data set resulted in bear density estimates that appeared greater than those obtained by using the bear-days estimator; the adult (>3-years-old) population estimate would have been 35 with a 80% CI of 22 to 48 (95% CI = 13-57), and the total estimate would have increased to 49 ± 20 (80% CI). However, Eberhardt's method is very sensitive to outlying observations that can produce erroneous estimates (ADF&G files). Day No. 1 of our census could be considered an outlier because no marked bears were observed. If day No. 1 were excluded from the analysis for both bear-days estimator and Eberhardt's method, the resulting population estimates are nearly identical.

Density Comparisons

Our reported total density estimate of 1 bear/50 km^2 (based upon the bear-days estimator) was near the midpoint of published density estimates for arctic study areas in North America (Table 40). If we had used the mean of the daily Peterson estimates, as suggested by Eberhardt, the total density would have been one of the greatest in an arctic environment. Reynolds (1982) reported that for North Slope Alaska populations, high bear densities in optimum habitat approached 1 bear/50 km^2 and low density in lower quality habitats was about 1 bear/207 km^2. Most grizzly bear density estimates are based on total numbers of bears observed over several years of study; consequently, they are imprecise, containing no objective estimate of area occupied by the population. Because a high proportion of our census area was composed of denning habitat, it is not representative of average bear densities in northwest Alaska. Ninety percent of the marked and unmarked bears observed during the survey period were located in the mountainous portions of the study area (Fig. 2, CA;s 5-10). Only 10% of the bears observed during the surveys were found in CA's characterized by lower elevation terrain (i.e., Nos. 1-4), and 80% of those observations were within CA No. 4. Typically, bears move out of the mountainous terrain and inhabit lower-lying areas as spring and summer progress (Ballard et al. 1988). A similar distribution of bears was evident during 1986, when we initially captured bears for movements and demographic studies.

During the spring of 1986, we captured 48 bears (31 of which we radio-collared) to aid in defining a census area boundary but also to minimize potential observability biases for sows with COY. During that capture effort, we attempted to search all portions of the NRSA equally. Thirty-one bears were captured in the mountainous portions of the NRSA, and 17 (45% fewer) were captured in the southern half. We concluded that our reported bear density estimates are probably representative of high-quality denning habitat in an arctic ecosystem and not of overall year-round habitat.

Current Status, Survival, and Mortality among Radio-collared Bears

Since inception of this study, 14 (20.9%) of 67 adult radio-collared bears have been killed by hunters (Table 41). Status of 43 adult radio-collared females as of 1 November 1990 was as follows: 25 (58.1%) had functioning collars upon entering dens, two (4.7%) had shed their collars and their current status was unknown, eight (18.6%) were missing due to malfunctioning collars or unreported harvest, seven (16.3%) had been shot by hunters, and one (2.3%) died in a snow avalanche. As of November 1990, the status of the 24 males radio-collared during the study was as follows: seven (29.2%) had prematurely shed their collars that had been put on too loosely and their current status was unknown, one (4.2%) was missing because of a malfunctioning collar or unreported harvest, seven (29.2%) had been shot, and one (4.2%) had been probably killed by wolves. Rate of collar slippage was relatively high in this study, but we wanted to avoid rub marks or lacerations from the collars, particularly on young males. Excluding slipped collars, 24.1% of the radio-collared bears (41.2% of the males and 17.1% of the females) were killed by hunters; the latter statistic also includes all reported defense-of-life-or-property kills during 1986-1990 (one). If we also excluded missing animals, 28.6% of the radio-collared bears had been shot (43.8% of males and 21.2% of females) by late 1990.

Alaskan biologists have frequently used the sex and age structure of the harvest as 1 bear management tool. We compared the sex and age structure of harvested grizzly bears in GMU 23 from 1969 through 1989 with the sex and age structure of bears captured in the NRSA during 1986 through 1990 (Figs. 41 and 42). The age structure of captured males was more skewed towards younger bears compared with the age structure of the 20-year harvest. Apparently, historical harvests appear to have reduced the numbers of older males in the NRSA bear population. In comparison, the age structure of captured females does not appear to be as skewed towards younger age classes. The skewed age structure of males observed in this study is one indication that the population may be over-exploited. If hunters select larger, older bears attempts to increase bear harvests may put additional pressure on adult females. Such changes could reduce the bear population as has occurred in other bear populations such as GMU 13 in southcentral Alaska (Miller and Miller 1988, Miller 1990b).

Survival rates of COY during their first summer of life were relatively high, averaging 0.874 (Table 42). Unfortunately, this rate may have overestimated survival because 67% of the females without COY had apparently produced COY but lost them between den emergence and capture (Table 2). Consequently, these lost COY would not have been included in our estimates. Survival of COY through their first winter was also relatively high, averaging 0.955 (Table 43). There were no differences in COY survival rates among years (range of t = 0.316 to 2.15, $P > 0.05$).

Yearling grizzly bear survival rates during the study averaged 0.887 (Table 44). There were no differences in yearling survival rates among years (t = 0.610 to 1.565, $P > 0.05$).

Adult female survival rates averaged 0.940 (Table 45). There were no significant differences ($P > 0.05$) in survival rates among years. Eight of 43 radio-collars on females prematurely failed, so they were censored from the survival data set. Because we replaced radio collars every 2 years, the number of premature radio failures should have been low. We heard rumors that some bears had been shot but not sealed. Loon and Georgette (1989) reported that most bears killed by subsistence users had not been to Department officials. They estimated that only 14% to 18% of the rural harvest was actually reported. If this is correct, there is a high probability that many of the missing adult females may have been shot and not reported. Five of 8 missing standard format collars occurred between 15 May and 25 June; the others were lost after 4 September. If we assumed all of these missing radio-collared females have been shot, the overall survival rate would decline to 0.879 (Table 46).

Survival rates of adult males during 1986 through 1988 averaged 0.906, ranging from 0.838 in 1987 to 0.929 in 1986 (Table 47). There were no differences in survival rates among years ($P >$ 0.05) nor were there differences between adult males and females. We removed collars from males after 1988 because project objectives had been met. Only 1 radio collar was classified as missing during the 3-year period we maintained radio contact with males.

Assessment of Population Status and Harvest Impacts

One of the objectives of this study was to resolve conflicting views over the status of grizzly bears in northwest Alaska. Some local residents have expressed concerns about losses of property and potential threats to human life (Larsen 1988). Some residents of Unit 23 also believe that bear populations are currently higher than historical levels (Loon and Georgette 1989). Because of these concerns and because grizzly bears are classified as a "subsistence use" species in northwest Alaska, many local residents have advocated liberalizing grizzly bear hunting seasons and bag limits. "Subsistence use" is defined as "customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation and for the making and selling of inedible portions for handicraft articles for barter, customary trade, and sharing (ANILCA, P. L. 96-487, Title 8, 1980])." Many local residents of Unit 23 believe bear densities are too nigh, prefering a smaller population (Loon and Georgette 1989).

Alaska hunting regulations require that the hide and skull of all grizzly bears harvested be presented to officials of the Alaska Department of Fish and Game (ADF&G) within 30 days of the date of harvest for sealing. Sealing of beacurrently r hides and skulls has been required since statehood (1953), but compliance in some Unit's, especially Unit 23, has been low. Annual reported harvests of grizzly bears therehave gradually increased over the years (Fig. 43), ranging from eight in 1962 to a high of 57 in 1979. Since 1979 annual reported harvests have ranged between 22 and 48. Patterns of annual reported harvests within the bear study area have paralleled those of the unit but an increasing proportion of the total unit harvest has come from NRSA (Fig. 44). There has been no trend in the proportion of the reported harvest composed of females (Fig. 45).

Use of grizzly bears for food is widespread in Unit 23 (Loon and Georgette 1989). Based on key respondent interviews in selected villages, Loon and Georgette (1989) estimated that only 14-18% of actual harvests of grizzly bears are reported to the ADF&G. Most of the reported harvests were by nonlocal Alaska residents and nonresidents (Larsen 1988). Compliance with sealing regulations by guides and nonlocal residents is thought to be high. Although the accuracy and precision of Loon and Georgette's (1989) harvest estimate, noncompliance with regulations, and historic use of bears are not known because of the methodology used, they provide the only attempt at quantification of these parameters. If we assume their estimates were correct, the actual harvests in Unit 23 could be from 103% to 142% larger than reported. Many knowledgeable authorities consider the use of harvest statistics for assessing population status as marginal at best, even when the sex and age structure of a high proportion of the harvest is known (Harris 1984; Harris and Metzgar 1987<u>a</u>, 1987<u>b</u>). The use of such data, when $\geq$50% of the harvest is unreported, would be nearly meaningless. Because of unreported harvests and problems with using harvest data to assess population status, it was necessary to evaluate the status of the population and the potential for allowing higher harvests using other methods in addition to harvests.

To assess the potential impacts of human harvests on the study area population, it was necessary to extrapolate the bear density estimate from the census area to a much larger area, herein refereed to as "Harvest Area" (HA), and compare this estimate with known minimum harvests. We estimated the total bear population within the NRSA and adjacent areas (Fig. 46). This area encompassed nearly all of the home ranges of the radio-collared bears (i.e., as determined in 1986 and 1987). For this analysis, we assumed that bear densities in the mountainous portions of the NRSA were similar to those in the census area (1 bear/50.5 km^2). In the lower elevation southern areas, we assumed densities were 50% lower or about 1 bear/100.5 km^2. This was based upon the distribution of bear sightings and captures in 1986 and 1987. Based on our stratification of the HA, these densities were then extrapolated to the HA into 1 of 2 density strata. Approximately 5,947 km^2 were classified as high-density habitat and 6,932 km^2 as low-density habitat. The extrapolated bear population for the 12,879 km^2 area (Fig. 46) was 188 bears, or 1 bear/69 km^2. If our stratification was correct, overall bear density was much lower than the 1 bear/50 km^2 reported in Table 40.

Minimum reported annual harvests within the NRSA harvest area have ranged from zero to 23. From 1983 through 1989, reported harvests have ranged from 4 to 23. Comparison of these latter annual harvests with the estimated size of the bear population results in annual harvest rates ranging from 2.1% to 12.2% of the bear population (Fig. 47). If estimated unreported harvests from communities within or adjacent to the NRSA (Noatak, Kivalina, and 25% of Kotzebue harvests from Loon and Georgette [1989]) were added to known reported harvests, the estimated annual harvest rates during 1983 through 1989 would increase to 3.7-15.7%. However, these rates may also be low, because in additon to unreported subsistence harvests, a number of unreported defense-of-life-or-property kills were known to have occurred (ADF&G files). These latter kills were not represented in Loon and Georgette's (1989) sample. Earlier, Ballard et al. (1990) used Eberhardt's method of estimating bear density, in addition to the bear-days estimator. Because no marked bears were observed during the first day of the census, the use of Eberhardt's method resulted in an overestimation of the density. Consequently, the annual harvest rates of 6-12% reported by Ballard et al. (1990) underestimated the actual rates and should be disregarded. However, the reported harvest rates of 8-16% reported by Ballard et al. (1990) (i.e., using the bear-days estimator) are still valid.

We also attempted to assess allowable harvests for this bear population using population modeling. We used the deterministic model developed by Miller and Miller (1988). The model allows users to input reproductive and mortality parameters from their individual study area. Relative mortalities of each age class are estimated based on study data or estimates provided in the literature. Although the model has a number of uses, we were most interested in the predicted allowable harvests using our reproductive and mortality data. After inputting our best estimates of survival (Tables 42 through 47) to determine allowable harvests, survival rates are then adjusted until the population growth curve becomes level. When recruitment equals mortality the population is stable. This exercise suggested that our estimates of adult male survival may have been too high and that mortalities for the 2- to 4-year-old age classes may be relatively high. All simulations suggested that an annual harvest rate of about 8% may be sustainable, assuming males have a higher vulnerability to harvest than females.

Although our harvest rate estimates are admittedly crude, comparison with harvest rates reported elsewhere in North America (Grizzly bear compendium 1987:81, LeFranc et al. 1987) suggests that current harvests approach or possibly exceed the maximum allowable harvest. They certainly exceed the conservative exploitation rates of 2-4% recommended for northerly latitudes by Lortie (unpubl. data), Reynolds (1976), and Sidororowicz and Gilbert (1981). They also exceed the 5.7% maximum sustainable rates for grizzly bears suggested by Miller (1990a), who used "generous estimates of reproductive rates and survivorship." Even if our estimates are only a rough approximation of actual harvest rates, combined with modeling efforts they suggest that hunting seasons and bag limits cannot be liberalized without causing a reduction in the bear population. If unreported harvests are actually larger than our estimates, the population is probably being overexploited and restrictions in harvest may be appropriate.

Some local residents have expressed a desire for changes in current bear hunting regulations so that customary and traditional uses and methods of harvest can be accommodated (Loon and Georgette 1989). Current bear hunting regulations in Unit 23 require that hunters possess a $25 tag and a state hunting license, take only one bear every 4 years, and present the skull and hide of all harvested bears to a ADF&G representative for sealing. When sealed, skull measurements are taken, a tooth is extracted for age determination, and sex is determined from the hide. Hunting seasons during this study were 1 September to 10 October and 15 April to 25 May. Nonresident hunters are restricted by permit to a maximum harvest of 25 bears (7 permits in the spring and 18 permits in the autumn). A number of proposed changes to these regulations were made and discussed during this study.

Loon and Georgette (1989) reported that the bag limit of 1 bear/4 years was largely ignored by local hunters. Apparently, some hunters killed many bears, while others killed bears less frequently or not at all. Because it is traditional for only a few hunters to do the majority of the hunting for most villages, the concept of a bag limits clashes with this tradition.

Subsistence hunters prefer to hunt in spring and autumn, but current hunting season lengths are not adequate (Loon and Georgette 1989). Apparently, hunters frequently take bears as soon as they emerge from their dens; in inland areas, this can be as early as March or as late as May. Such harvest practises must be dependent on snow machines for access. Bears, particularly boars that emerge first, are particularly vulnerable to this type of hunting, because den sites are usually easy to spot, and access by snow machine is relatively easy.

Loon and Georgette (1989) also reported that requiring subsistence hunters to salvage the skull and hide conflicts with traditional practices because some hunters leave the skull in the field or in camp as a sign of respect for the bear and that sealing is an additional burden on them. Subsistence users also believe that regulations should require the salvage of meat (Loon and Georgette 1989). Current regulations only require the salvage of the hide and skull. During our study we found 1 instance of a marked bear that had been obviously killed for meat rather than hide. In that case the skull, radio collar, ear tags, and hide had been left at the kill site, while the 4 quarters and other parts had been removed.

Current hunting regulations require hunters to possess a state hunting license (cost was 25 cents prior to this year; it now costs $5.00) and a $25.00 special bear tag. Loon and Georgette (1989) suggested that many local hunters view the purchase of a special tag as an announcement of the hunters intention to kill a bear, which conflicts with their traditional values.

Current state regulations also prohibit the taking of female bears accompanied by cubs (includes COY and yearlings) and the purchase, selling, or bartering of any bear part. Whether these issues also impose undue restrictions on subsistence bear hunters has not been determined.

If all of the suggested changes mentioned so far were implemented, there would be few, if any, restrictions on the harvesting of grizzly bears by subsistence users. The current system of bear hunting regulations in Alaska was developed over a period of years in response to an ever-increasing demand on a limited supply of bears. Seasons and bag limits were imposed as methods of limiting the harvest within sustained-yield limits. We do concur, however, that the regulations are biased towards trophy hunting rather than toward use of bears as meat.

Although only 14% to 18% of the bear harvest by subsistence users may be reported, what is not known is how many subsistence hunters comply with state hunting regulations to some degree. Certainly fear of being apprehended and general respect for laws cause some individuals to comply with all or some of the regulations. Because the bear population in the study area and surrounding adjacent area is probably being harvested at or above sustained-yield levels, eliminating all restrictions on bear hunting would in our opinion have disastrous consequences for the bear population. This is particularly true, given the widespread availability of snow machines, motor boats, and aircraft in northwest Alaska. Loon and Georgette (1989:49) maintain that local hunters would be more likely to report their bear harvests if regulations accommodated their hunting practices and the reporting procedure was simple. However, caribou hunting regulations have been changed in relatively recent years to accommodate some of their hunting practices and the reporting system is quite simple, but reporting compliance is still low. If compliance with bear hunting regulations could be enforced, some changes in bear hunting regulations might be possible and appropriate.

Some individuals have suggested that bag limits and season dates could be eliminated for resident subsistence hunters by establishing a village quota system; however, whether such regulations are legally possible needs to be established. Such a system would have to be administered by village IRA councils or some other local organization. Compliance would have to be strictly enforced. We recommend initial quotas be established, based on the findings of Loon and Georgette (1989), and that additional refinement occur through joint research by the Division of Wildlife Conservation, Division of Subsistence, National Park Service, and Fish and Wildlife Service. Currently, all objective analyses suggest that current harvests are at or above sustained-yield levels. Changes in subsistence harvest regulations must result in improvements in harvest reporting for such a system to work.

Biologists have traditionally used the sex and age structure of the harvest as one tool for assessing the trend and status of a bear population. For the method to work, however, a large representative portion of the total harvest must be reported and the appropriate biological samples collected. Because most of the subsistence harvest is not reported, such data are now probably meaningless. Few other relatively inexpensive alternatives for bear management exist, however. Apparently, some subsistence hunters would prefer not to retrieve the skull and/or hide. This would result in loss of data concerning sex and age of the harvest. However, if hunters were required to return the front portion of the lower jaw and take several field measurements of their bear, the sealing requirement may not be necessary, so long as this information was collected and the total harvest statistic was accurate.

RECOMMENDATIONS

1. Maintain radio collars on 30 to 50 adult female grizzly bears for the next 5- to 10-year period. Because the bear population within a 13,000 Km^2 is being harvested at or above sustained-yield levels and the impacts of the Red Dog Mine have not yet been fully determined, maintaining a pool of radio-collared females will allow managers to continue to assess the impacts of harvest and gross impacts of the mine on the bear population. It also will allow managers to gather long-term productivity and mortality data, which will be necessary to determine sustainable harvest limits. Without maintaining a radio-collared sample of bears, biologists will have no way of distinguishing between harvest- or mine-related impacts.

2. Radio-collared females should be monitored more frequently during March through April to gather more accurate data on productivity and survival of COY and yearlings. Our low intensity monitoring efforts in late May and June underestimated initial bear mortality to COY and yearlings.

3. If research on grizzly bears continues, effort should be made to obtaining accurate estimates of survival rates of subadult bears, particularly 2- through 4-year-old age classes. Modeling exercises suggest these parameters are important for estimating sustainable harvest. These types of data are difficult to collect because of the expense involved with capturing subadults and use of temporary collars or frequently changing them.

4. A mark-recapture census should be repeated within the Red Dog Mine census area within the next 5 to 10 years. Full-scale ore production did not begin until 1990, so by 1995 many of the impacts from the mine on the bear population should be evident.

5. If the various agencies decide to continue research, we recommend that all bears encountered during capture operations be marked. This includes COY, yearlings, subadults, and unmarked males. Saturation-tagging permits managers to effectively track marked bears through the harvest. The latter may be particularly important, if large changes are to be made in bear hunting regulations to accommodate subsistence users.

6. Satellite telemetry should be used on selected bears to monitor how bears interact with the mine site. Even though the collars used in 1988 did not perform as advertised, they provided useful data on bear's use of garbage dumps in 1988, and they provided estimates of home range sizes and movement patterns equivalent to estimates based on 3-5 years of conventional telemetry data.

7. Changes in current bear hunting regulations are necessary to accommodate subsistence uses; however, if changes are made, a

strong enforcement effort will be necessary to ensure compliance with regulations and adequate conservation of the resource. If regulations are changed to accomodate subsistence users but total harvest reporting does not drasticly improve, the state will have lost authority to regulate harvests.

8. Management biologists need to closely monitor the status of grizzly bears in Unit 23. The popular belief in Unit 23 is that bears are numerous and populations need to be reduced. Nearly half of the total bear harvest in Unit 23 comes from the area where we studied bears. Some local residents believe that bear densities are at an all-time high in Unit 23. Informal conversations with guides and results of our own observations gained from hundreds of hours of flying in the Kobuk, Selawik, and Purcell Mountain areas suggested that grizzly bears are much less numerous in those areas than in the NRSA (ADF&G files). Results of a meeting with professional guides in 1988 also suggested that grizzly bear densities in other areas of Unit 23 are much lower than those reported for the Red Dog Mine census area (ADF&G files). If sustainable harvests within the unit are indeed larger than we have reported, additional objective data concerning distribution and abundance of bears is needed above and beyond public comments received so far. Perhaps additional censuses are required to confirm whether bear densities are at historic high levels.

9. An informational and educational program geared towards local residents is necessary to ensure adequate conservation of grizzly bears in northwest Alaska. Loon and Georgette (1989) reported that many local residents believe that grizzly bear populations are high. Local residents apparently have expressed concerns about "the growing number of bears in the region and the hazard they pose to children, cabins, camps, and food caches." Unfortunately, the location of several villages, such as Noatak and Kivilina, are adjacent to fish concentration areas where bears feed. At times local residents can come into contact with a relatively large proportion of the bear population that may be temporally concentrated at these sites. Local residents need additional information concerning the methods available for avoiding confrontations with bears and may, in some instances, need our assistance. Grizzly bears are an important national resource; they are one reason why the Northwest Areas National Parks and Wildlife Refuges were established. The nation has an interest in grizzly bear conservation, and managing bear numbers to satisfy subsistence users will not find sympathy with conservationists.

10. The Division of Wildlife Conservation should establish a bear management plan that sets population objectives, levels of harvest by various user groups, methods of implementation, and time-tables for implementation. The Division should determine which of the current bear hunting regulations are appropriate for northwest Alaska, draft new regulations if necessary, determine the timing and degree of enforcement required, and make

appropriate recommendations to the Alaska Board of Game. Most hunting regulations in northwest Alaska are ignored by subsistence users. Enforcement is minimal, and as a result, compliance is low. Without increased education and enforcement efforts, conservation of wildlife resources in northwest Alaska may be an insurmountable task.

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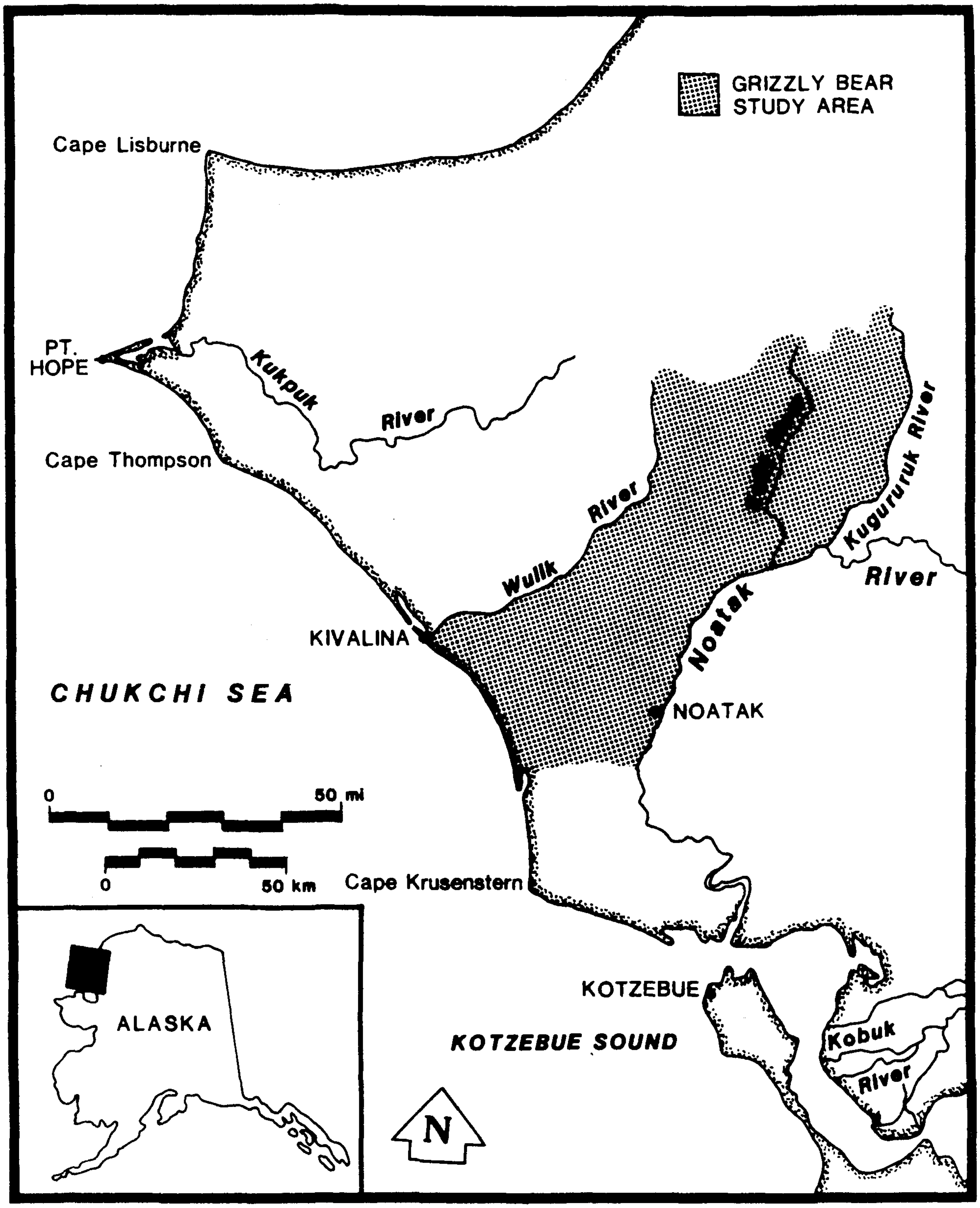

Fig. 1. Location and boundaries of Noatak River Study Area where grizzly bears were studied during 1986 through 1990 in northwest Alaska.

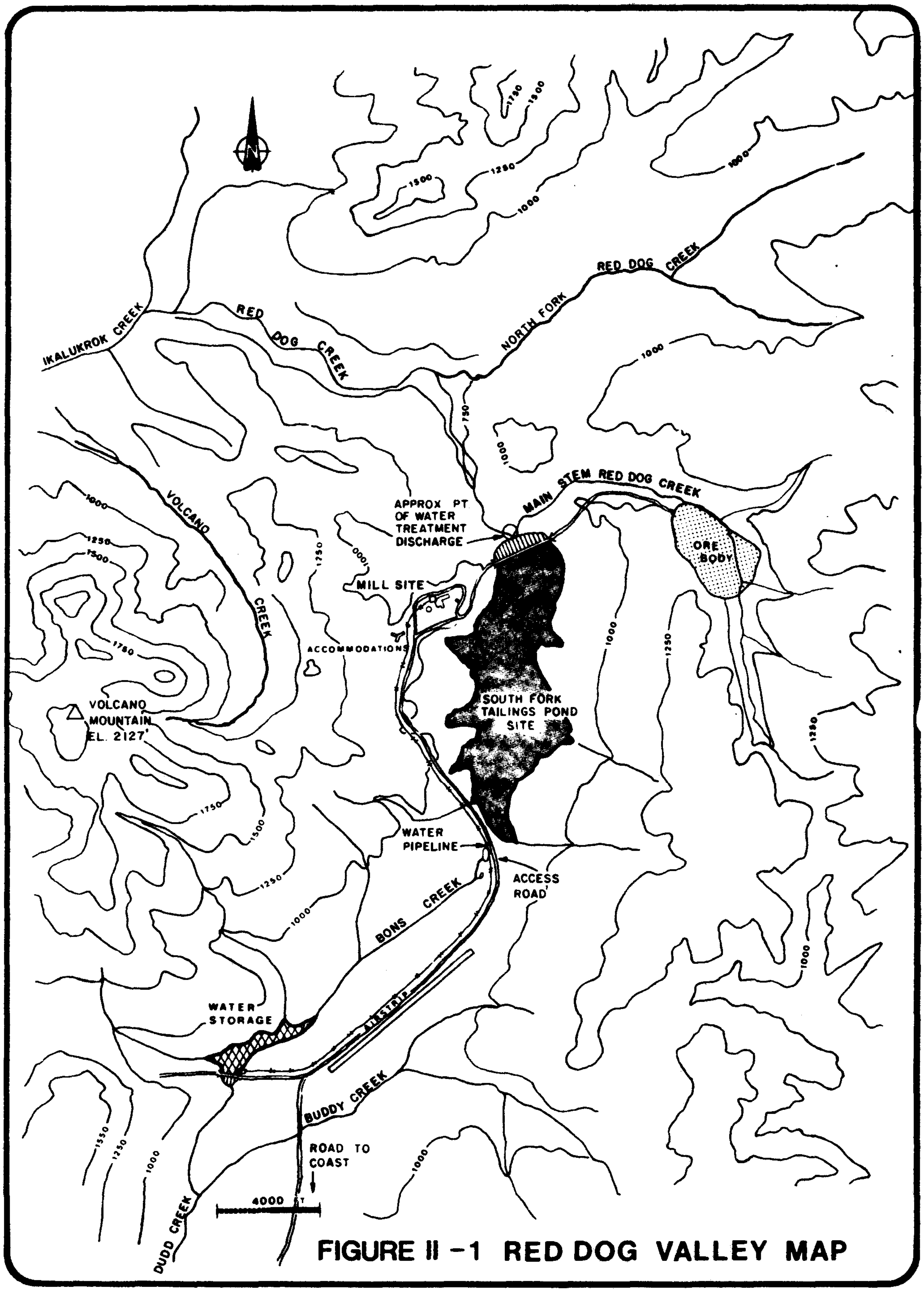

Fig. 2. Map of the Red Dog Mine project in northwest Alaska as envisioned at start up of full production of ore in 1990.

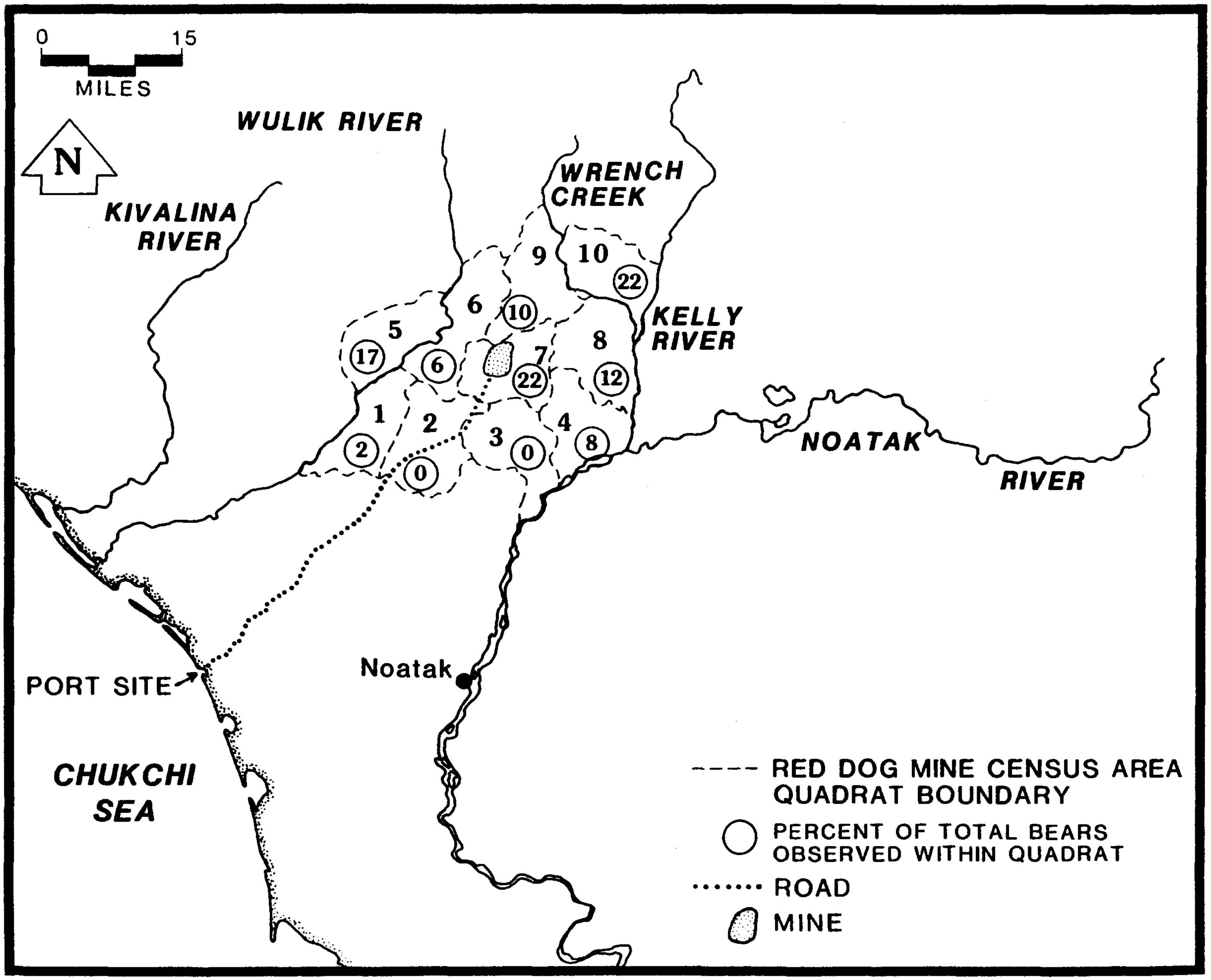

Fig. 3. Boundaries of Count Areas used to census grizzly bears within the Red Dog Mine Census Area of northwest Alaska from 29 May through 4 June 1987.

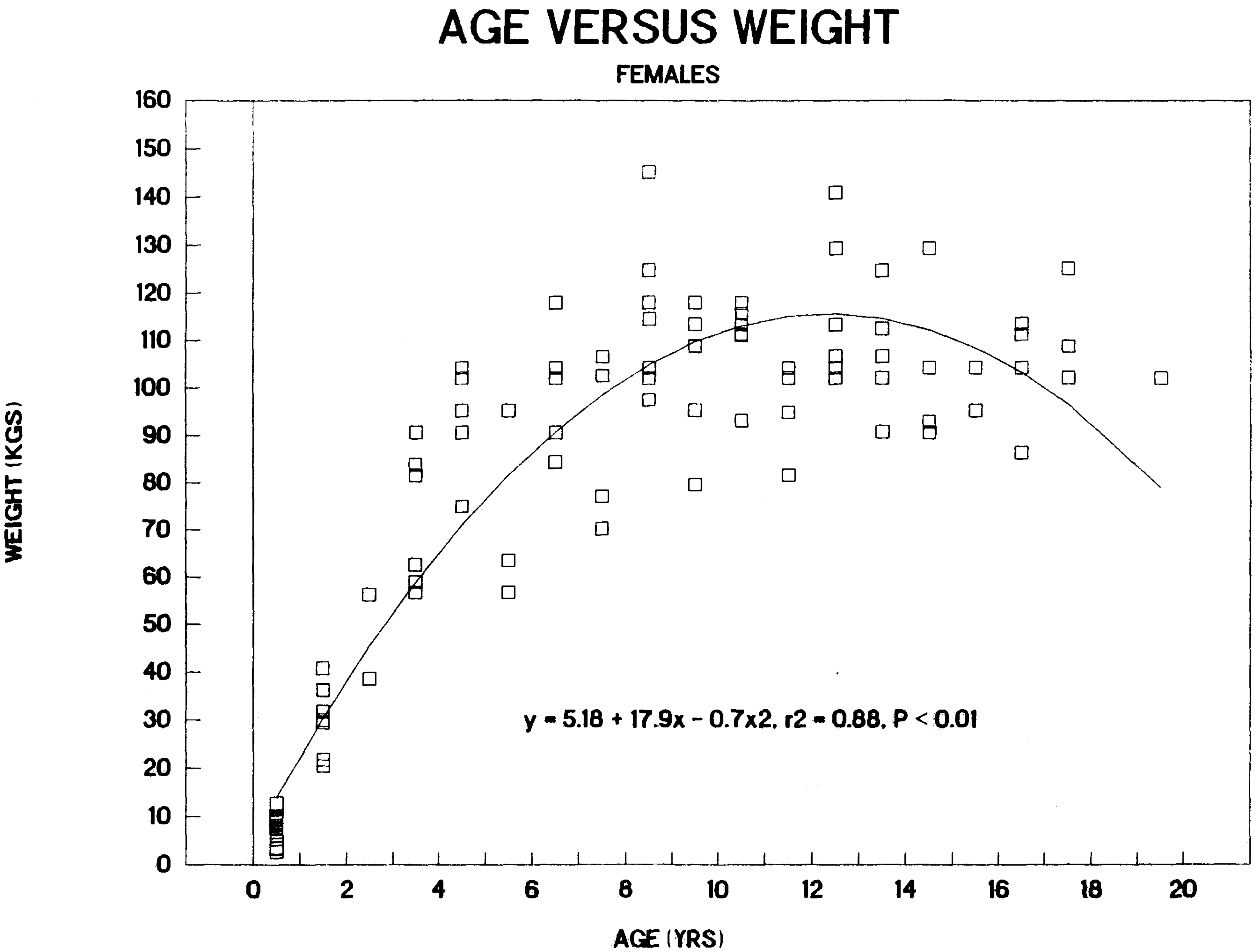

Fig. 4. Relationship between age and weight of female grizzly bears captured in northwest Alaska during 1986 through 1990.

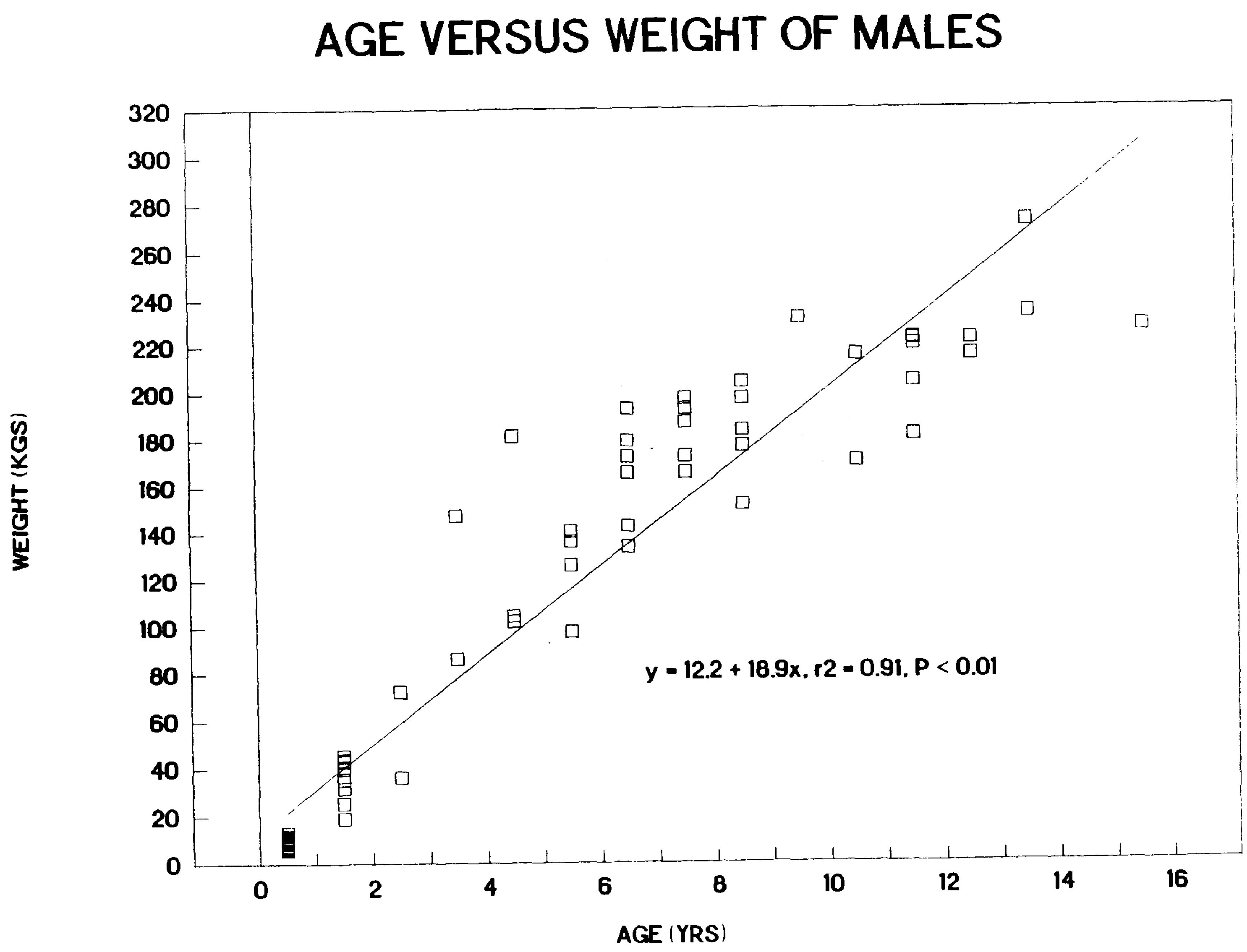

Fig. 5. Relationship between age and weight of male grizzly bears captured in northwest Alaska during 1986 through 1990.

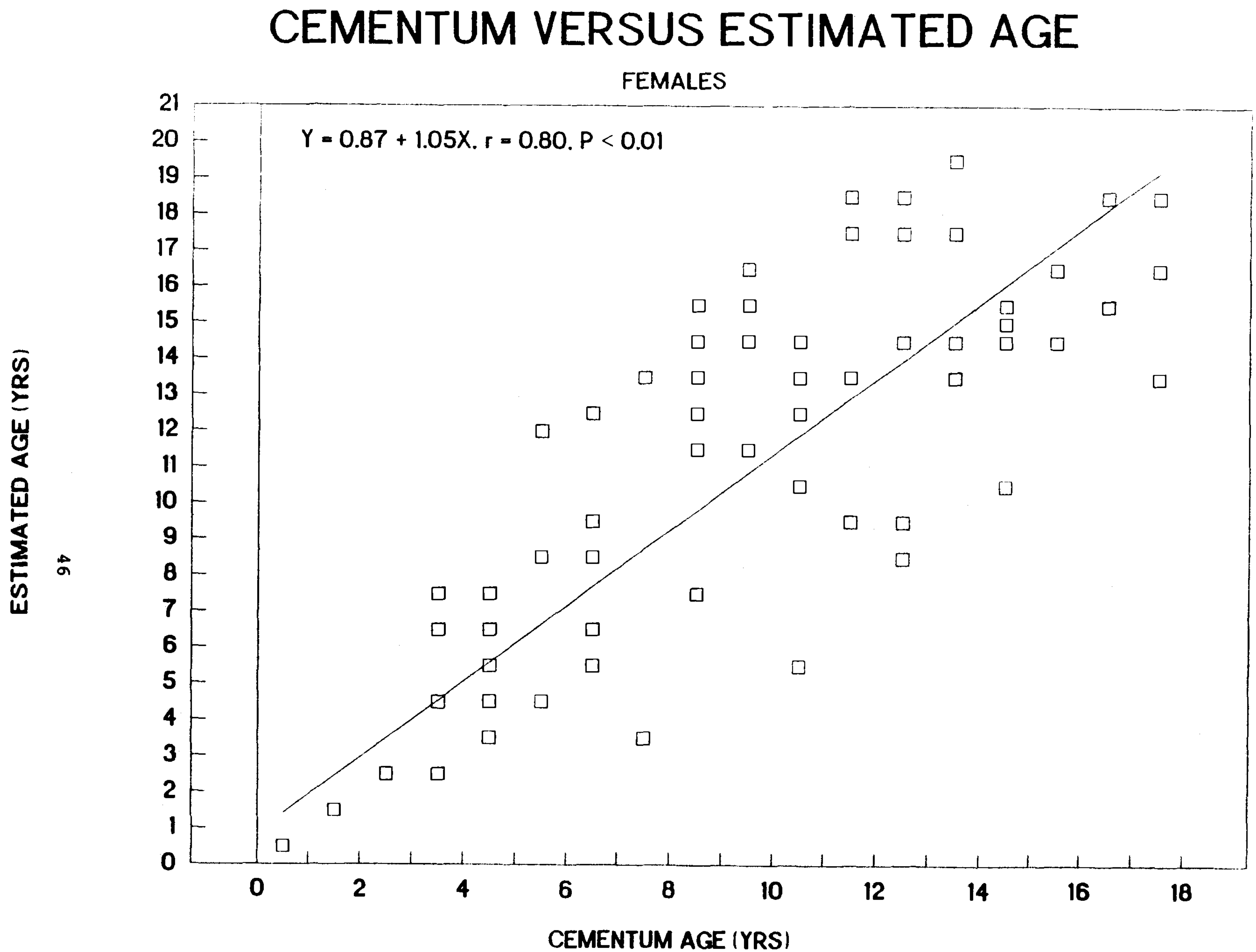

Fig. 6. Relationship between ages estimated from tooth wear and replacement versus those obtained from counts of cementum annuli of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

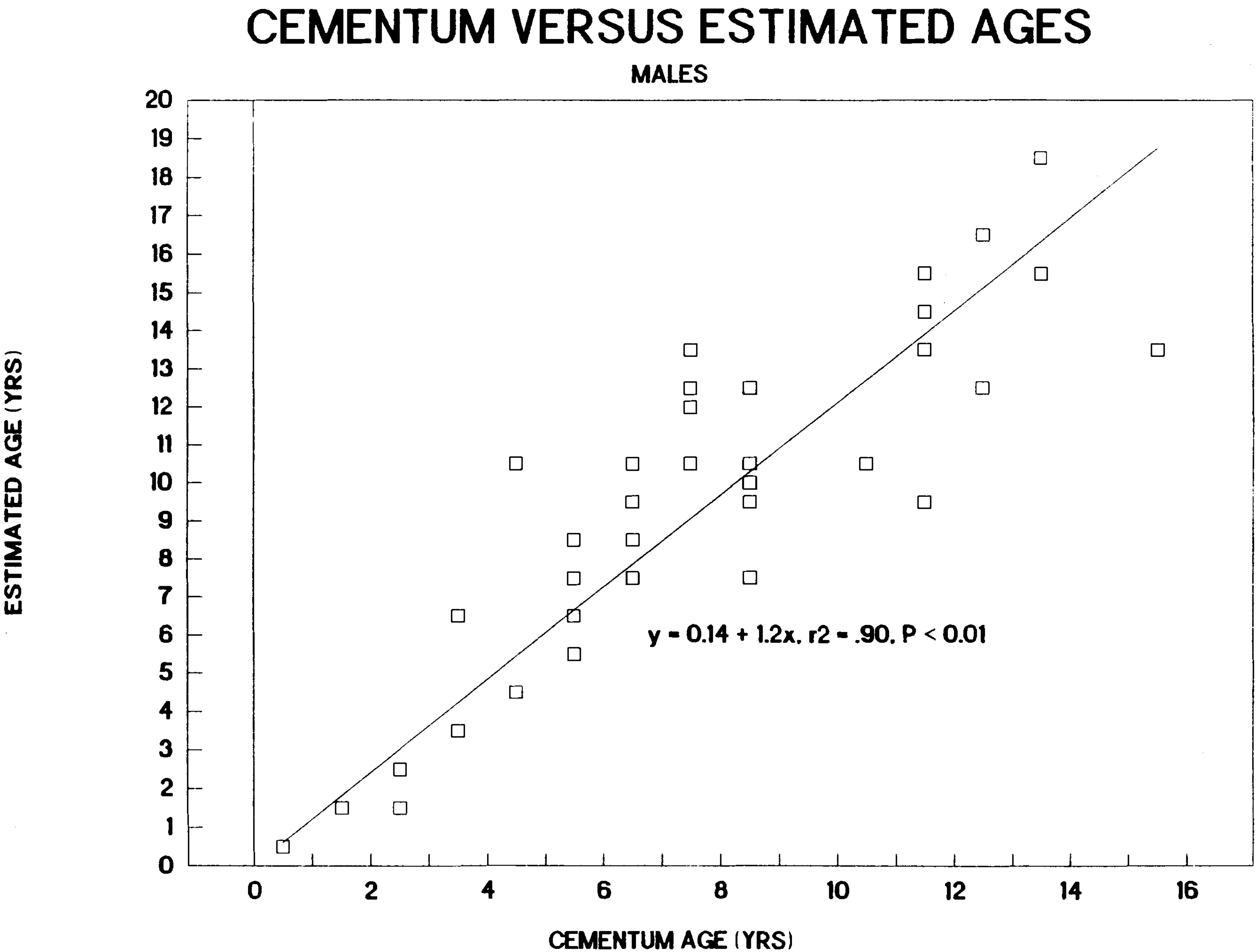

Fig. 7. Relationship between ages estimated from tooth wear and replacement versus those obtained from counts of cementum annuli of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

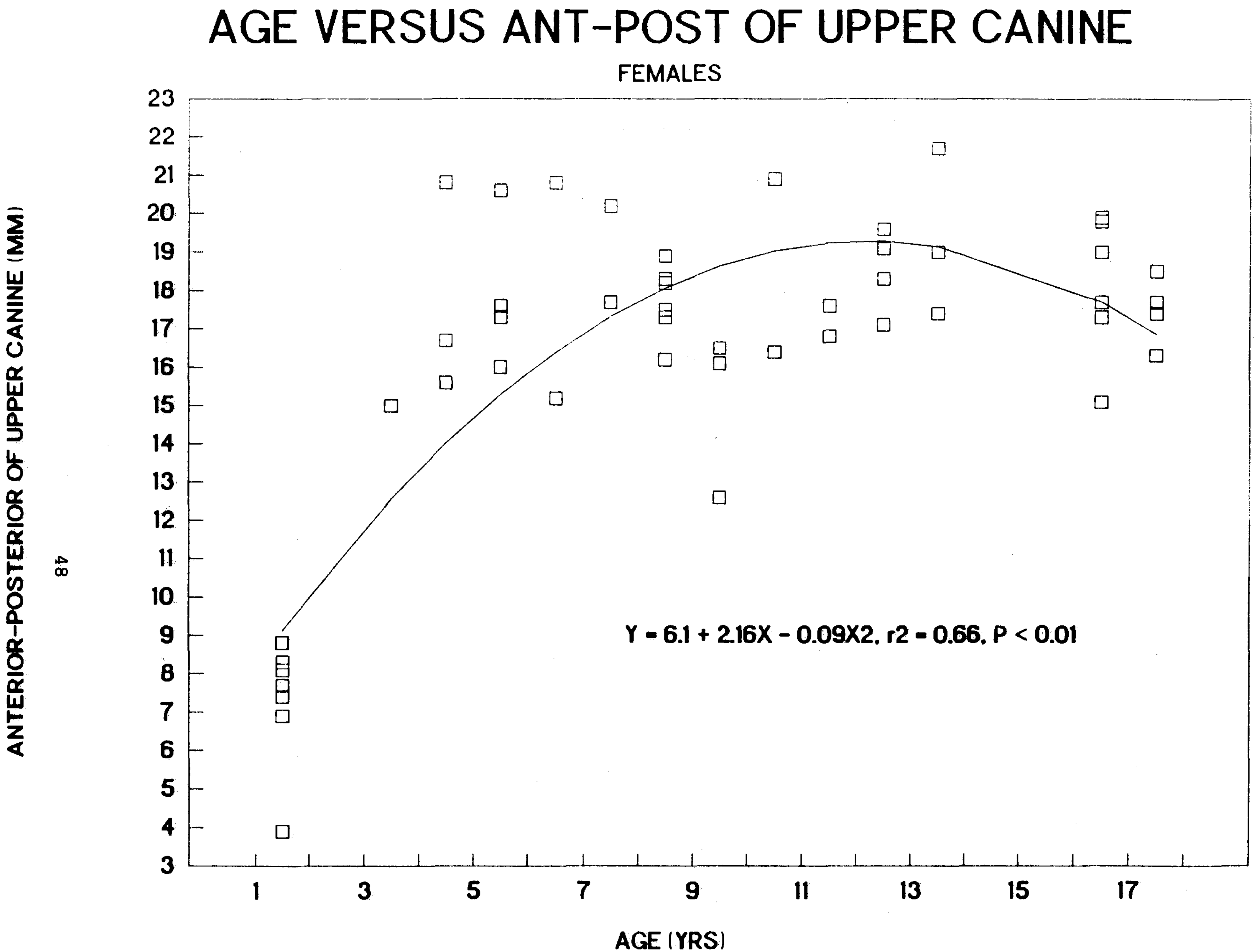

Fig. 8. Relationship between age and anterior-posterior measurements of the upper canine tooth at its base of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

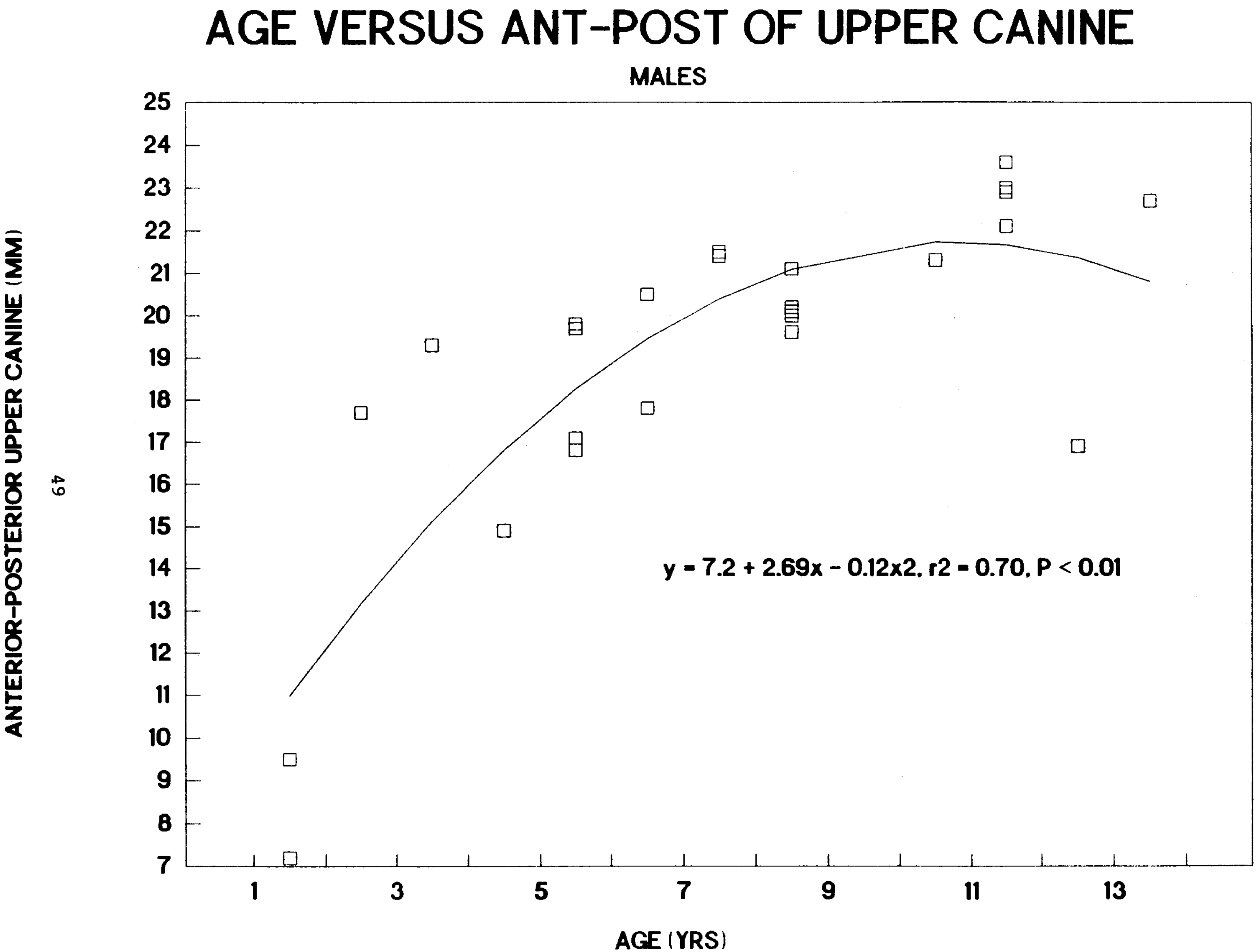

Fig. 9. Relationship between age and anterior-posterior measurements of the upper canine tooth at its base of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

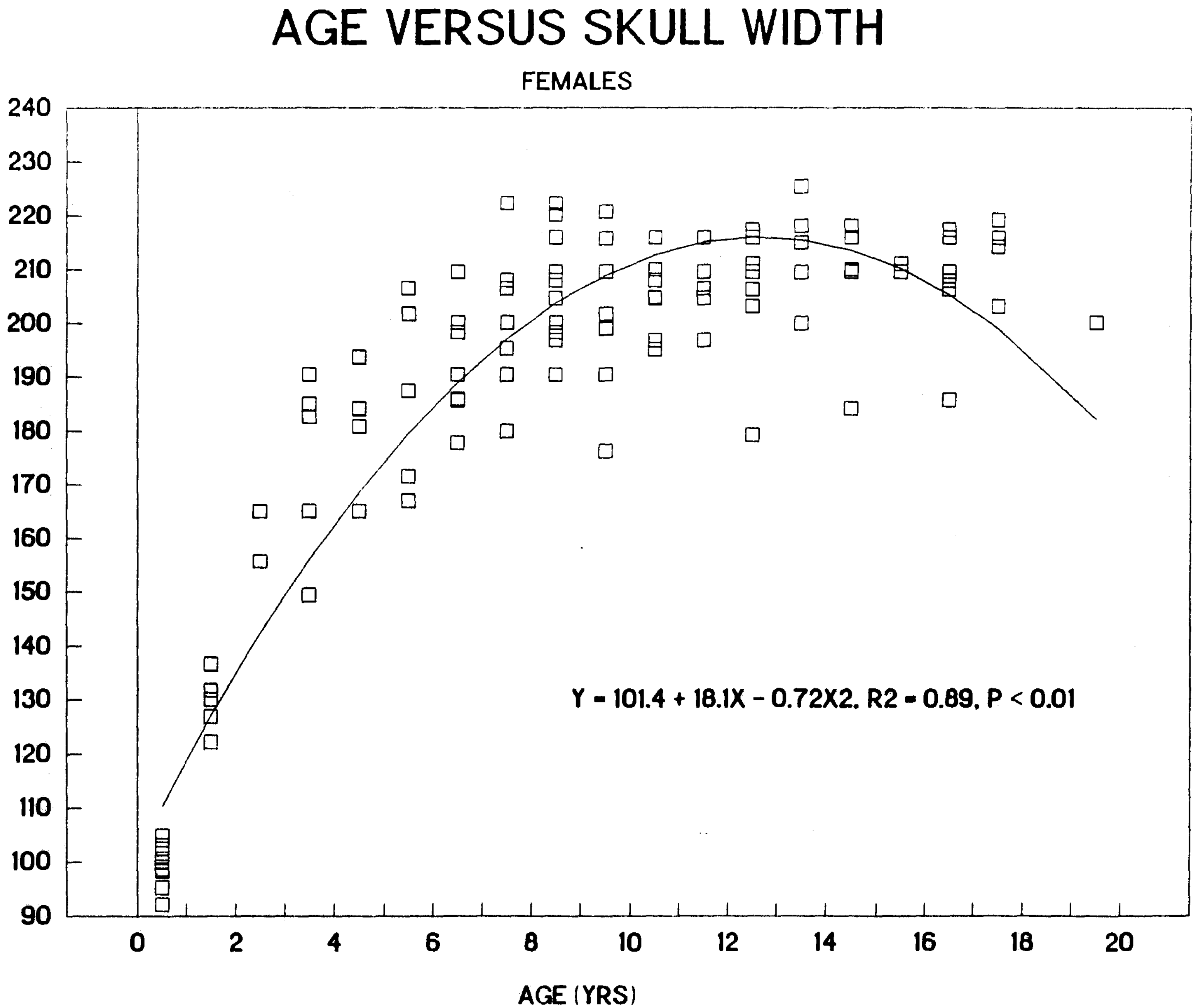

Fig. 10. Relationship between age and width of skull of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

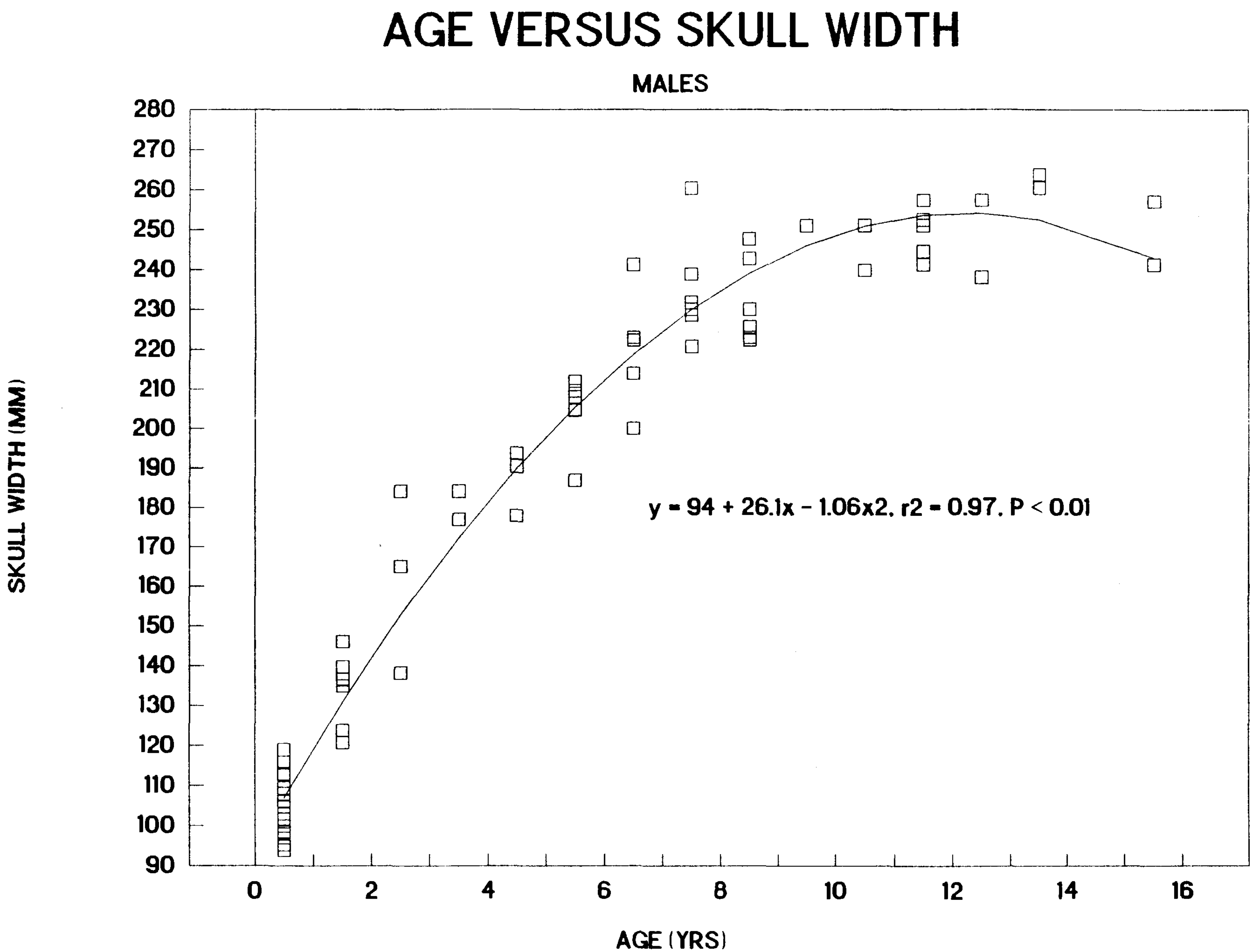

Fig. 11. Relationship between age and width of skull of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

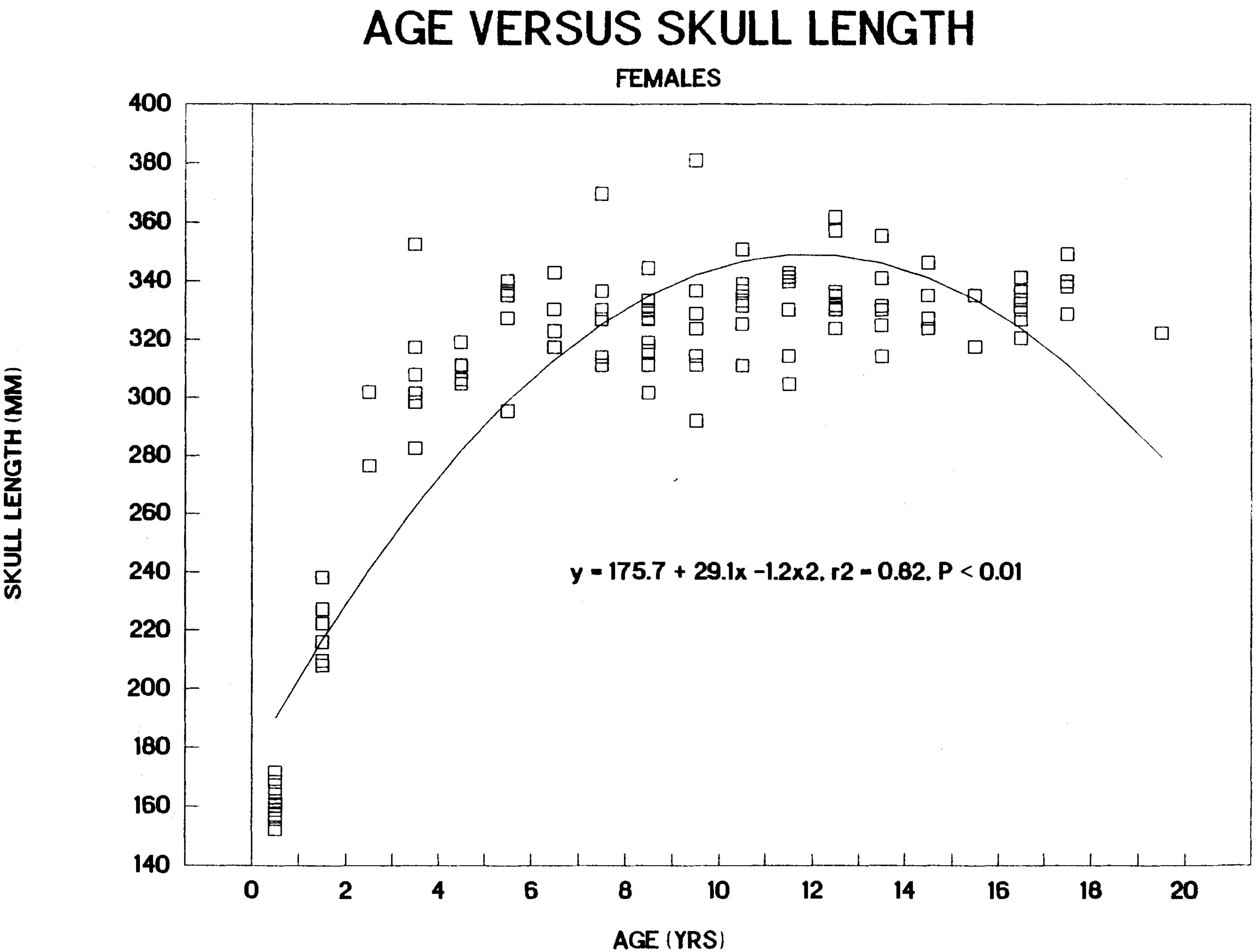

Fig. 12. Relationship between age and length of skull of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

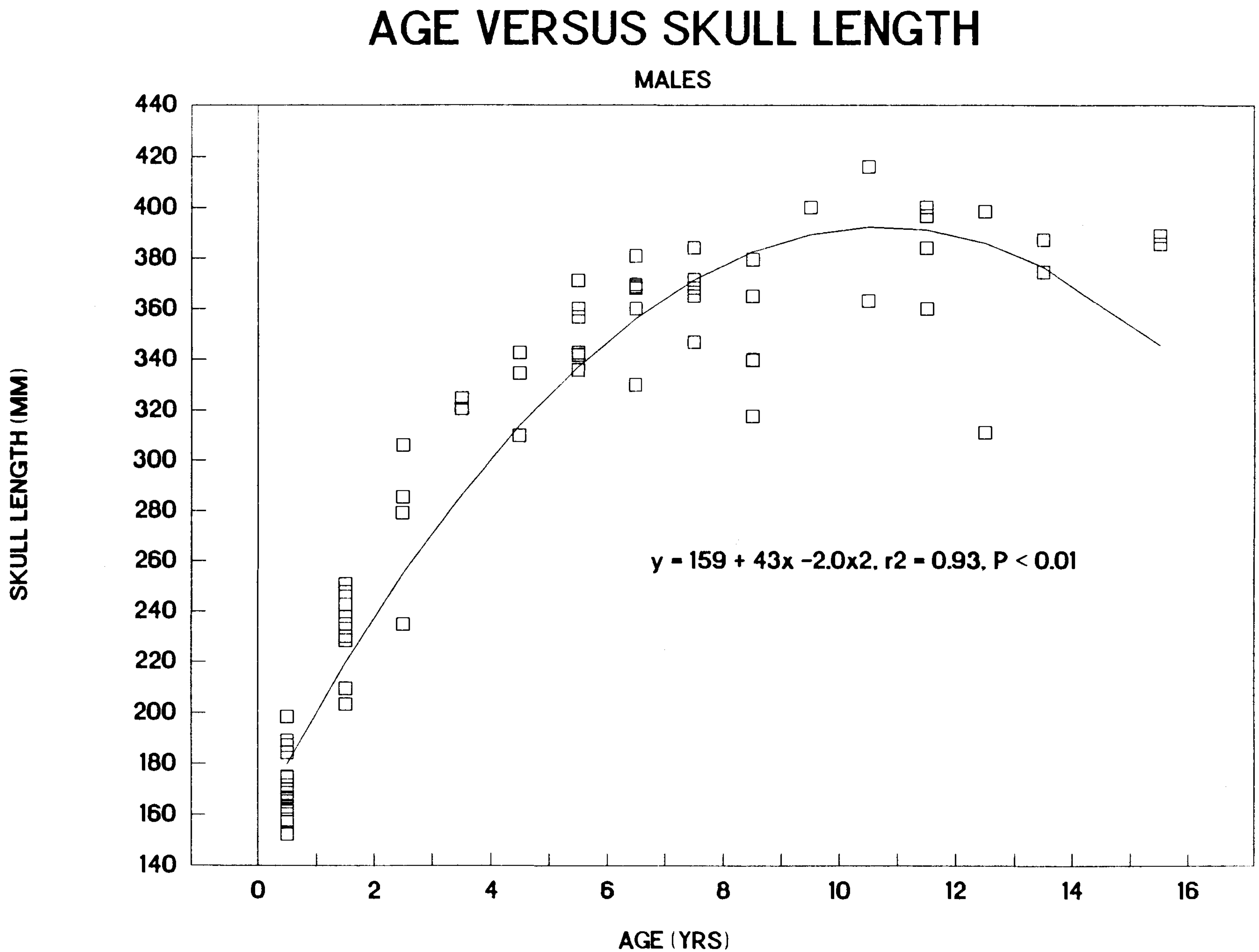

Fig. 13. Relationship between age and length of skull of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

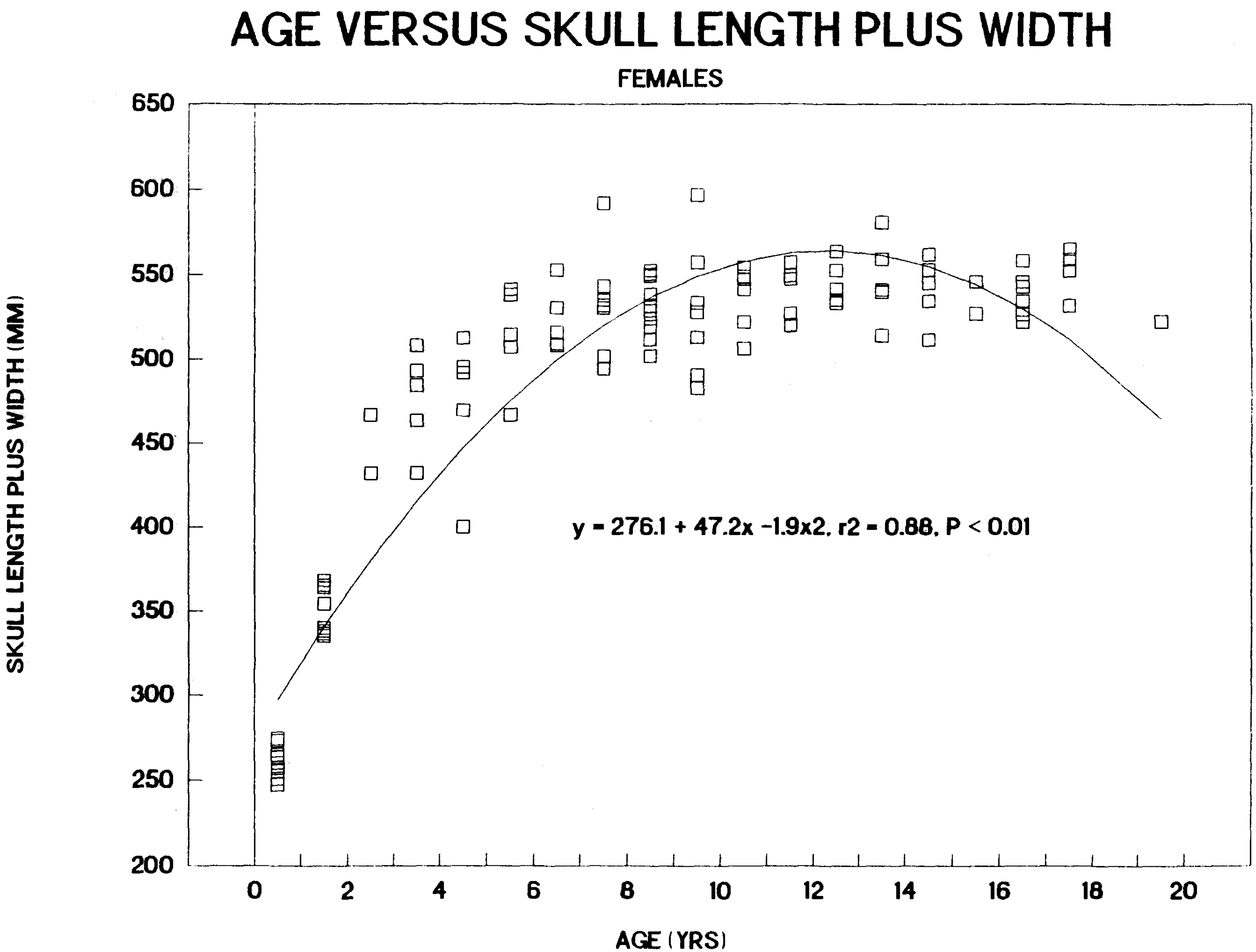

Fig. 14. Relationship between age and length plus width of skull of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

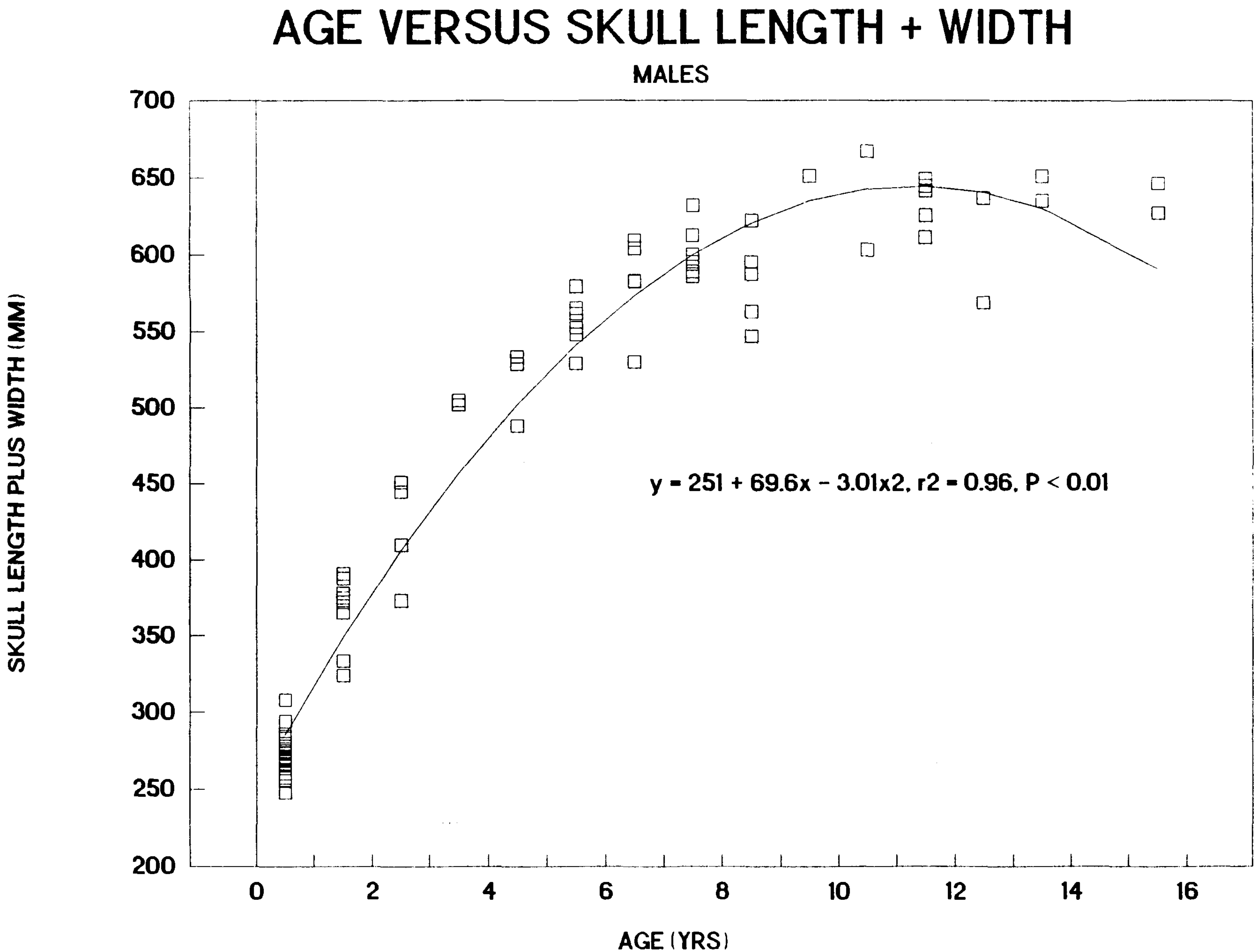

Fig. 15. Relationship between age and length plus width of skull of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

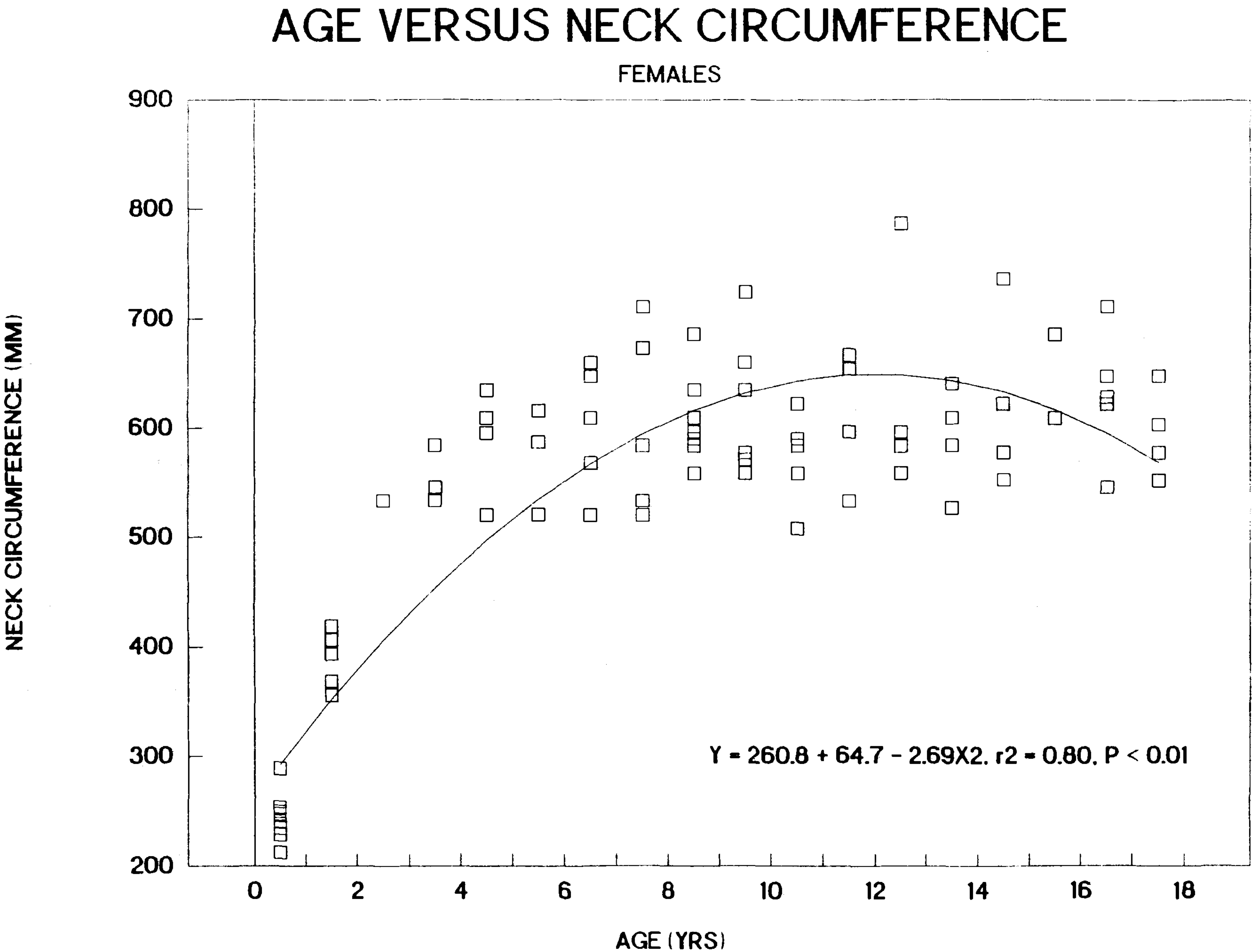

Fig. 16. Relationship between age and neck circumference of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

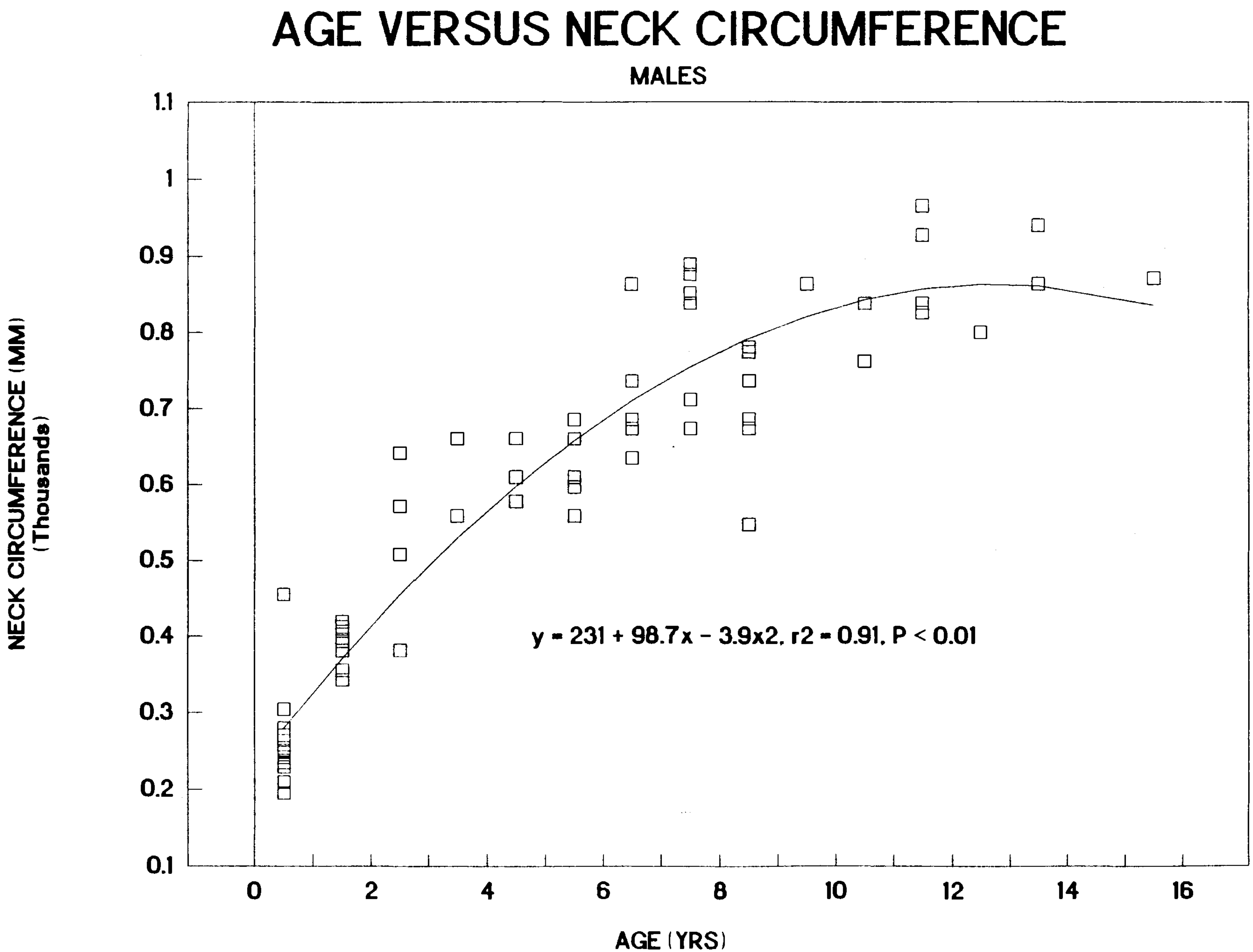

Fig. 17. Relationship between age and neck circumference of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

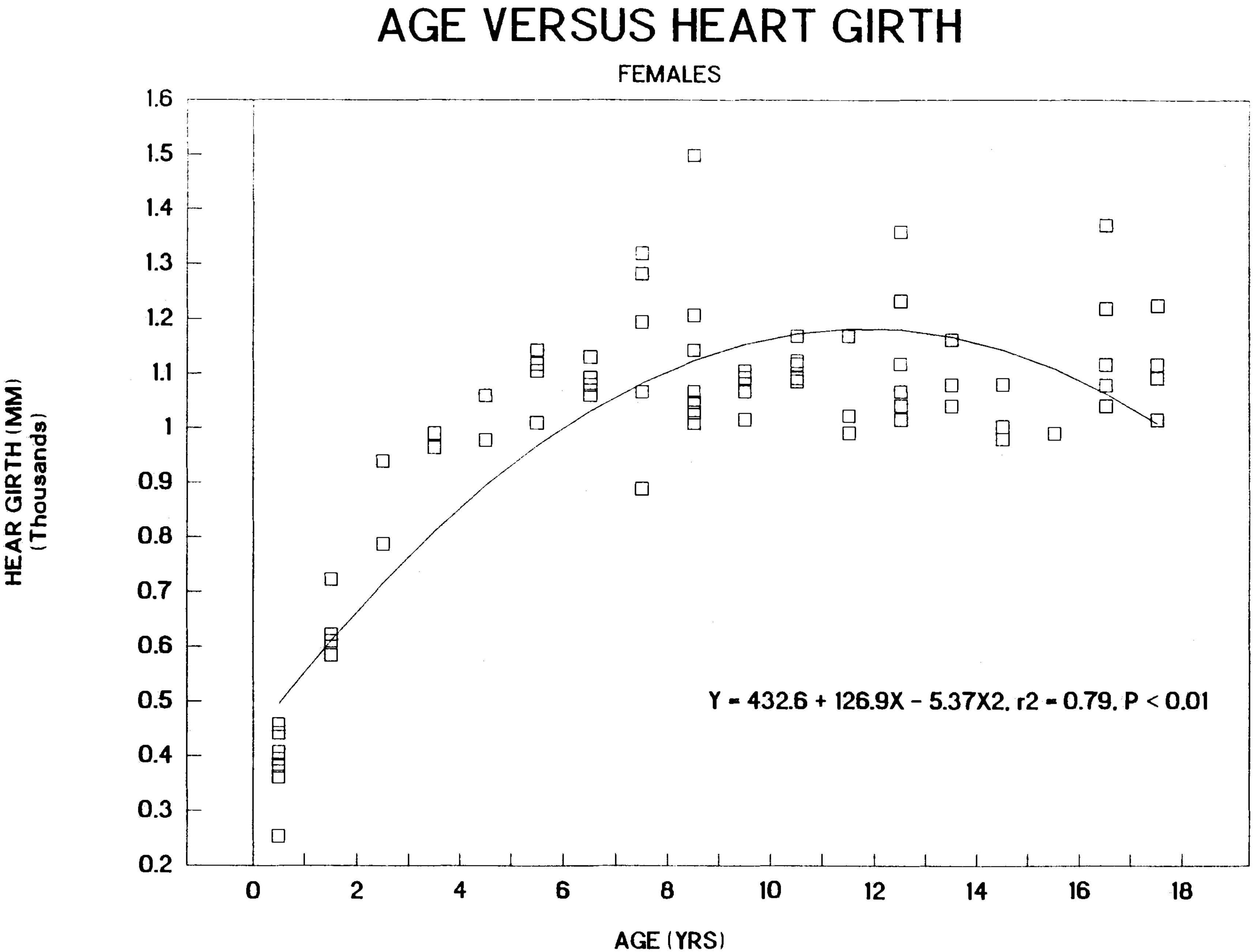

Fig. 18. Relationship between age and heart girth circumference of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

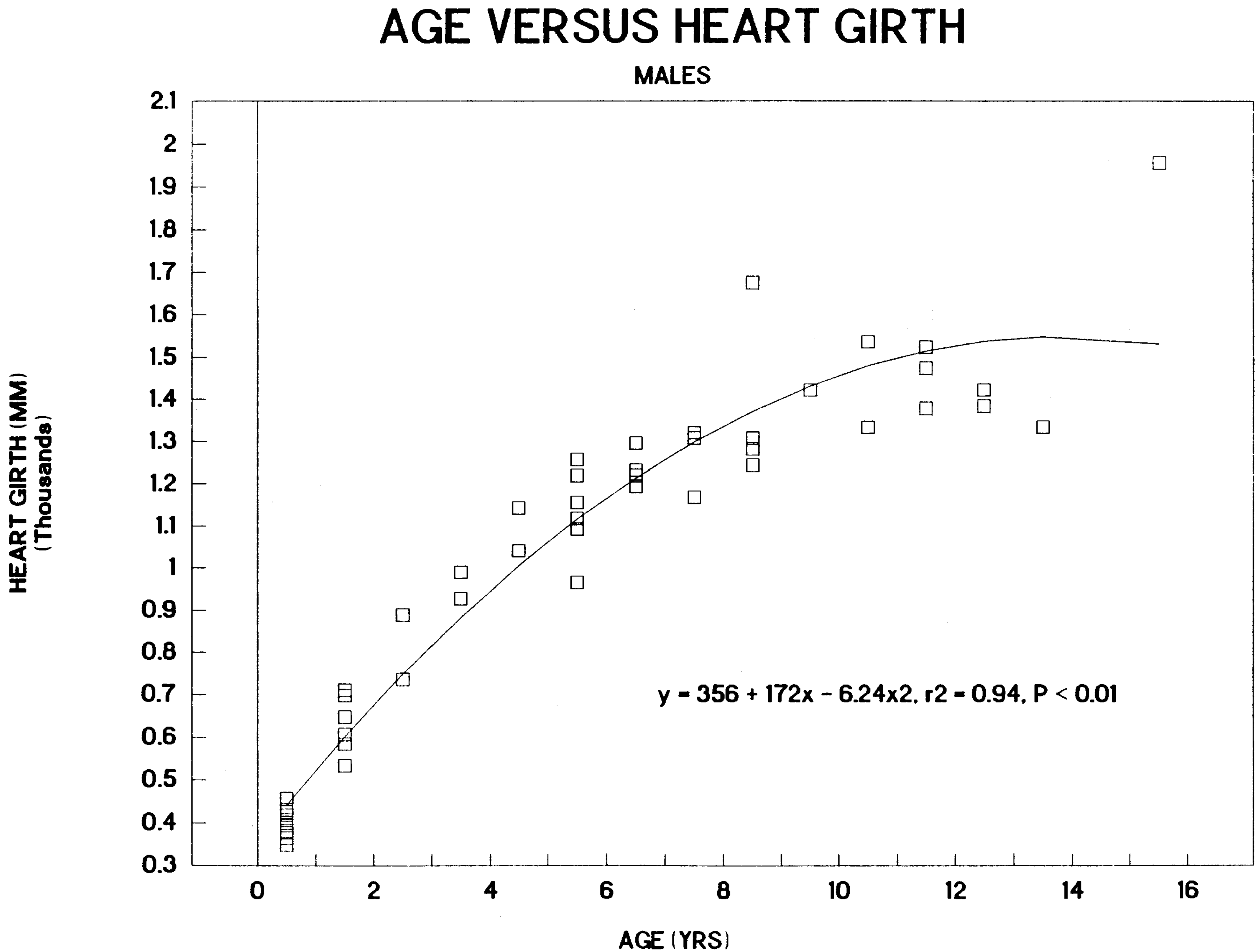

Fig. 19. Relationship between age and heart girth circumference of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

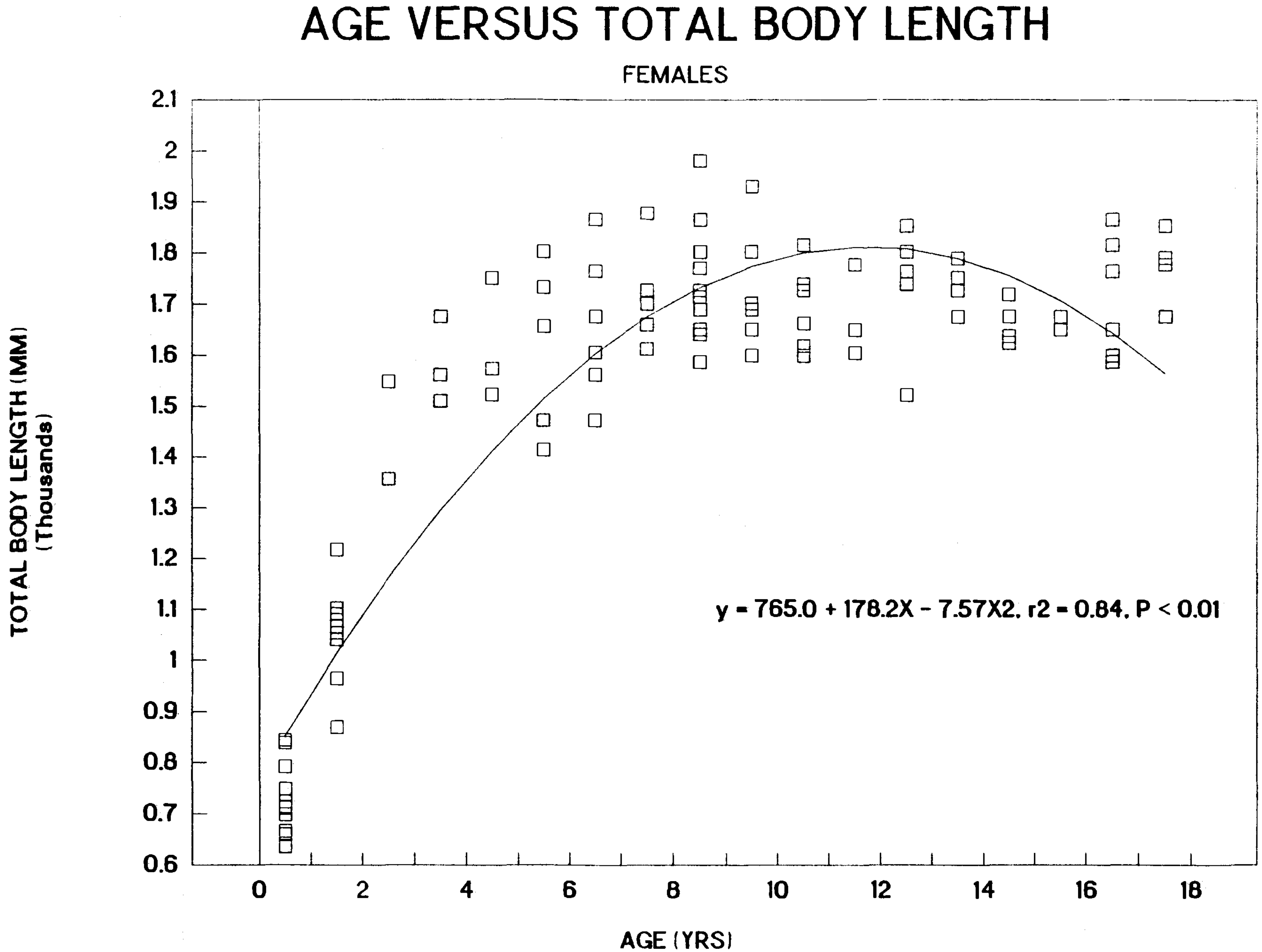

Fig. 20. Age versus total body length of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

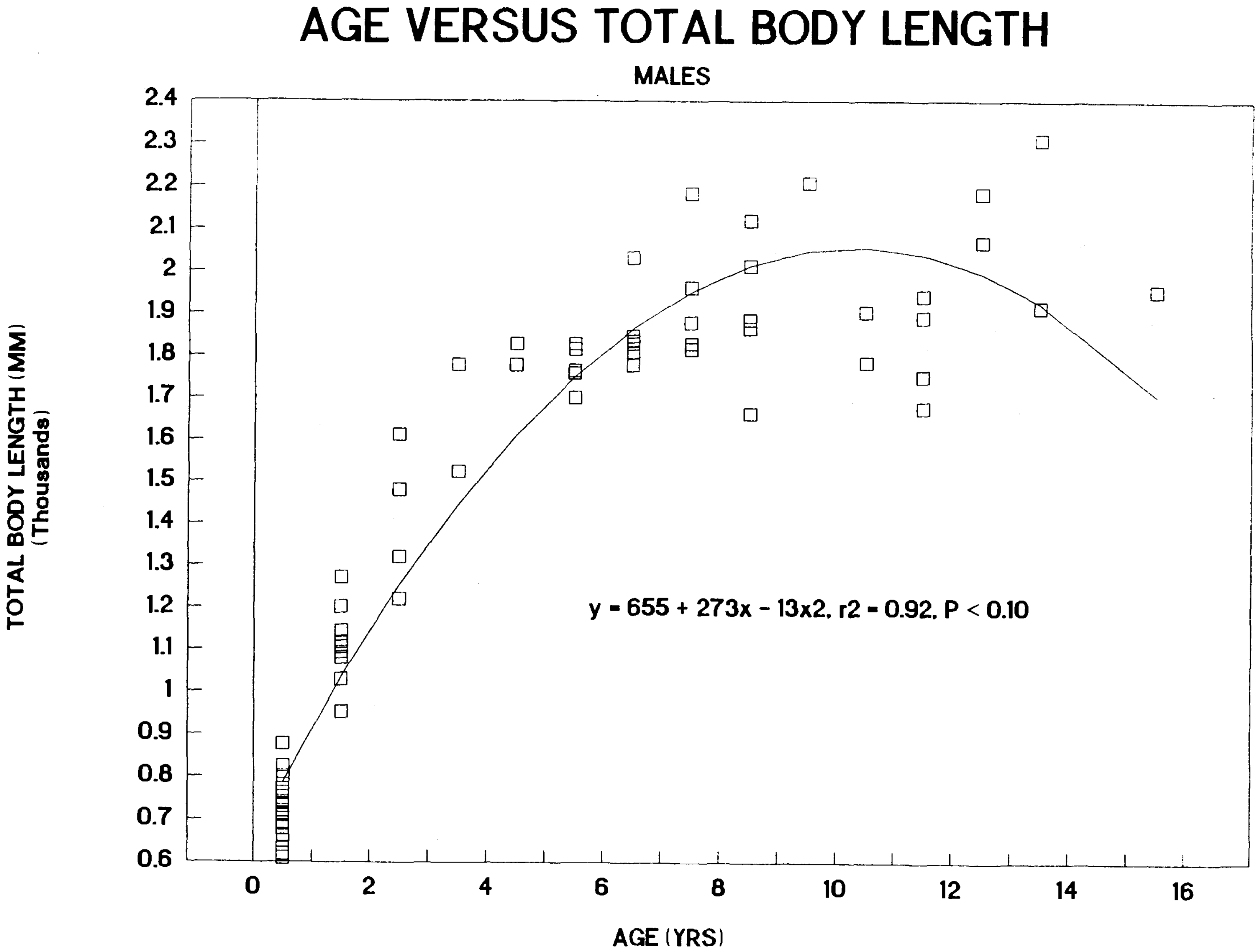

Fig. 21. Age versus total body length of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

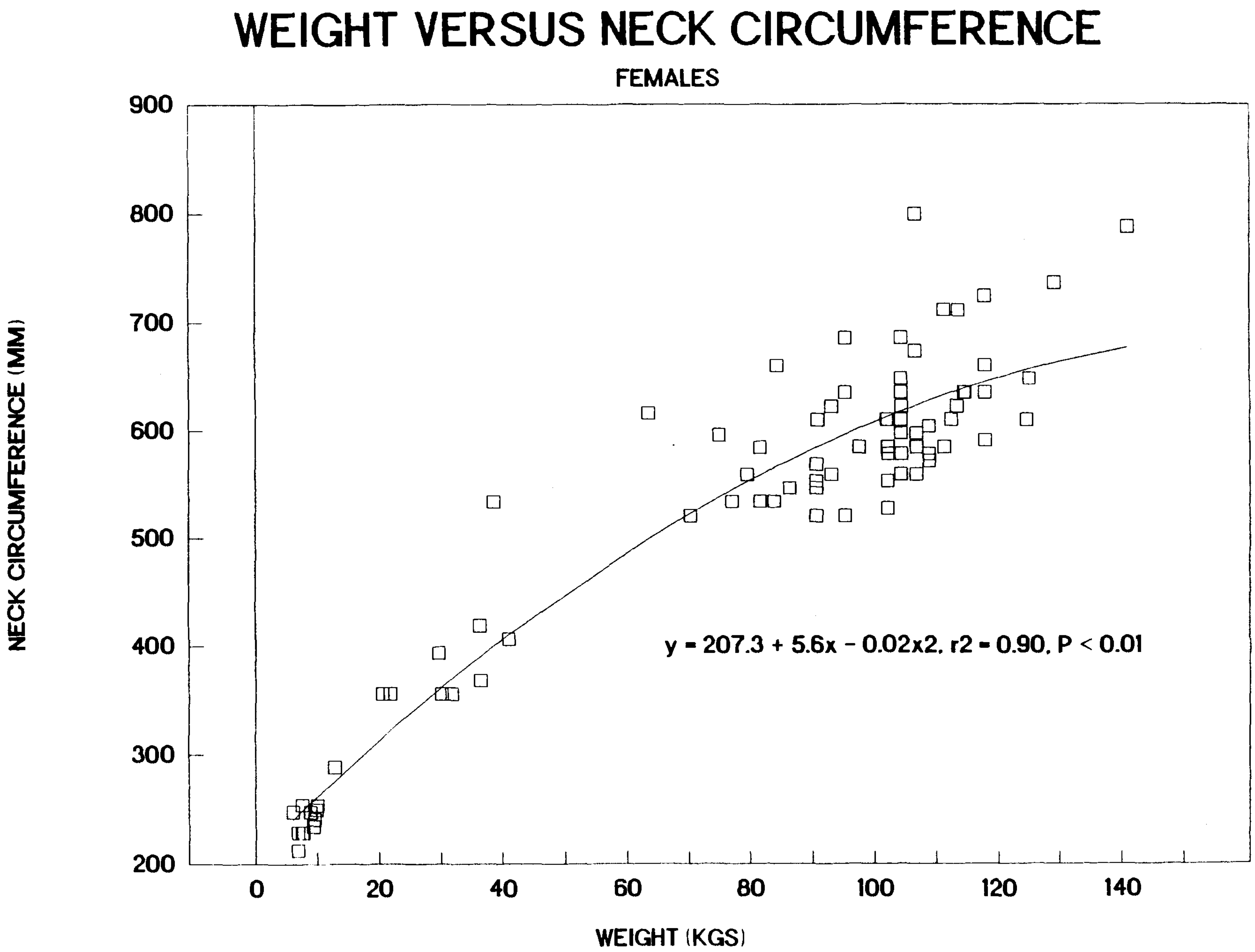

Fig. 22. Relationship between weight and neck circumference of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

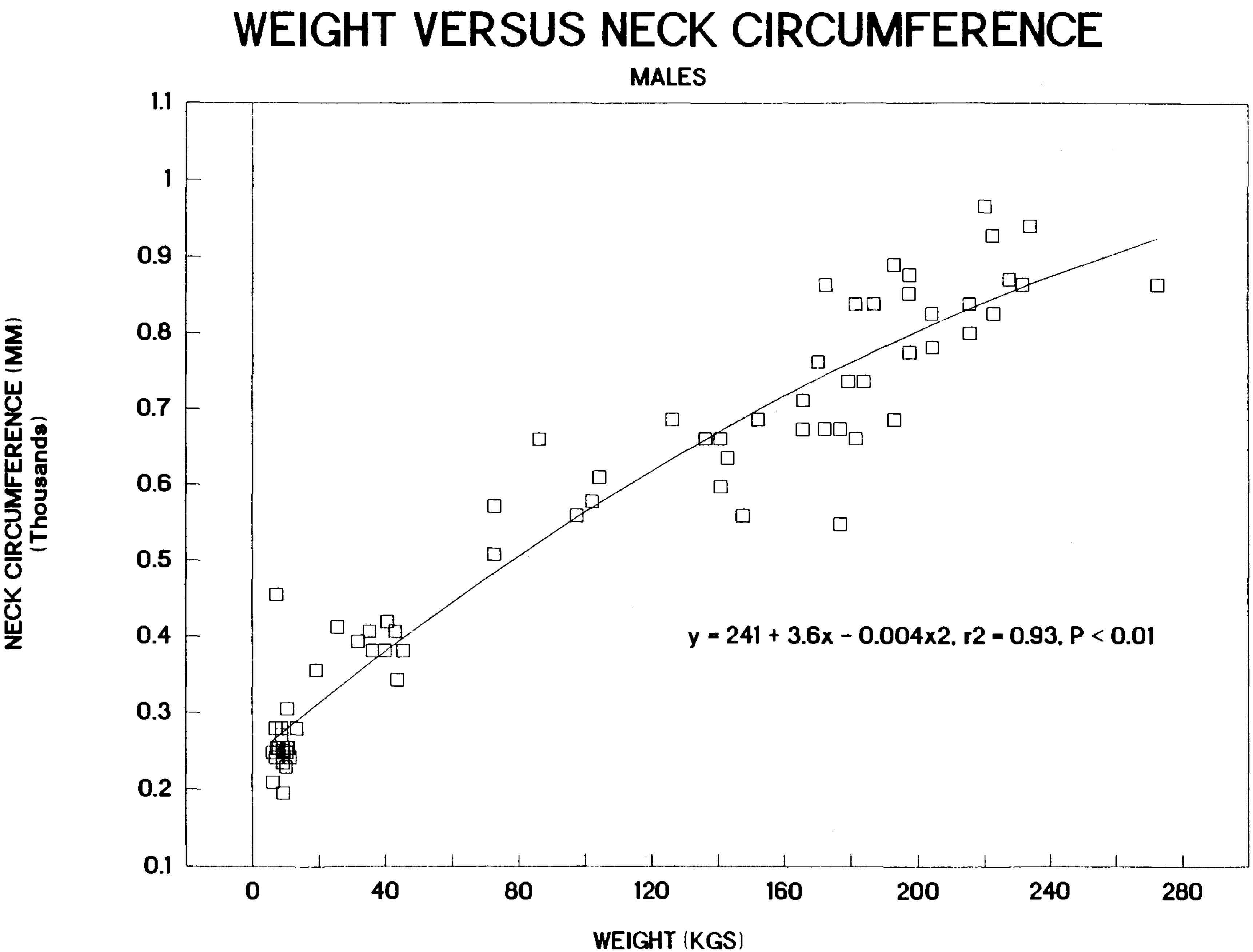

Fig. 23. Relationship between weight and neck circumference of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

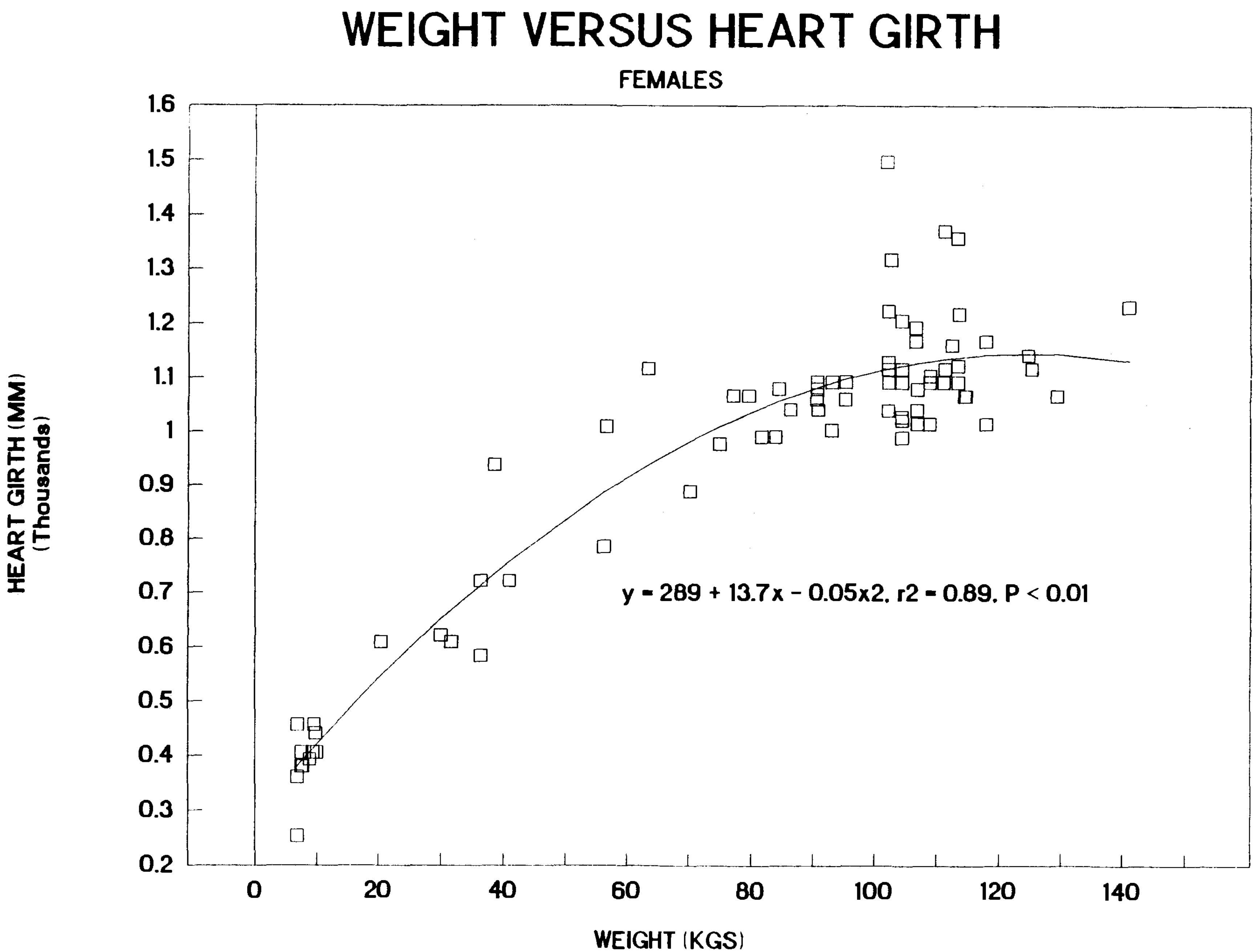

Fig. 24. Weight versus heart girth circumference of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

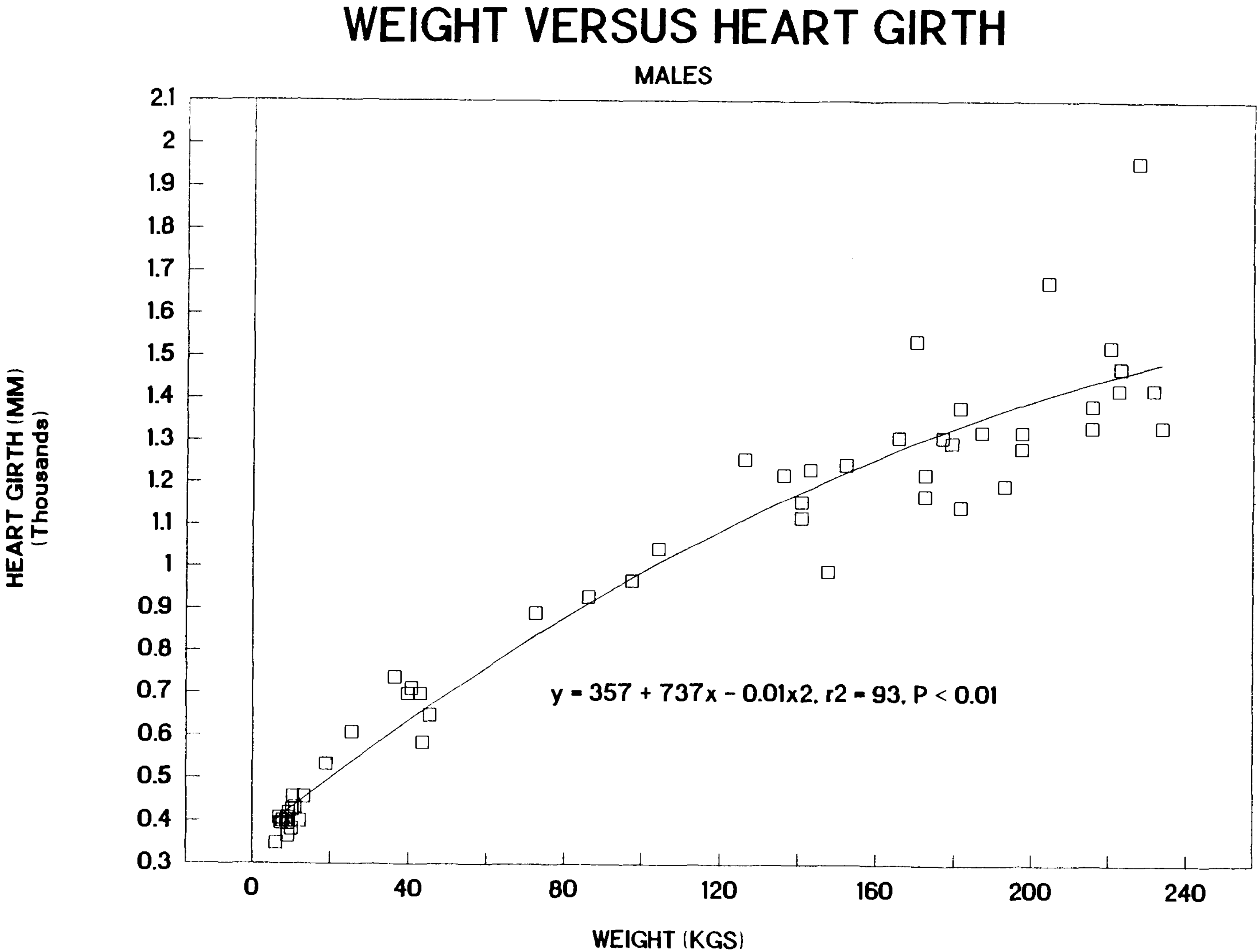

Fig. 25. Weight versus heart girth circumference of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

WEIGHT VERSUS TOTAL LENGTH OF BODY

FEMALE

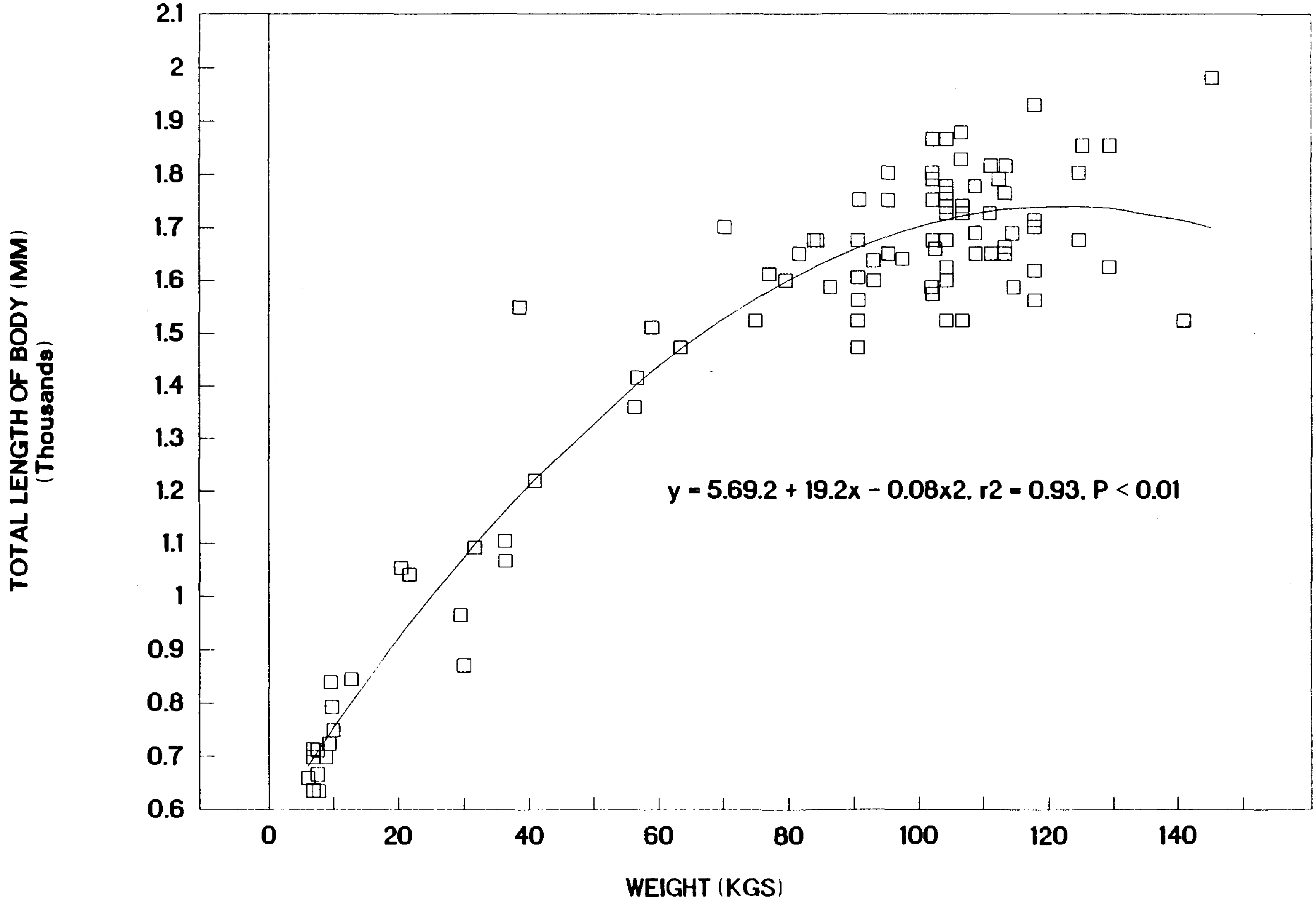

Fig. 26. Weight versus total body length of female grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

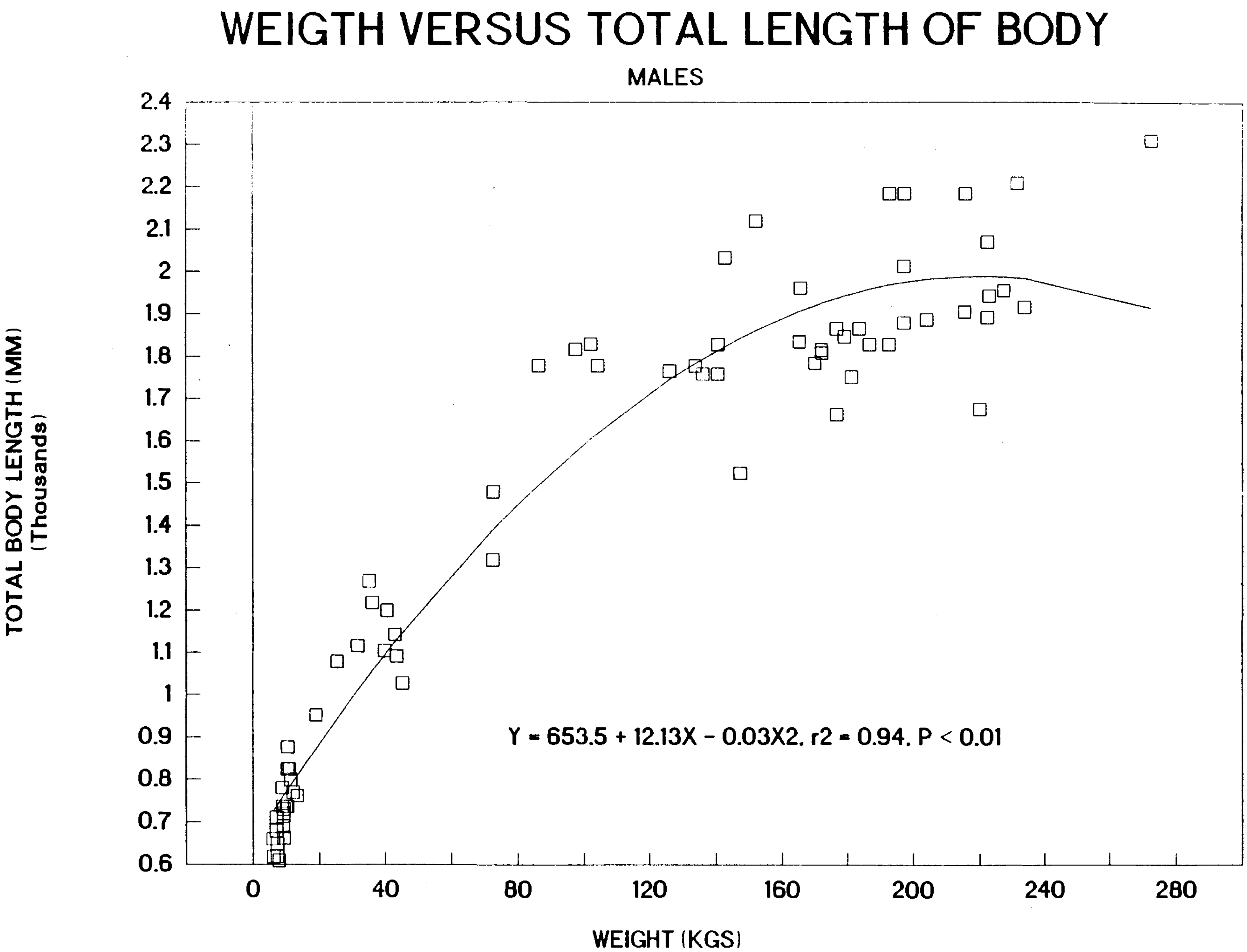

Fig. 27. Weight versus total body length of male grizzly bears captured in the Noatak River Study Area during 1986 through 1990.

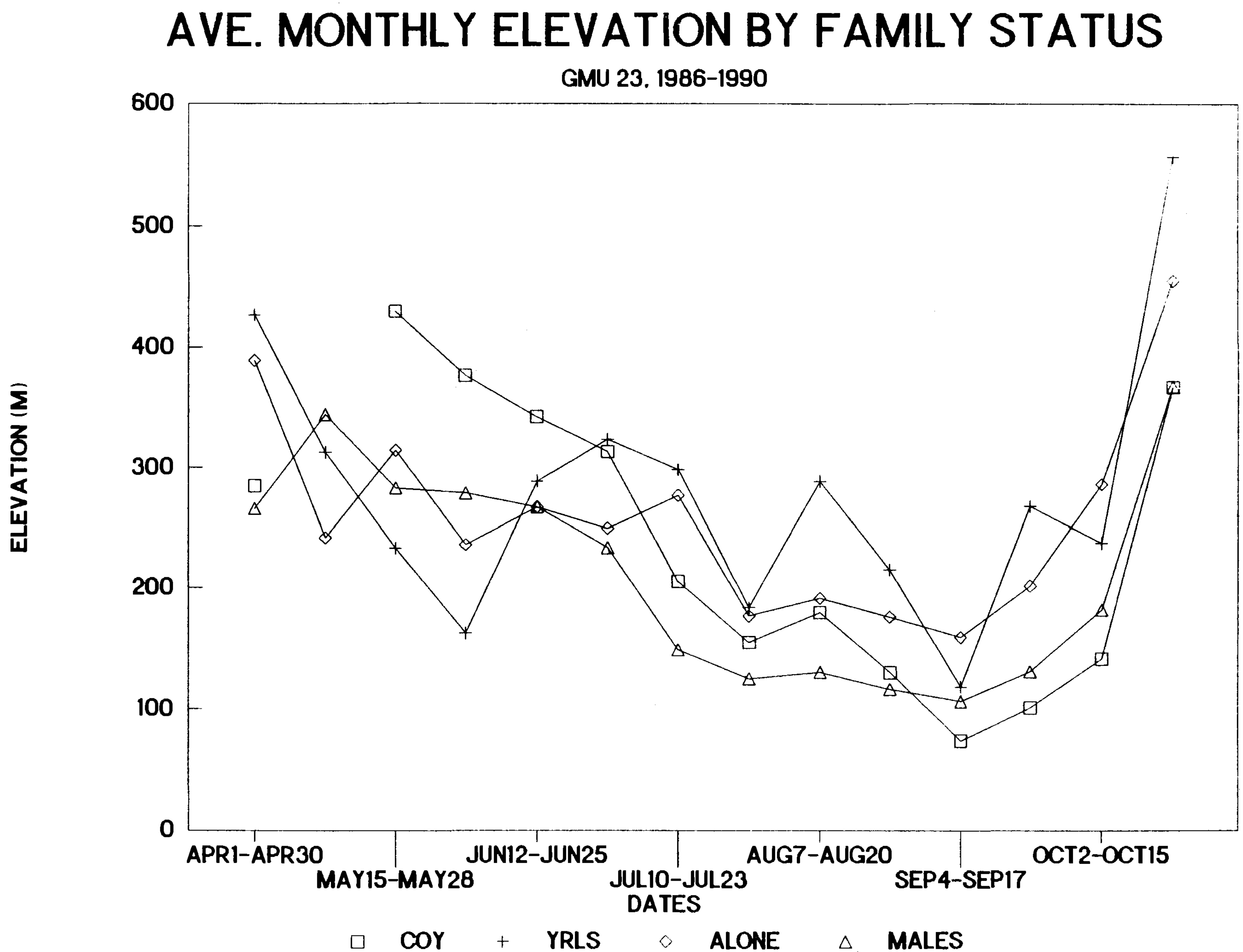

Fig. 28. Average elevations occupied by grizzly bears at 2-week intervals by sex and family class in the Noatak River Study Area during 1986 through 1990.

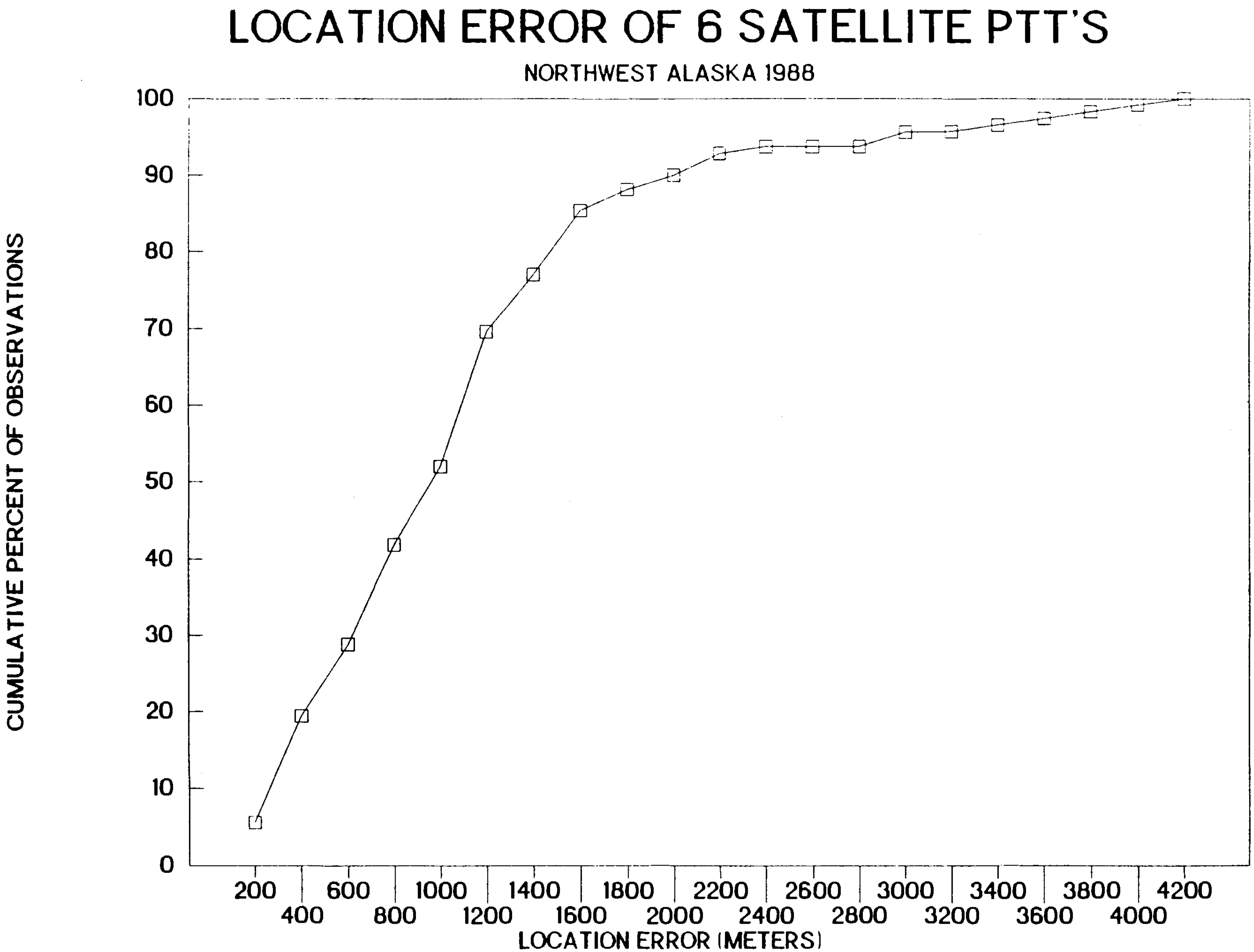

Fig. 29. Average location error (meters) expressed as percent of cumulative relocations of 6 satellite transmitters in Nome, Alaska for a 1-week period prior to deployment on grizzly bears in northwest Alaska in early June 1988.

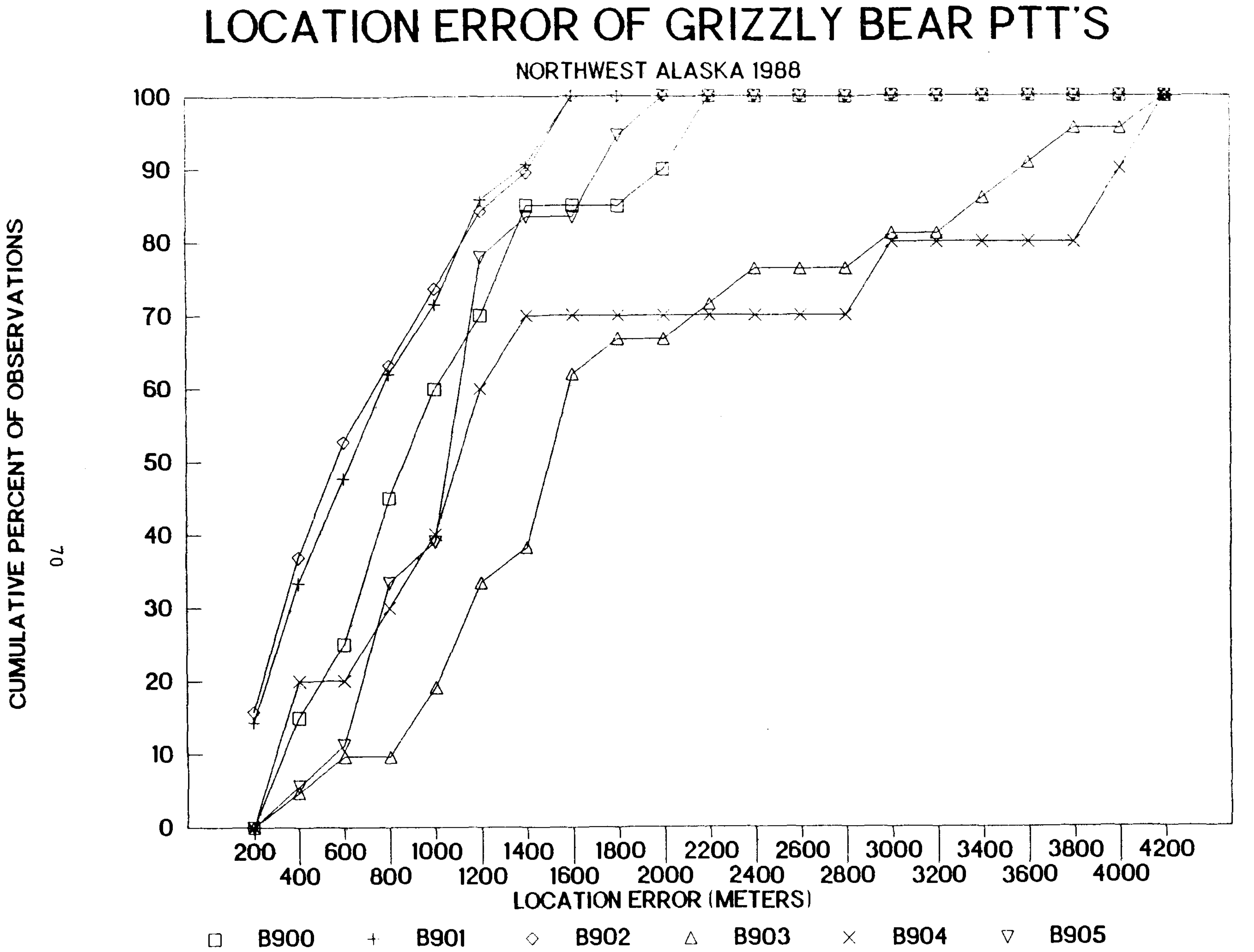

Fig. 30. Location error of 6 individual satellite transmitters expressed as percent of cumulative relocations ($\underline{n}$ = 109) in Nome, Alaska for a 1-week period prior to deployment on grizzly bears in the Noatak River Study Area in early June 1988.

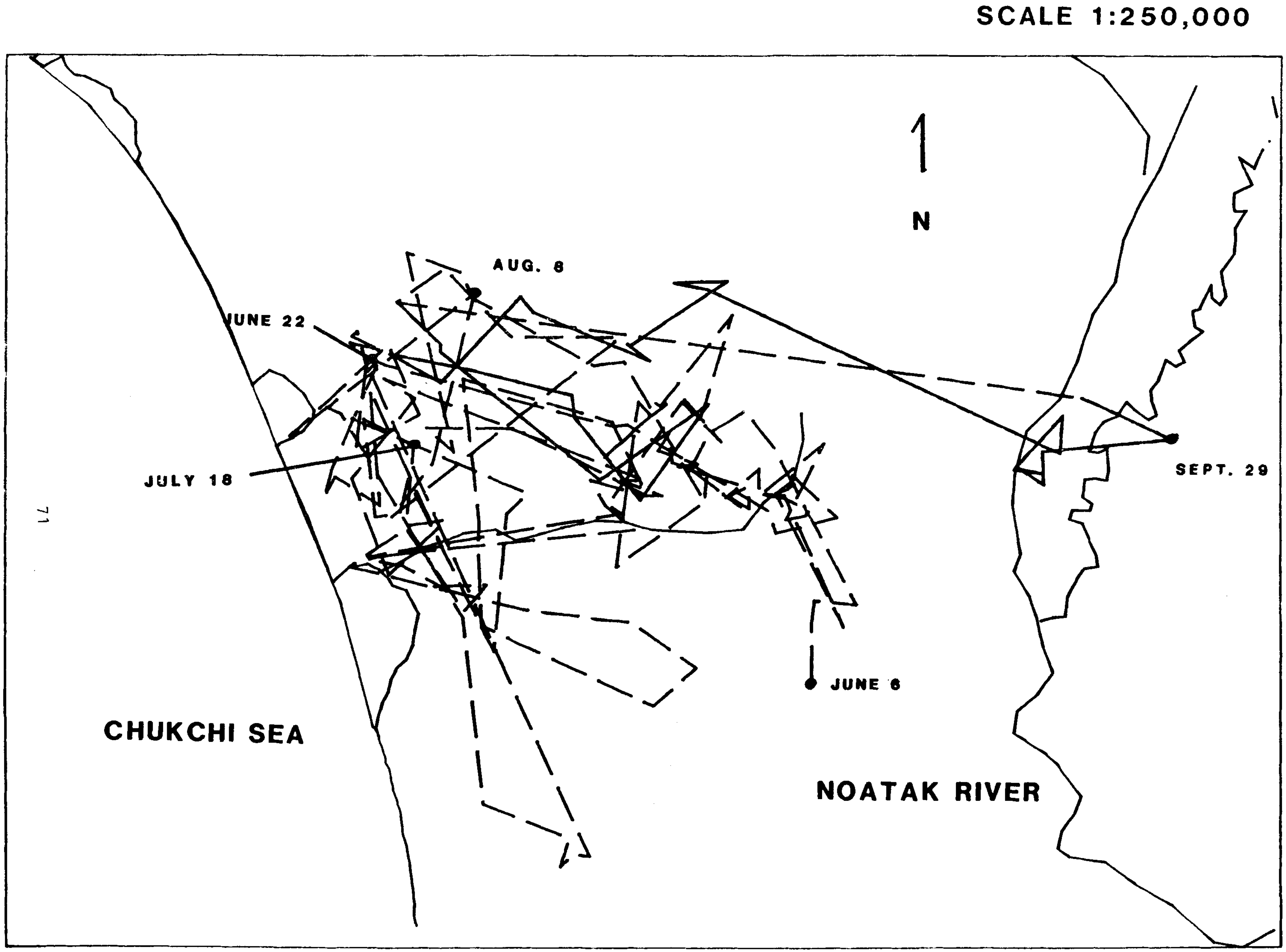

Fig. 31. Daily satellite relocations of female grizzly bear 014 from 5 June through 10 October 1988 in the Noatak River Study Area of northwest Alaska.

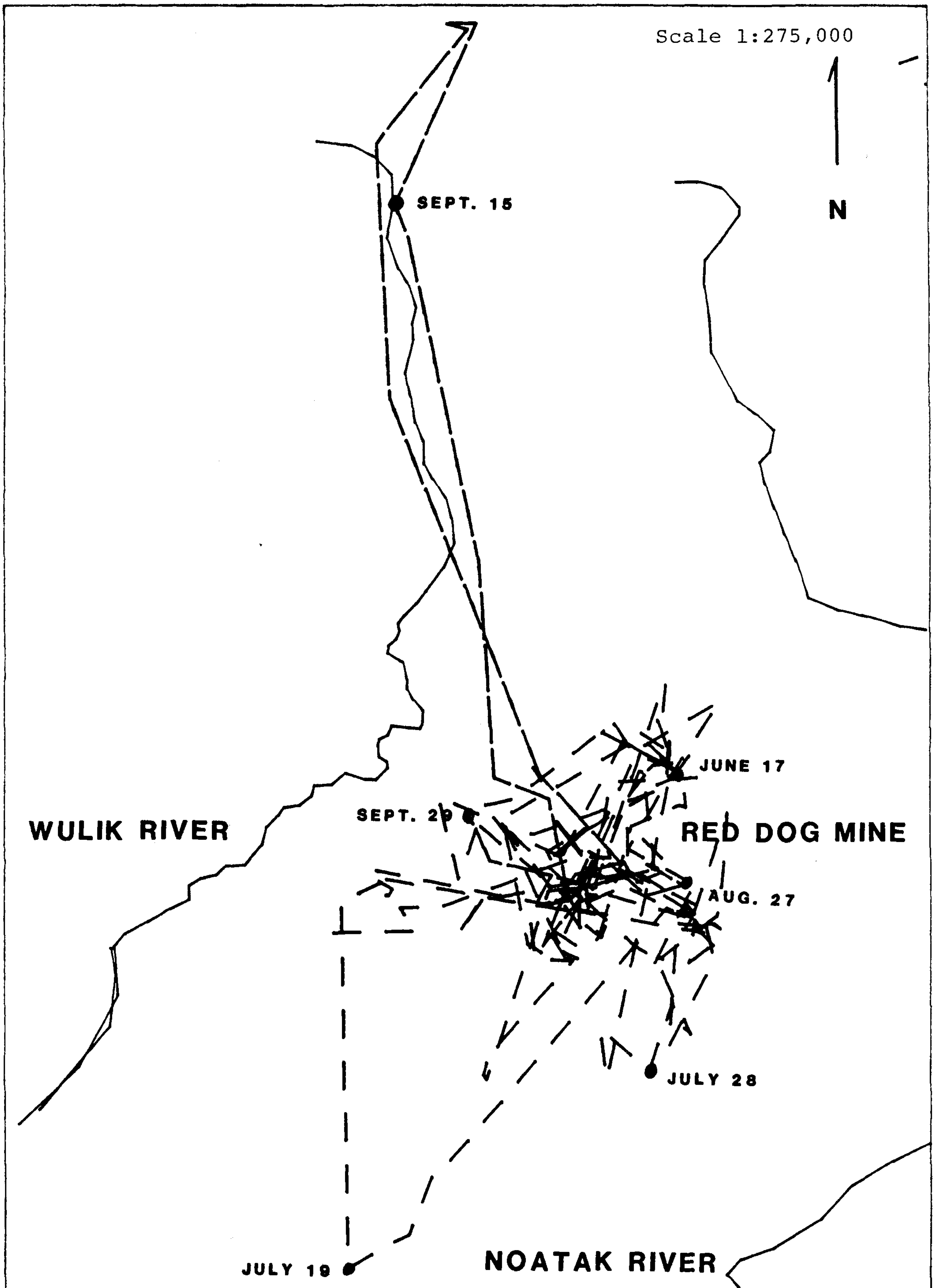

Fig. 32. Daily satellite relocations of female grizzly bear 063 from 5 June through 30 September 1988 in the Noatak River Study Area of northwest Alaska.

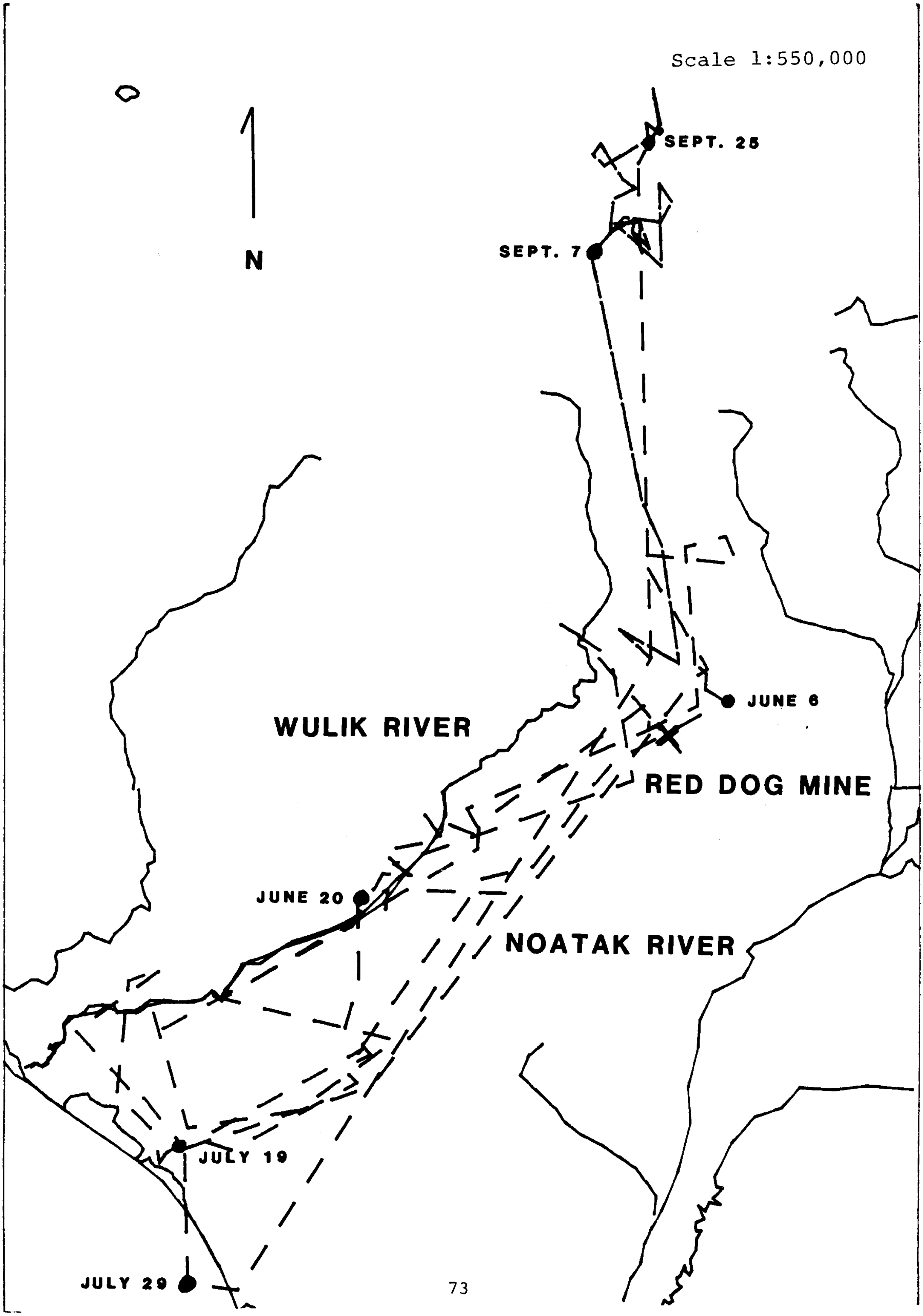

Fig. 33. Daily satellite relocations of female grizzly bear 058 from 5 June through 9 October 1988 in the Noatak River Study Area of northwest Alaska.

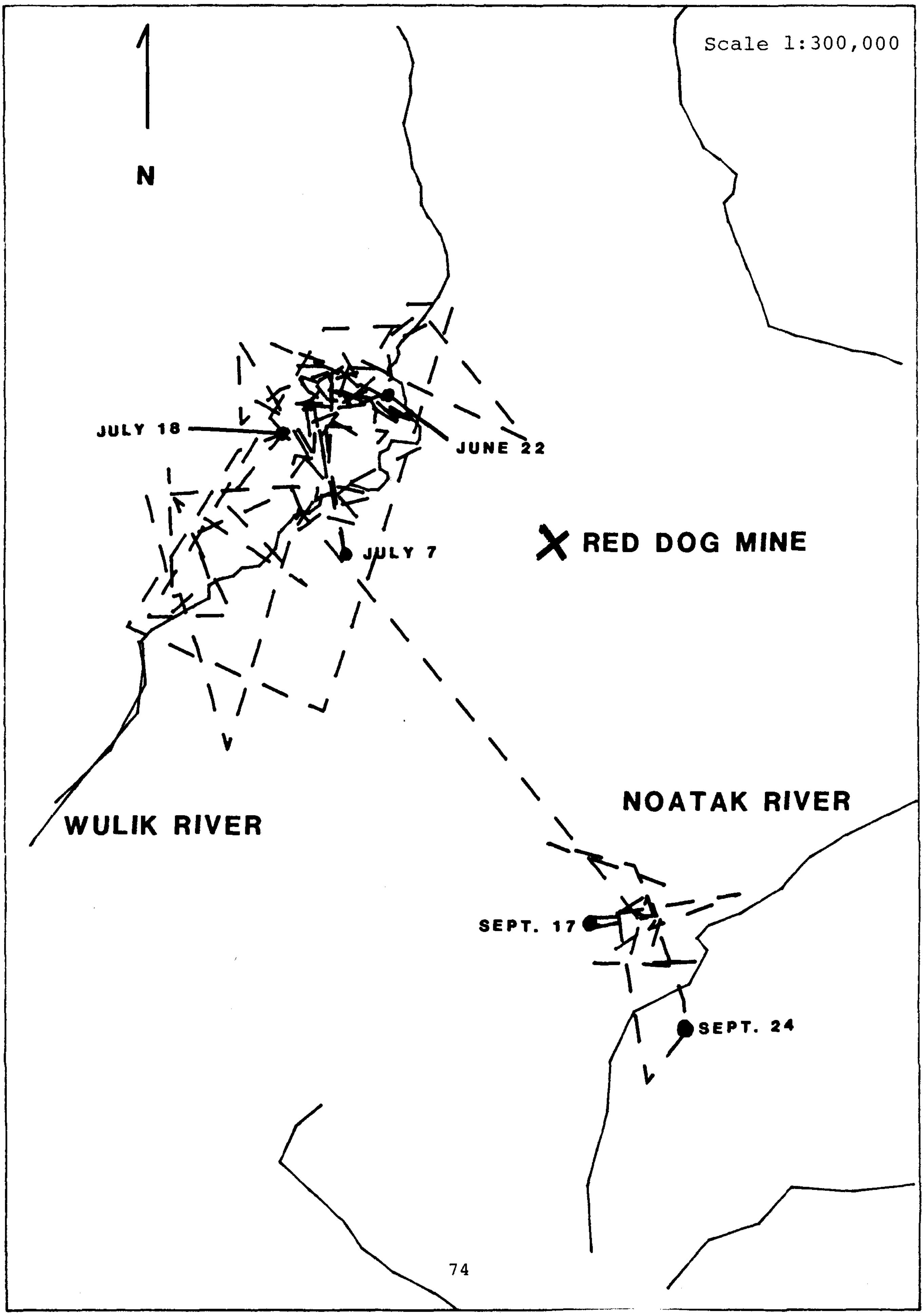

Fig. 34. Daily satellite relocations of female grizzly bear 028 from 5 June through 11 October 1988 in the Noatak River Study Area of northwest Alaska.

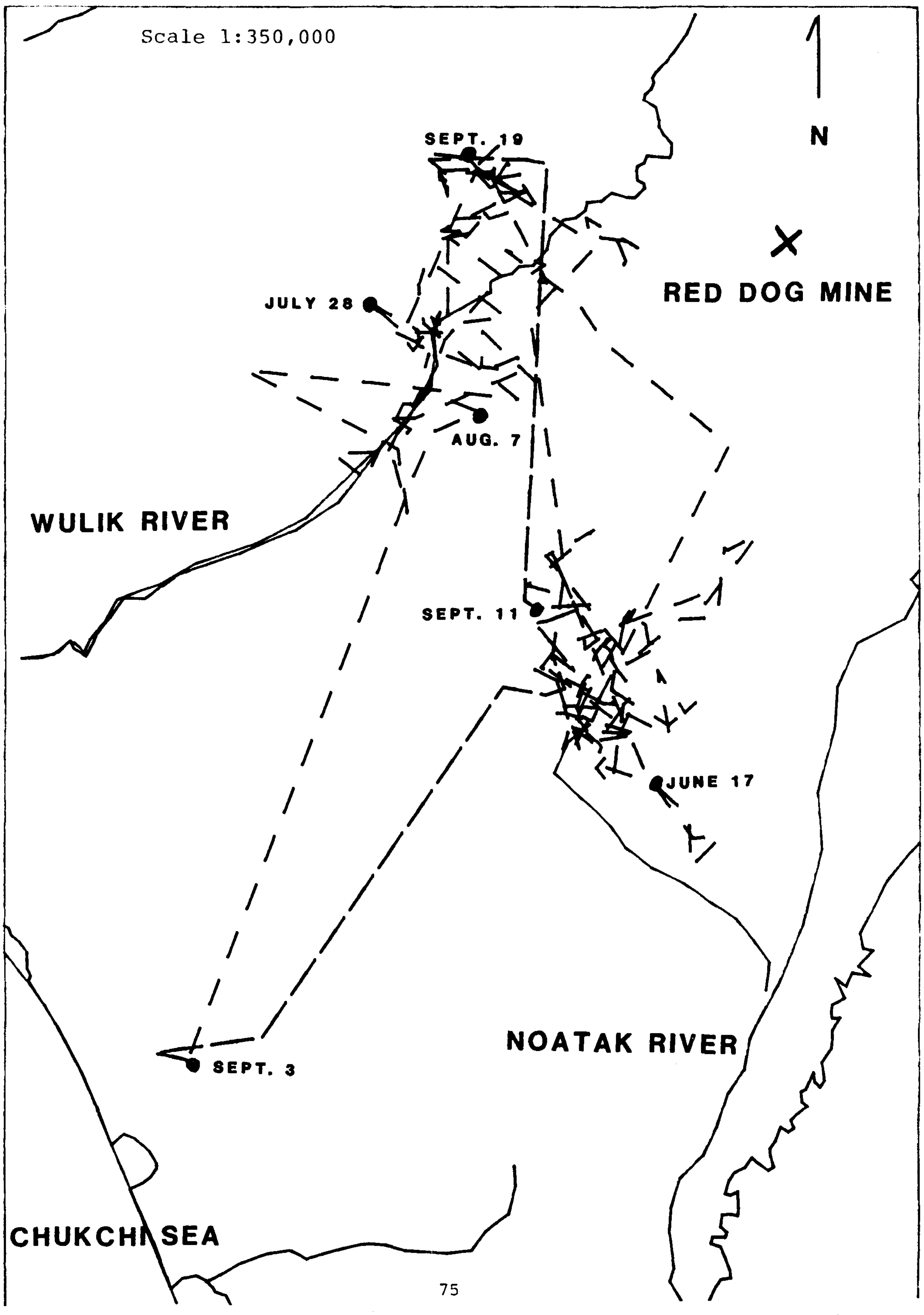

Fig. 35. Daily satellite relocations of female grizzly bear 043 from 5 June through 22 September 1988 in the Noatak River Study Area of northwest Alaska.

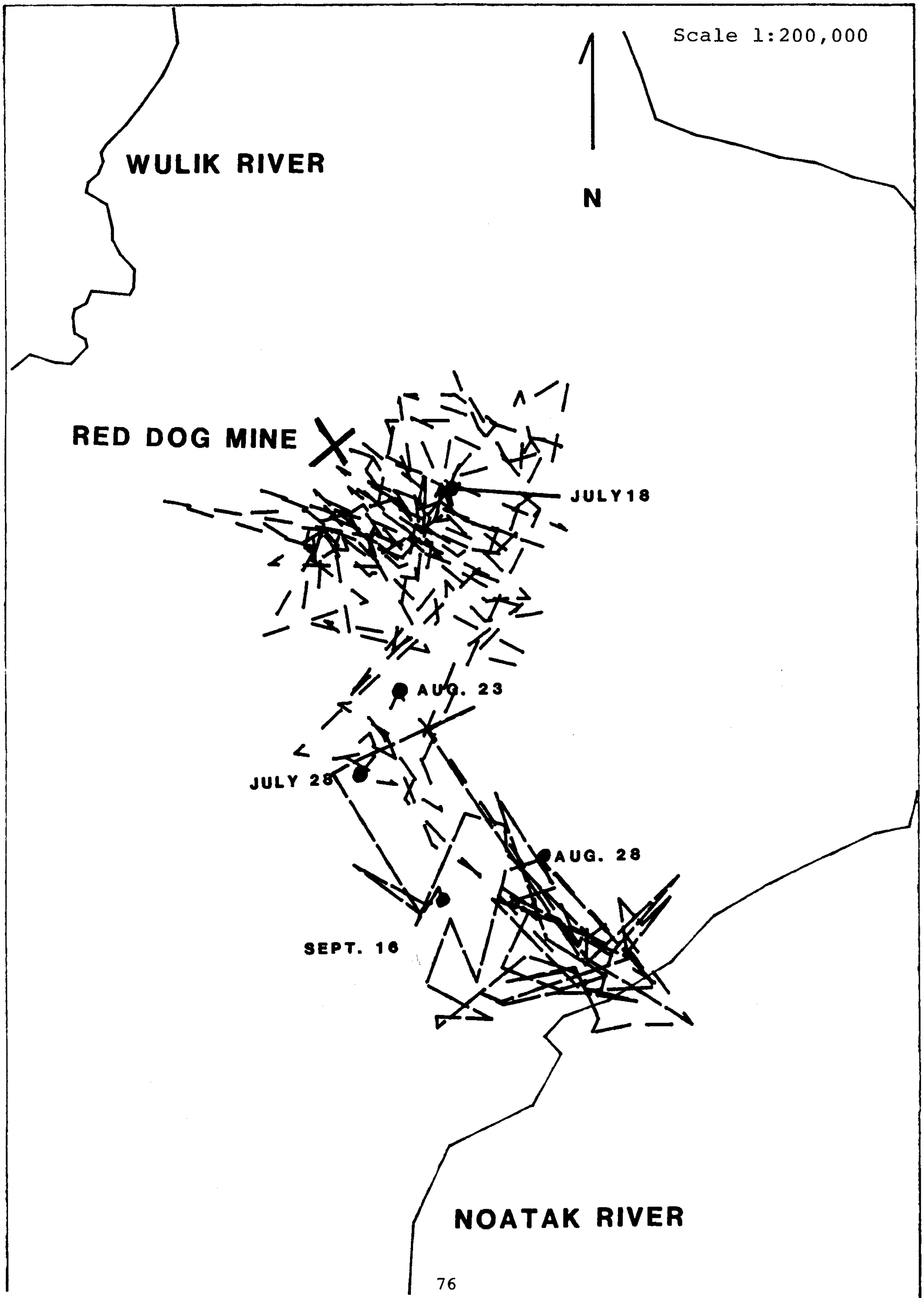

Fig. 36. Daily satellite relocations of female grizzly bear 069 from 5 June through 11 October 1988 in the Noatak River Study Area of northwest Alaska.

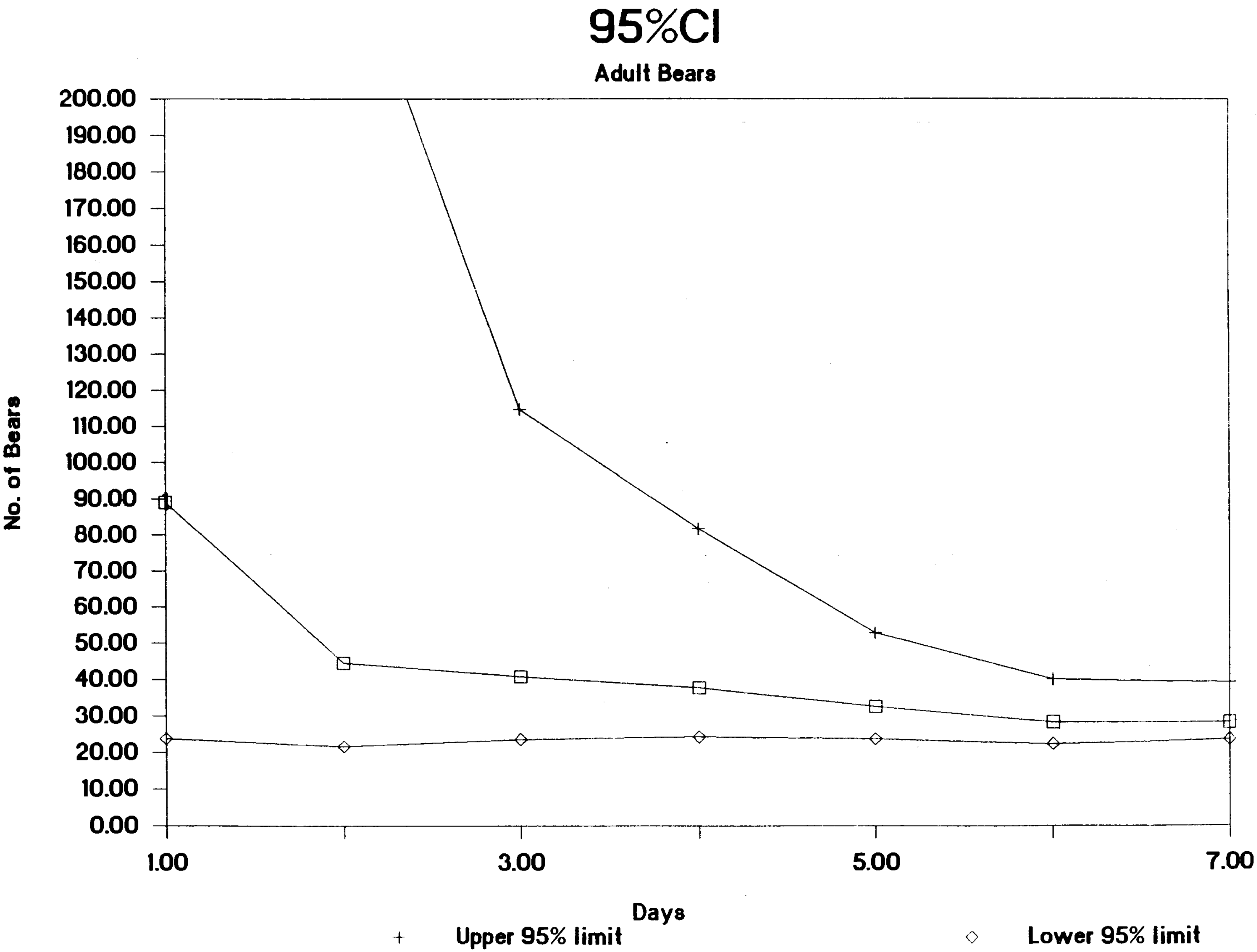

Fig. 37. Changes in population estimates of adult (> 3-years-old) grizzly bears and 95% confidence intervals over time for the Red Dog Mine Study Area in northwest Alaska during 29 May through 4 June 1987.

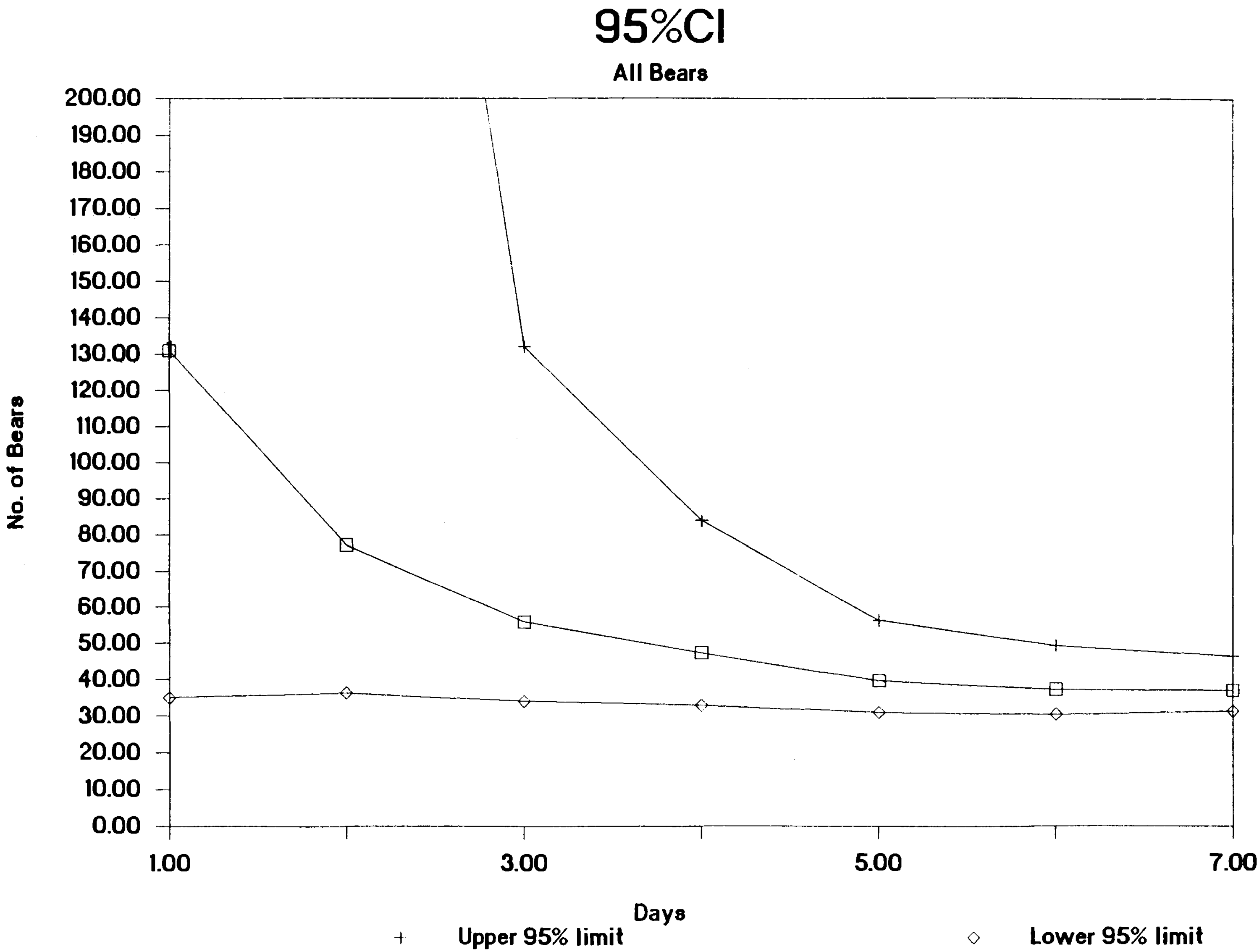

Fig. 38. Changes in population estimates of grizzly bears of all ages and 95% confidence intervals over time for the Red Dog Mine Study Area in northwest Alaska during 29 May through 4 June 1987.

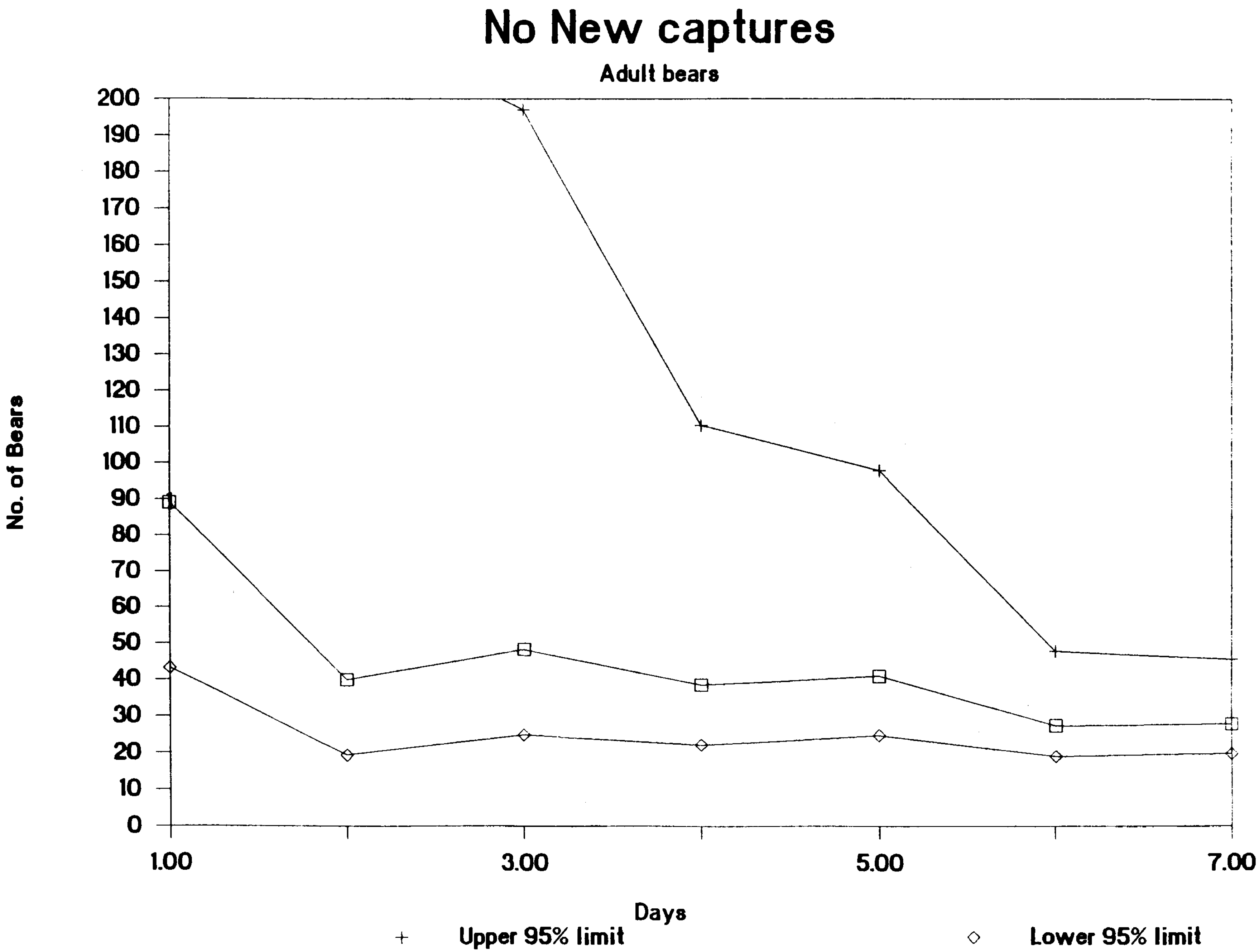

Fig. 39. Changes in population estimates of adult (> 3-years-old) grizzly bears and 95% confidence intervals over time had no new bears been captured and radio collared as part of the census of the Red Dog Mine Study Area in northwest Alaska during 1987.

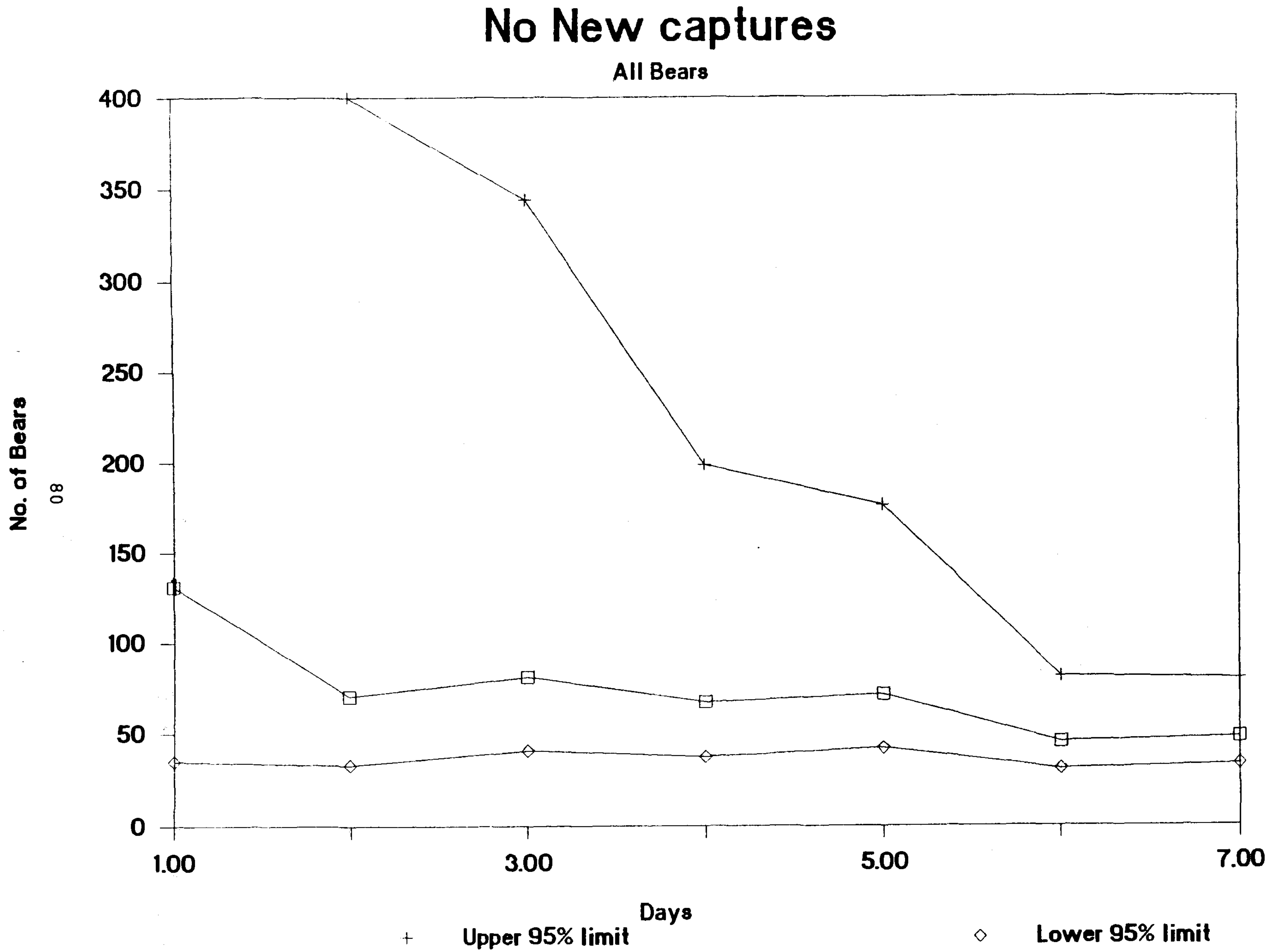

Fig. 40. Changes in population estimates of grizzly bears of all ages and 95% confidence intervals over time had no new bears been captured and radio collared as part of the census of the Red Dog Mine Study Area in northwest Alaska during 1987.

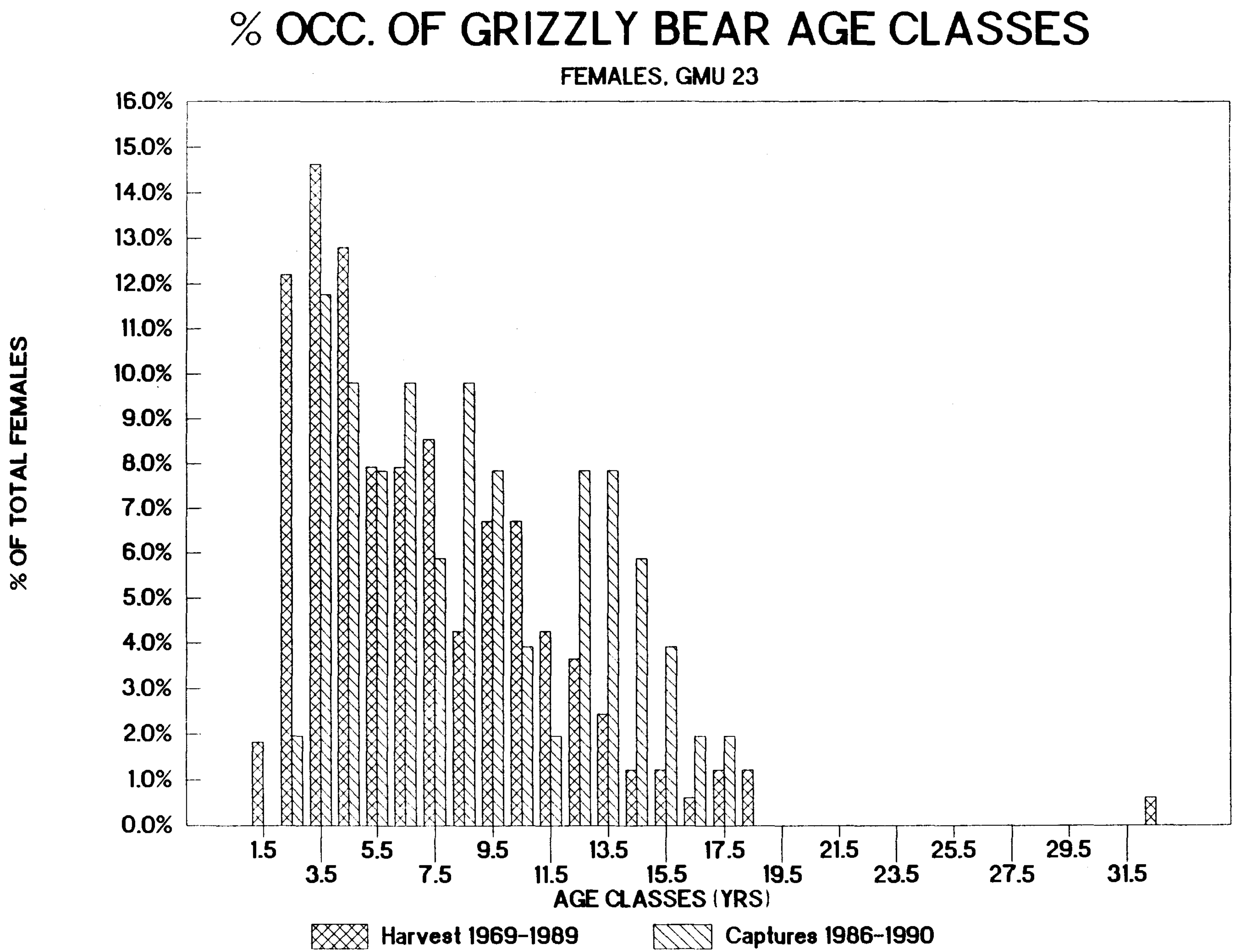

Fig. 41. Age structure of the harvest of female grizzly bears from 1969 through 1989 in comparison to the age structure of females captured within the Noatak River Study Area during 1986 through 1990 in northwest Alaska.

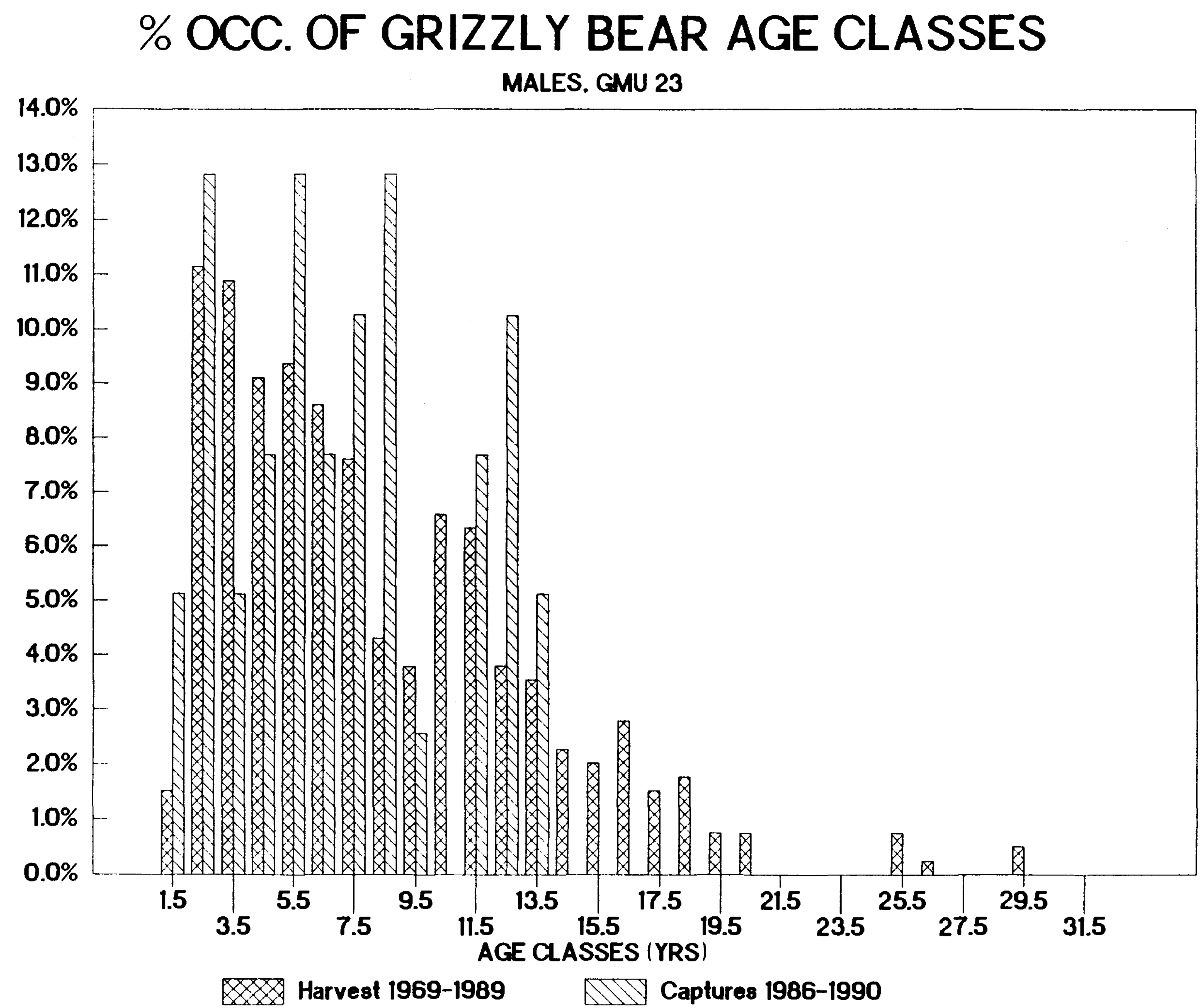

Fig. 42. Age structure of the harvest of male grizzly bears from 1969 through 1989 in comparison to the age structure of males captured within the Noatak River Study Area during 1986 through 1990 in northwest Alaska.

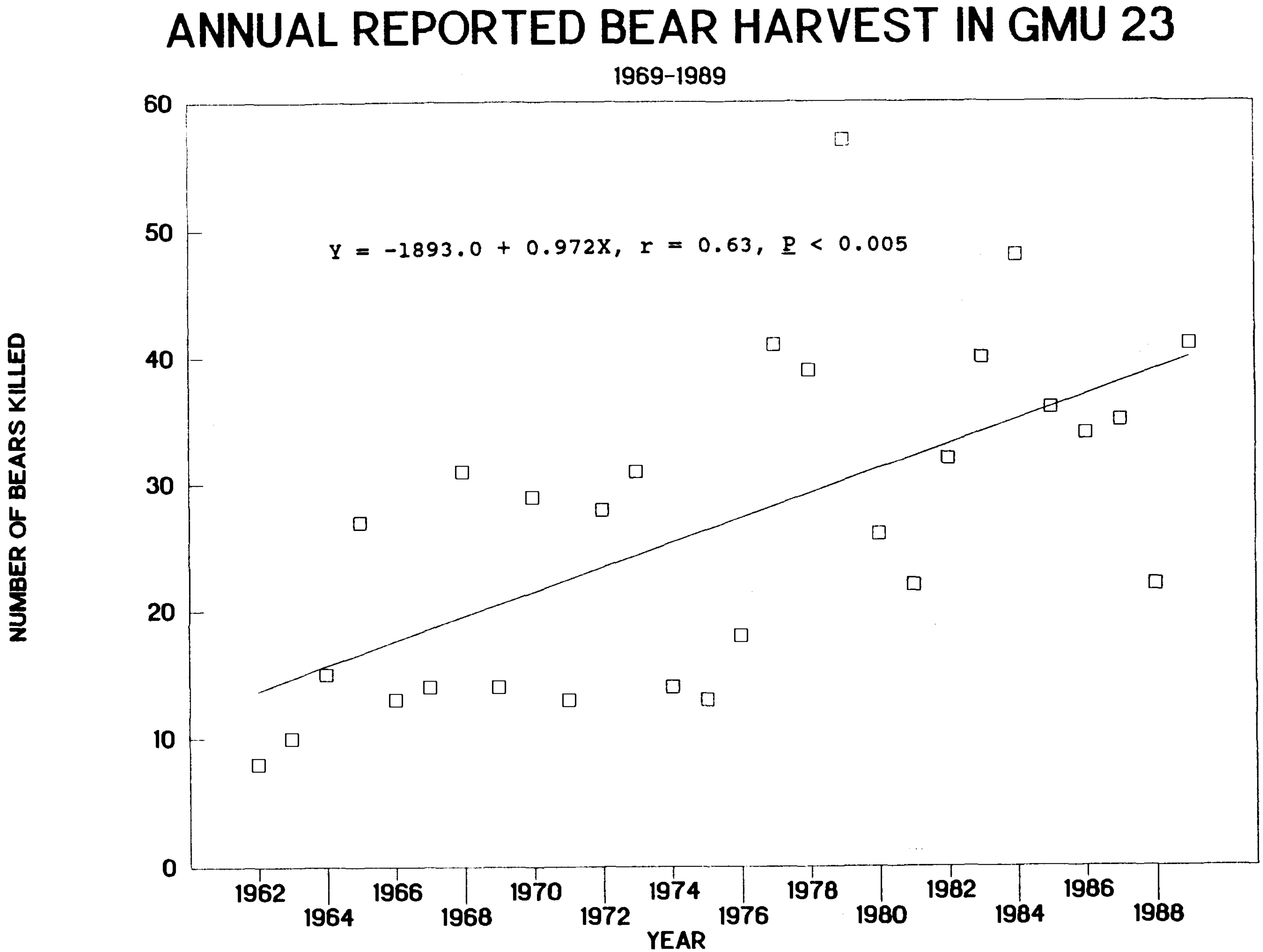

Fig. 43. Reported annual harvest of grizzly bears within GMU 23 of northwest Alaska from 1962 through 1989.

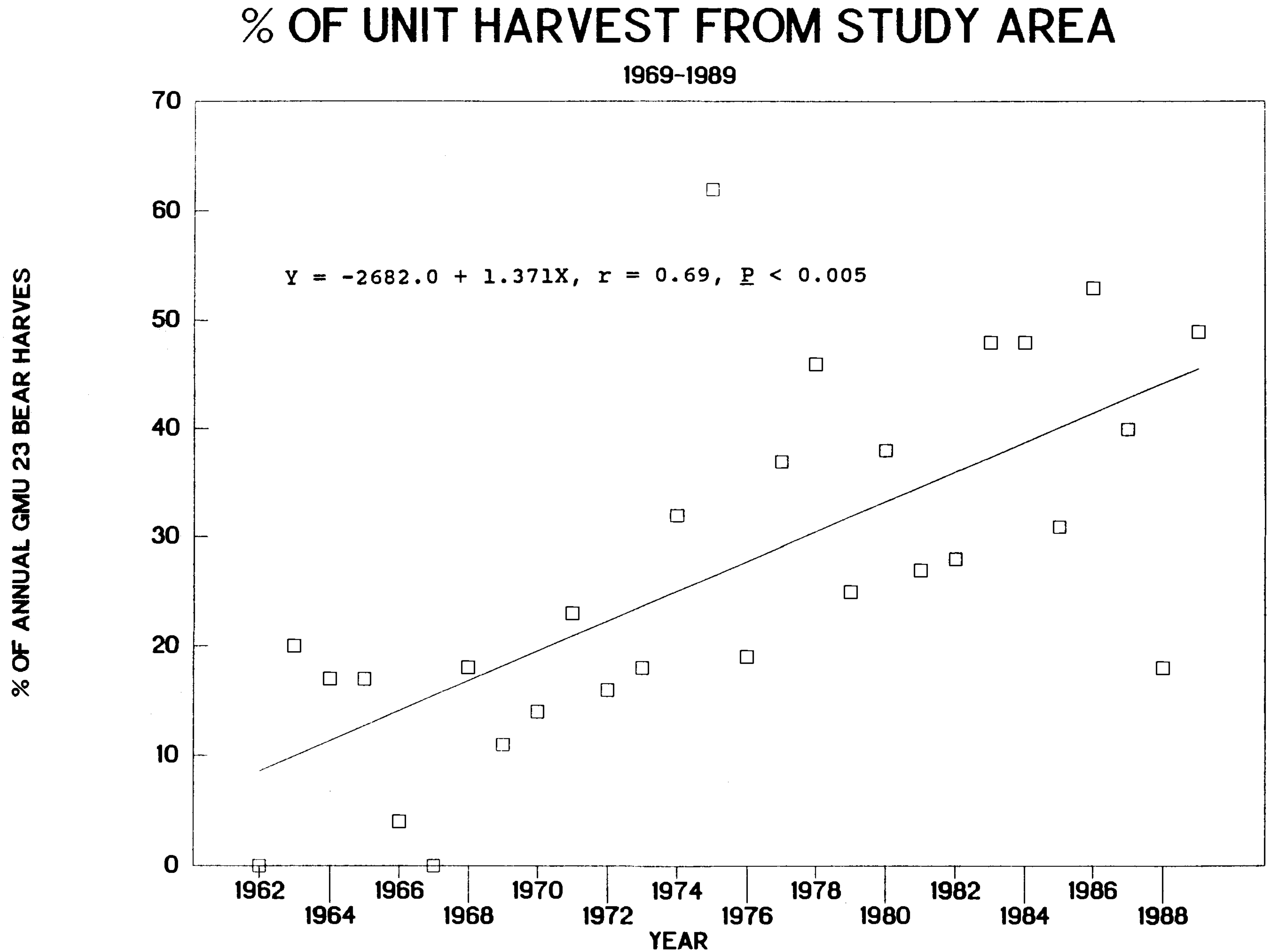

Fig. 44. Proportion of the reported GMU 23 grizzly bear harvest which occurs within the Noatak River Study Area in northwest Alaska during 1962 through 1989.

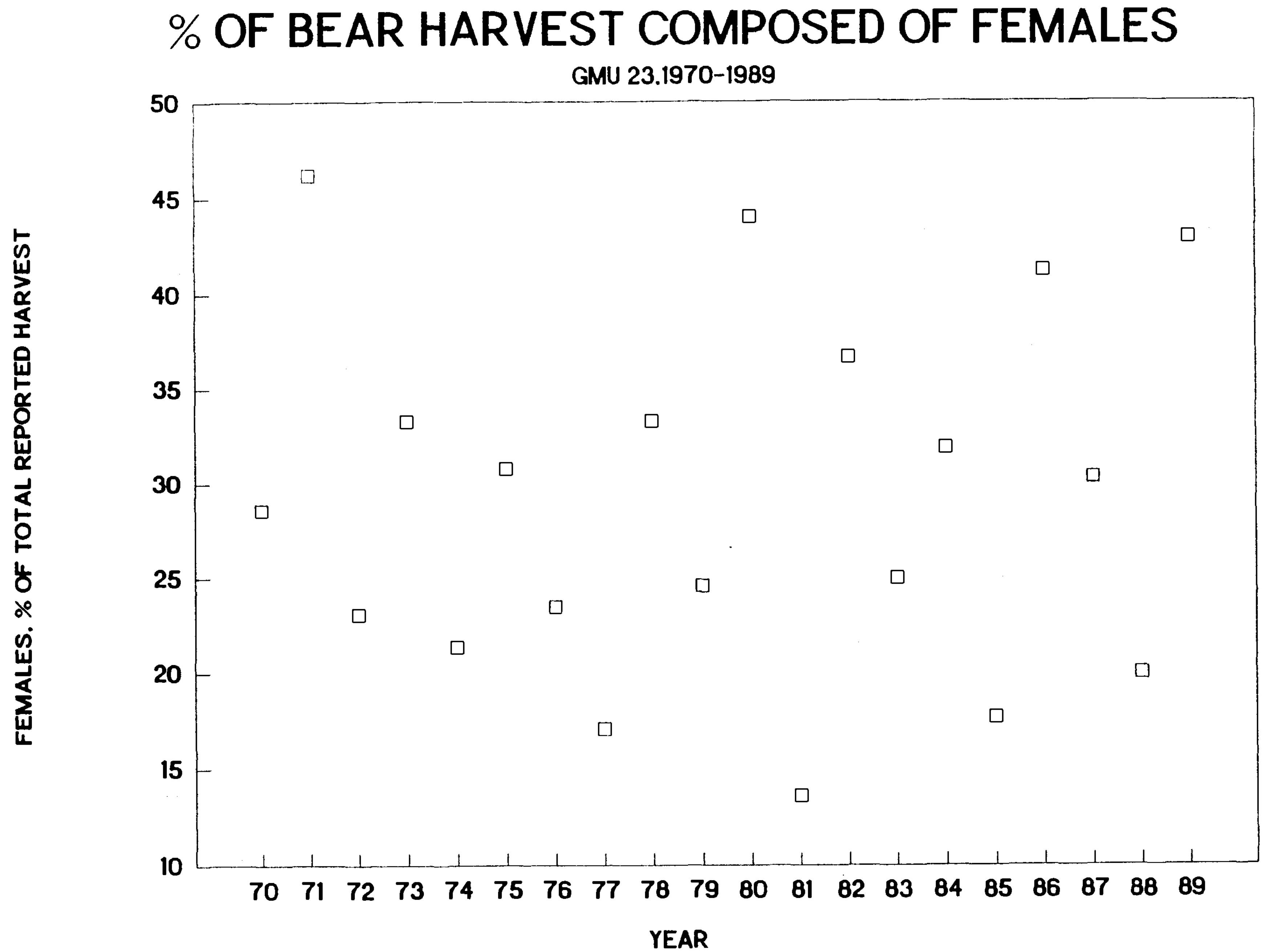

Fig. 45. Percent of the reported grizzly bear harvest composed of females in GMU 23 during 1970 through 1989.

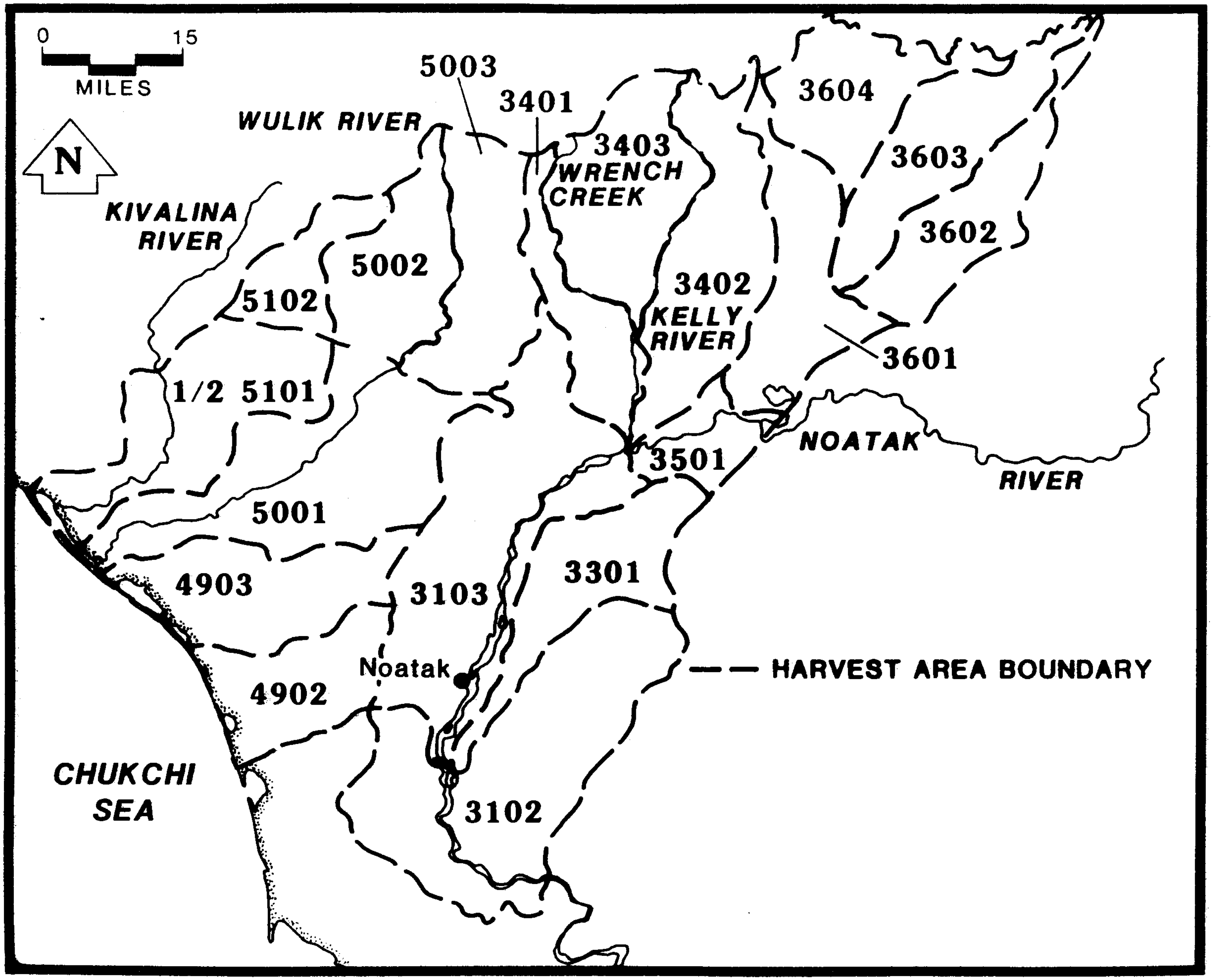

Fig. 46. Boundaries of individual harvest areas used (total = 12,879 km^2) to assess harvest rates of grizzly bears in northwest Alaska during 1962 through 1989.

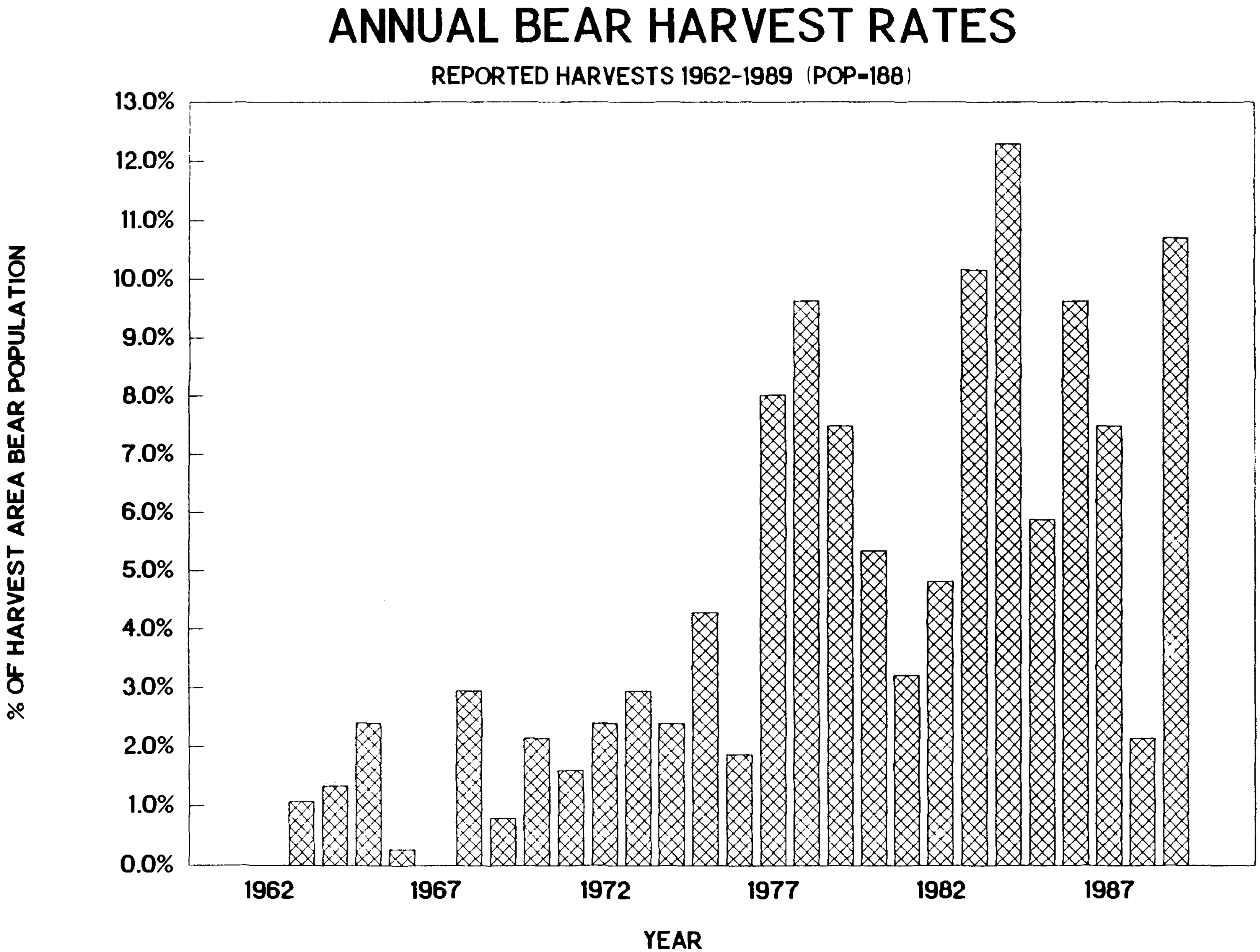

Fig. 47. Estimated annual harvest rates of grizzly bears within a 12,879 km^2 area which encompassed the Noatak River Study Area from 1962 through 1989. This assessment assumed a stable bear population of 188 individuals based on the bear-days estimator and considered only known reported harvests.

Table 1. Dates of capture, ages, weights, and physical measurements of female grizzly bears immobilized in northwest Alaska during 1986 through 1990.

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck (mm)	Total length (mm)	Heart girth (mm)
001	31 May 86	5.5	106.6	335.0	206.5	541.5	587.5	1733.6	1104.9
001	07 Jun 88	7.5		336.6	206.5	543.1	711.2	1727.2	1282.7
002	31 May 86	5.5	95.3	327.2	187.5	514.7		1803.4	
002	06 Jun 88	7.5		336.6	195.3	531.9	584.20	1727.2	
004	01 Jun 86	6.5	102.1	323.0	186.0	509.0		1866.9	1130.3
004	06 Jun 88	8.5	117.9	327.2	196.9	524.1	635	1714.5	
004	30 May 89	9.5	108.9	329.0	199.0	528.0	571.5	1651.0	1104.9
004	31 May 90	10.5	111.3	325.4	196.8	522.2	584.2	1816.1	1117.6
005	01 Jun 86	0.5	9.8	165.1	100.1	265.2	250.0	793.8	441.5
006	01 Jun 86	0.5	12.7	171.5	103.1	274.6	289.1	844.6	
008	02 Jun 86	4.5	95.3	306.3	193.8	400.1	520.7	1752.6	1060.5
008	07 Jun 88	6.5	104.3	330.2	200.2	530.4	647.7	1765.3	1092.2
008	28 May 90	8.5	100 E	327.0	204.7	531.7	590.5	1771.6	1047.7
009	02 Jun 86	13.5	112.5	325.0	215.0	540.0	609.6	1790.7	1162.1
009	31 May 87	14.5	129.3	346.1	215.9	562.0	736.6	1625.6	
009	29 May 89	16.5	104.3	330.2	215.9	546.1	647.7	1600.2	1117.6
011	03 Jun 86	0.5	6.0	155.7	95.3	251.0	247.7	660.4	
013	03 Jun 86	7.5	106.6	330.2	200.2	530.4	673.1	1879.6	1193.8
014	03 Jun 86	9.5	95.3	311.2	201.7	512.9	635.0	1803.4	1092.2
014	05 Jun 88	11.5	95.0	314.5	206.5	520.0			
014	31 May 90	13.5	102.2	314.3	200.0	514.3	527.0	1752.6	1041.4
018	03 Jun 86	8.5	145.2	316.0	222.3	538.3		1981.2	
020	04 Jun 86	5.5	63.5	295.4	171.5	466.9	616.0	1473.2	1117.6
020	07 Jun 88	7.5	77.1	314.0	180.0	494.0	533.4	1612.9	1066.8
020	30 May 90	9.5	79.5	314.3	176.2	490.5	558.8	1600.2	1066.8
021	03 Jun 86	12.5	113.4	335.0	217.4	552.4		1765.3	1358.9
021	08 Jun 88	14.5		335.0	218.0	553.0	578.0	1625.6	
021	30 May 90	16.5	111.3	341.3	217.4	558.7	711.2	1651.0	1371.6
022	04 Jun 86	8.5	97.5	330.0	220.2	550.2	584.2	1641.6	

Table 1. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck (mm)	Total length (mm)	Heart girth (mm)
022	06 Jun 88	10.5		331.7	215.9	547.6	508.0	1739.9	1085.9
025	04 Jun 86	12.5	102.1	323.9	211.1	535.0	584.2	1803.4	1117.6
025	06 Jun 88	14.5	90.7	323.9	209.6	534.5	552.5	1676.4	1079.5
025	30 May 90	16.5	86.4	320.6	206.3	526.9	546.1	1587.5	1041.4
026	04 Jun 86	3.5	56.7E	352.6					
028	05 Jun 86	9.5	117.9	381.0	215.7	596.9	660.4	1930.4	1016.0
028	28 May 87	10.5	115.7	333.4	208.0	541 4			
028	05 Jun 88	11.5		304.8	215.9	520.7	654.1		
028	30 May 90	13.5	106.8	331.7	209.5	541.2	584.2	1727.2	1079.5
032	05 Jun 86	3.5	62.6	282.7	149.4	432.1			
032	01 Jun 87	4.5	90.7	304.8	165.1	469.9	520.7	1524.0	
033	06 Jun 86	7.5	70.3	311.2	190.5	501.7	520.7	1701.8	889.0
036	07 Jun 86	0.0	106.6E	317.5	209.6	527.1	800.1	1828.8	1168.4
038	07 Jun 86	3.5	83.9	308.0	185.0	493.0	533.4	1676.4	990.6
039	07 Jun 86	8.5	124.7	301.8	209.6	511.4	609.6	1803.4	1143.0
039	07 Jun 88	10.5	117.9	339.0	210.0	549.0	590.6	1619.3	1168.4
039	31 May 90	12.5	140.9	336.5	216.0	552.5	787.4	1524.0	1231.9
041	08 Jun 86	6.5	84.4	317.5	198.4	515.9	660.4	1676.4	1079.5
041	08 Jun 88	8.5		311.2	190.5	501.7	596.9	1651.0	1009.7
041	30 May 90	10.5	93.1	311.1	195.2	506.3	558.8	1600.2	1092.2
043	09 Jun 86	17.5	125.2	328.7	203.2	531.9	647.7	1854.2	1117.6
043	05 Jun 88	19.5	102.1	322.3	200.2	522.5			
049	28 May 87	0.5	8.2						
051	28 May 87	4.5	102.1	311.2	184.2	495.4	609.6	1574.8	
052	29 May 87	14.5		335.0	210.0	545.0		1720.0	980.0
052	29 May 89	16.5	104.3	333.5	209.6	543.1	622.3	1866.9	1117.6
052	30 May 90	17.5	102.2	338.1	214.3	552.4	552.4	1790.7	1092.2
053	29 May 87	7.5	102.6	327.0	208.0	535.0		1660.0	1320.0
053	27 May 89	9.5	108.8	323.9	209.6	533.5	577.9	1689.1	1092.2
054	29 May 87	5.5	56.7	340.0	167.0	507.0		1415.0	1010.0

Table 1. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck (mm)	Total length (mm)	Heart girth (mm)
055	29 May 87	6.5	90.7	330.2	177.8	508.0	520.7	1606.6	1092.2
055	29 May 89	8.5	104.3	319.0	200.2	519.2	558.8	1727.2	1028.7
058	30 May 87	6.5	117.9	342.9	209.6	552.5		1562.1	
058	01 Jun 87	6.5							
058	05 Jun 88	7.5		369.8	222.3	592.1			
059	30 May 87	15.5	95.3	335.0	211.1	546.1	685.8	1651.0	
059	27 May 89	17.5	108.8	339.9	219.2	559.1	603.3	1778.0	1016.0
060	30 May 87	0.5	2.7						
061	30 May 87	0.5	3.6						
062	30 May 87	0.5	3.4						
063	30 May 87	12.5	104.3	331.8	209.6	541.4	558.8	1739.9	
063	05 Jun 88	12.5	129.3	362.0	179.3	541.3		1854.2	1066.8
065	31 May 87	9.5	113.4	292.1	190.5	482.6		1651.0	1092.2
065	27 May 89	11.5	81.6	330.2	196.9	527.1	533.4	1651.0	990.6
066	31 May 87	3.5	59.0	298.5	165.1	463.6		1511.3	
067	31 May 87	4.5	104.3	319.1	193.7	512.8	635.0	1524.0	
067	28 May 89	6.5		317.5	190.5	508.0	609.6	1562.1	1130.3
069	02 Jun 87	10.5	111.1	336.6	204.8	541.4		1727.2	1092.2
069	06 Jun 88	11.5	104.3	339.9	209.6	549.5	596.9	1778.0	1022.4
069	28 May 90	13.5		355.6	225.4	581.0	641.3	1727.2	1079.5
070	02 Jun 87	3.5	90.7	317.5	190.5	508.0	546.1	1562.1	965.2
070	30 May 89	5.5		336.6	201.7	538.3	520.7	1657.4	1143.0
071	02 Jun 87	3.5	81.6E	301.6	182.6	484.2	584.2		
074	04 Jun 87	9.5	117.9	336.6	220.7	557.3	723.9	1702.1	
074	28 May 89	10.5		341.4	215.9	557.3	666.8	1606.6	1168.4
075	05 Jun 88	2.5	38.6	301.8	165.1	466.9	533.4	1549.4	939.8
077	06 Jun 88	0.5	9.5	165.1	098.6	263.7	241.3	838.2	457.2
079	06 Jun 88	0.5	7.5	158.8	098.6	257.4	254.0	711.2	406.4
080	06 Jun 88	0.5	6.8	152.4	098.6	251.0	228.6	635.0	457.2
081	06 Jun 88	10.5	113.4	350.8	204.7	554.5	622.3	1663.7	1124.0

Table 1. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck (mm)	Total length (mm)	Heart girth (mm)
081	31 May 90	12.5	106.8	357.1	206.3	563.4	558.8	1740.0	1016.0
085	07 Jun 88	0.5	6.8	155.7	095.3	251.0	228.6	698.5	
086	07 Jun 88	0.5	6.8	155.7	095.3	251.0	228.6	637.1	254.0
087	07 Jun 88	2.5	56.3	276.4	155.7	432.1		1358.9	787.4
090	07 Jun 88	0.5	10.0	168.4	104.9	273.3	254.0	749.3	406.4
092	08 Jun 88	1.5	21.7	215.9	122.2	338.1	355.6	1041.4	
095	08 Jun 88	6.5	90.7	330.2	185.7	515.9	568.5	1473.2	1060.5
095	28 May 90	8.5	114.5	333.3	216.0	549.3	635.0	1689.1	1066.8
096	09 Jun 88	14.5	93.0	327.2	184.2	511.4	622.3	1638.3	1003.3
096	28 May 90	16.5	102 E	327.0	207.9	534.9	628.6	1765.3	1079.5
097	09 Jun 88		114.7	311.2	200.2	511.4	635.0	1587.5	1066.8
098	09 Jun 88	15.5	104.3	317.5	209.6	527.1	609.6	1676.4	990.6
098	01 Jun 90	17.5	102.2	349.2	215.9	565.1	577.8	1676.4	1225.5
099	09 Jun 88	0.5	7.7	155.7	092.2	247.9	228.6	635.0	381.0
102	28 May 89			335.0	225.6	560.6	762.0	1549.4	
103	28 May 89	8.5	104.3	344.4	208.0	552.4	685.8	1866.9	1206.5
104	28 May 89	1.5	36.3	227.1	136.7	363.8	419.1	1104.9	723.9
107	28 May 89	1.5	29.5	222.3	131.8	354.1	393.7	965.2	
109	29 May 89	1.5	31.7	208.0	127.0	335.0	355.6	1092.2	609.6
117	30 May 89	13.5	124.7	341.0	218.0	559.0	609.6	1676.4	
120	31 May 89	8.5	102.0	330.2	198.4	528.6	609.6	1587.5	1498.6
178	28 May 90	13.5	90.9	330.2	209.5	539.7	609.6	1752.6	1041.4
182	30 May 90	0.5	7.5	161.9	101.6	263.5	228.6	666.7	381.0
184	30 May 90	0.5	6.8	157.1	98.4	255.5	212.7	714.3	361.9
186	30 May 90	1.5	40.9	238.1	130.1	368.2	406.4	1219.2	723.9
188	31 May 90	1.5	36.4	238.1	127.0	365.1	368.3	1066.8	584.2
190	31 May 90	0.5	8.9	158.7	101.6	260.3	247.6	698.5	393.7
191	31 May 90	0.5	9.3	160.3	100.0	260.3	234.9	723.9	406.4
193	01 Jun 90	4.5	75.0	311.1	180.9	492.0	595.9	1524.0	977.9
194	31 May 90	16.5	113.6	336.5	185.7	522.2	711.2	1816.1	1219.2

Table 1. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck (mm)	Total length (mm)	Heart girth (mm)
195	01 Jun 90	12.5	106.8	330.2	203.2	533.4	596.9	1524.0	1041.4
196	01 Jun 90	1.5	20.5	209.5	127.0	336.5	355.6	1054.1	609.6
197	01 Jun 90	1.5	30.0	209.5	130.1	339.6	355.6	869.9	622.3
198	01 Jun 90	11.5	102.2	342.9	204.7	547.6			

[a] Weight data denoted by an "E" represents estimated weights.

Table 2. Physical measurements, reproductive status, blood values, and ear tag numbers of female grizzly bears immobilized in northwest Alaska during 1986 through 1990.

		Canine teeth				Status							
Bear ID	Dates	Upper Ant-Post[a] (mm)	Upper lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	L[c]	Rep[d]	Con[e]	HB[f]	PCV[g]	Left ear tag[h]	Right ear tag	Drug used[i]
001	31 May 86	R17.3	R13.9	R20.3	R19.7	Y	2	3	20.0	58.5	WD2235	WD2231	PHCL
001	07 Jun 88					Y	3	2	18.0	47.0	WD2231	WD2235	TELA
002	31 May 86	U16.0	U11.4	U17.1	U12.3	N	1	2	18.0	53.5	WD2233	WD2243	PHCL
002	06 Jun 88					N	3		15.0	48.0	R112	WD2243	TELA
004	01 Jun 86	R20.8	R14.9	R19.8	R13.2	Y	2	3	20.0	49.0	WD2276	WD2298	PHCL
004	06 Jun 88					Y	3	1	18.5	54.0	R186	R187	TELA
004	30 May 89					Y	3	2	17.0	50.0	R186	R187	TELA
004	31 May 90	20.9	13.9	20.6	12.9	Y	2	3	14.5	38.0	R186	R187	TELA
005	01 Jun 86								17.5	42.5	WD2236	WD2270	PHCL
006	01 Jun 86							3	17.0	45.0	WD2286	WD2290	PHCL
008	02 Jun 86	L15.6	L11.6	L17.9	L12.4	N	3	1	18.5	55.5	WD2282	WD2296	PHCL
008	07 Jun 88					Y	2	3	18.0	47.0	R122	WD2296	TELA
008	28 May 90	18.9	12.2	20.2	11.6	N	1	3	18.0	44.0	R122	R3026	TELA
009	02 Jun 86					Y	1	3	17.0	44.0	WD2300	WD2287	PHCL
009	31 May 87					Y	2	2			WD2300	WD2287	TELA
009	29 May 89	L15.1	L12.1	L15.7	L10.9	N		2	17.0	51.0	Y2300	Y2287	TELA
011	03 Jun 86							1	16.0	42.0	WD2203	WD2241	PHCL
013	03 Jun 86	R20.2	R14.1	R20.5	R17.4	Y	2	4	20.0	51.5	WD2237	WD2246	PHCL
014	03 Jun 86	R16.1	R12.1	L17.5	L12.6	Y	2	4	17.0	46.0	WD2283	WD2297	PHCL
014	05 Jun 88						3				WD228	R125	TELA
014	31 May 90	L17.4	L12.6	L18.5	L 9.8	Y	2	2	16.5	25.5	R3034	R125	TELA
018	03 Jun 86					Y	1	4	18.5	50.0	WD2291	WD2295	PHCL
020	04 Jun 86	L20.6	L11.3	L17.1	L12.4	N	1	4	19.5	54.5	WD2242	WD2240	PHCL
020	07 Jun 88					Y	2	4	19.5	52.0	WD2242	WD2240	TELA
020	30 May 90	L12.6	L12.1	L18.5	L12.6	Y	2	3	19.0	57.0	WD2242	WD2240	TELA
021	03 Jun 86	U17.1	U12.1	U17.3	U13.1	Y		2	18.5	47.5	WD2212	WD2227	PHCL
021	08 Jun 88					Y		2	15.5	43.0	R121	R120	TELA

Table 2. (continued)

Bear ID	Dates	Canine teeth: Upper Ant-Post[a] (mm)	Upper lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	Status: L[c]	Rep[d]	Con[e]	HB[f]	PCV[g]	Left ear tag[h]	Right ear tag	Drug used[i]
021	30 May 90	R17.7	R12.2	R18.3	R13.0	Y	2		17.0	49.0	R121	R120	TELA
022	04 Jun 86	R18.2	R10.9	R19.2	R13.0	Y	2	4	19.1	47.3	WD2211	WD2202	PHCL
022	06 Jun 88					Y	2		15.0	46.0	WD2211	WD2202	TELA
025	04 Jun 86					N	1	3	19.9	55.0	WD2292	WD2293	PHCL
025	06 Jun 88					Y	2	3	18.0	47.0	R124	R123	TELA
025	30 May 90	L19.8	L13.3	L18.8	L13.0	Y	2	5	16.0	50.0	R124	R123	TELA
026	04 Jun 86					N	2	3			WD2239	WD2238	M 99
028	05 Jun 86	R16.1	R10.0	R15.0	R09.8	Y	2	3	20.0	52.0	OD2550	OD2579	M 99
028	05 Jun 88					Y	3	3	17.5	50.0	R2550	R2579	TELA
028	30 May 90					N	2	2	14.0	37.0	R3020	R3025	TELA
032	05 Jun 86	L15.0	L11.9	L15.1	L12.4	N	2	4	17.5	49.5	WD2232	WD2245	M 99
032	01 Jun 87					N	2	3	16.5	43.0	WD2232	WD2445	TELA
033	06 Jun 86	L17.7	L15.3	L14.9	L12.5	N	1	4	20.0	55.5	WD2249	WD2244	M 99
036	07 Jun 86	L18.4	L13.7	L18.7	L13.0	Y	1	4					M 99
038	07 Jun 86					N		2	19.5	49.5	WD2277	WD2299	M 99
039	07 Jun 86	L17.3	L13.7	L18.1	L12.5	Y	1	4	19.0	48.0	WD2204	WD2210	M 99
039	07 Jun 88					Y	2	2	17.5	44.0	WD2204	WD2210	TELA
039	31 May 90	L19.6	L12.1	L17.6	L 9.9	Y	3	2	14.5	46.0	WD2204	WD2210	TELA
041	08 Jun 86	L15.2	L13.5	L17.1	L15.2	N	1	4	19.0	52.5	WD2234	WD2228	M 99
041	08 Jun 88					Y	2	2	16.5	46.0	WD2234	WD2228	TELA
041	30 May 90	R16.4	R12.2	R17.0	R11.0	Y	3	3	16.0	55.0	WD2234	WD2228	TELA
043	09 Jun 86	L16.3	L13.2	L15.2	L13.1	N	1	2	18.0	53.0	WD2230	WD2250	M 99
043	05 Jun 88					Y	3	2	17.5	52.0	WD2230	WD2250	TELA
049	28 May 87								17.0	40.3			TELA
051	28 May 87	L16.7	L13.8	L16.6	L12.8	Y	1	3	19.5	45.5	BL0762	BL0761	TELA
052	29 May 87					Y	2	4	18.0	42.8	BLO750	BL0749	TELA
052	29 May 89	L19.0	L13.5	L19.9	L12.81	Y	3	3	19.0	45.0	BL750	BL749	TELA
052	30 May 90	L17.4	L14.1	L19.8	L13.2	Y	2	2	16.0	44.0	BL750	BL749	TELA

Table 2. (continued)

		Canine teeth				Status							
Bear ID	Dates	Upper Ant-Post[a] (mm)	Upper lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	L[c]	Rep[d]	Con[e]	HB[f]	PCV[g]	Left ear tag[h]	Right ear tag	Drug used[i]
053	29 May 87					Y	2	2			BL0737	BL0736	TELA
053	27 May 89	R16.5	R11.8	17.35	12.05	Y	2	3	13.0	49.0	BL737	BL736	TELA
054	29 May 87					N	2	5	17.0	42.3	BL0753	BL0751	TELA
055	29 May 87					Y	2	5					TELA
055	29 May 89	L16.2	L12.2	L17.3	L13.3	Y	2	4	20.0	50.0	BL755	BL754	TELA
058	30 May 87					Y	2	4	17.5	45.8	BL0757	BL0758	TELA
058	01 Jun 87												TELA
058	05 Jun 88					Y	3	2	14.0	48.0	BL757	BL758	TELA
059	30 May 87					Y	2	5	20.0	44.5	BL0732	BL0733	TELA
059	27 May 89	R17.7	R13.4	R18.5	R14.4	Y	2	3	16.0	46.0	BL733	BL732	TELA
060	30 May 87												TELA
061	30 May 87												TELA
062	30 May 87												TELA
063	30 May 87					Y	2		20.0	48.0	BL0748	BL0747	TELA
063	05 Jun 88					Y	3	3	17.5	53.0	BL748	BL747	TELA
065	31 May 87					Y	1	4	20.0	50.0	BL0729	BL0728	TELA
065	27 May 89	R17.6	R12.3	R18.7	R13.1	Y	3	4	17.5	50.0	BL729	BL728	TELA
066	31 May 87		L11.7	L15.6	L10.6	N	2	4	18.3	42.0	BL0745	BL0727	TELA
067	31 May 87					N	1	4	20.0	37.5	BL0738	BL0739	TELA
067	28 May 89					Y		2	15.5	41.0	BL738	BL739	TELA
069	02 Jun 87					Y	1	4	16.5	52.8	RD1273	RD1041	TELA
069	06 Jun 88					Y	2	3	17.0	47.0	R1273	R1041	TELA
069	28 May 90	L21.7	L12.8	L20.0	L12.7	Y	2	3	15.0	41.0	R1041	R1273	TELA
070	02 Jun 87					Y	1	4	18.5	46.5	RD1274	RD1262	TELA
070	30 May 89	L17.6	L12.2			Y	2	4	20.0	54.0	R1274	R1262	TELA
071	02 Jun 87					N	1	4	18.0	43.5	RD1114	RD1287	TELA
074	04 Jun 87					y	4	3	19.0	45.5	BL0760	BL0764	TELA
074	28 May 89	L16.8	L13.0			Y	2		11.0	32.0	BL764	BL760	TELA

Table 2. (continued)

Bear ID	Dates	Canine teeth: Upper Ant-Post[a] (mm)	Upper lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	Status: L[c]	Rep[d]	Con[e]	HB[f]	PCV[g]	Left ear tag[h]	Right ear tag	Drug used[i]
075	05 Jun 88					N	2	4			R199	R200	TELA
077	06 Jun 88										R550	R548	TELA
079	06 Jun 88					N			17.5	45.0	R1256	R574	TELA
080	06 Jun 88					N			16.5	40.0	R1288	R543	TELA
081	06 Jun 88					N	3	2	16.5	46.0	R184	R185	TELA
081	31 May 90	L19.5	L11.0	L20.2	L11.2	N	2	3	14.5	40.5	R184	R185	TELA
085	07 Jun 88								18.0	43.0	BL763	BL766	TELA
086	07 Jun 88								16.0	43.0			TELA
087	07 Jun 88					N	2		18.5	49.0	R110	R111	TELA
090	07 Jun 88								16.0	39.0	R109	R108	TELA
092	08 Jun 88							3	18.0	46.0	R196	R195	TELA
095	08 Jun 88					N	3	1	18.0	50.0	R116	R115	TELA
096	09 Jun 88					Y	3	4	19.0	51.0	R150	R149	TELA
096	28 May 90	L17.3		L18.9		Y	2	1	19.0	47.0	R150	R149	TELA
097	09 Jun 88					Y	3	3	20.0	40.0	R134	R135	TELA
098	09 Jun 88					Y		3	18.0	43.0	R118	R117	TELA
098	01 Jun 90	L18.5	L13.7	L18.9	L13.6	Y	2	2	18.0	47.5	R118	R117	TELA
099	09 Jun 88								18.0	42.0	R103	R104	TELA
102	28 May 89					Y	3	2			R28	R29	TELA
103	28 May 89	L17.5	L13.6	R18.0	R13.1	Y	3		19.0	57.0	R143	R144	TELA
104	28 May 89	L8.1						2	14.0	43.0	R139	R140	TELA
107	28 May 89	L7.4	L6.6	L6.4	L6.3			4	14.0	52.0	R35	R34	TELA
109	29 May 89	R3.9	R3.3	R4.8	R3.7			2	16.5	39.0	R42	R41	TELA
117	30 May 89					Y	2	3			R22	R21	TELA
120	31 May 89										R23	R24	TELA
178	28 May 90	R19.0	R13.8	R18.0	R11.9	N	2	4	18.0	53.0	R3002	R3001	TELA
182	30 May 90								13.0	40.0	BL1033	BL1035	TELA
184	30 May 90								12.5	44.0	R1034	R1037	TELA

Table 2. (continued)

Bear ID	Dates	Canine teeth: Upper Ant-Post[a] (mm)	Upper lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	Status: L[c]	Rep[d]	Con[e]	HB[f]	PCV[g]	Left ear tag[h]	Right ear tag	Drug used[i]
186	30 May 90	L 6.9	L 4.6	L 7.1	L 3.8	N		3	15.0	49.0	R3023	R3022	TELA
188	31 May 90	R 8.3	R 7.2	R 8.9	R 7.8						R3042	R3031	TELA
190	31 May 90										R3029	R3040	TELA
191	31 May 90										R3035	R3048	TELA
193	01 Jun 90	R20.8	R12.0	R17.4	R13.1	N	3	2	14.5	45.5	R3041	R3049	TELA
194	31 May 90	R19.9	R13.4	R19.4	R12.2	Y	1	3	13.0	42.5	R3011	R3007	TELA
195	01 Jun 90	R18.3	R10.8	L16.9	L11.7	Y	2	2	12.0	42.5	R3043	R3044	TELA
196	01 Jun 90	R 8.8	R 6.6	R 7.1					16.5	45.0	R3014	R3017	TELA
197	01 Jun 90	R 7.7	R 6.6	R 7.2					11.0	33.5	R3010	R1012	TELA
198	01 Jun 90					N	1	3			R3033	R3027	TELA

a Ant. = Anterior, Post. = Posterior.
b lab. = labial, ling. = lingual.
c Lactating: Y = yes, N= no.
d Reproductive status: 1 = in estrus, 2 = not in estrus, 3 = pre-estrus, 4 = post-estrus.
e Condition: subjective evaluation from 1 = excellent through 5 = poor
f % hemoglobulin.
g Packed cell volume.
h OD = orange duflex, WD = white duflex, BL = blue roto, RD = red roto.
i PHCL = Phencylindire Hydrochloride (Sernylan); TELA = Tiletamine Hydrocholoride/ Zolazepan Hydrochloride mixture, also known as Telazol; M99 = Etorphine Hydrocholoride.

Table 3. Dates of capture, ages, weight, and physical measurements of male grizzly bears immobilized in northwest Alaska during 1986 through 1990.

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck circum. (mm)	Total length (mm)	Girth (mm)
003	31 May 86	7.5	186.9	384.3	228.6	612.9	838.2	1828.8	1320.8
003	28 May 89	10.5	170.1	363.5	239.8	603.3	762.0	1784.4	1536.7
007	02 Jun 86	8.5	176.9	317.5	225.6	547.1	547.1	1663.7	1308.1
010	02 Jun 86	11.5	222.3E	360.4	251.0	611.4	927.1	1892.3	
010	29 May 87	12.5							
012	02 Jun 86	12.5	215.5	311.2	257.3	568.5	800.1	2184.4	1384.3
012	08 Jun 86	12.5	215.5						
015	03 Jun 86	0.5	6.0	152.4	108.0	260.4	247.7	660.4	
016	03 Jun 86	0.5	7.0	162.1	95.3	257.4	279.4	679.5	
017	03 Jun 86	2.5	36.3	235.0	138.2	373.2	381.0	1219.2	736.6
019	04 Jun 86	11.5	181.4E	384.3	241.3	625.6	838.2	1752.6	1378.0
019	28 May 90	15.5	227.2	389.0	257.1	646.1	870.0	1955.8	
023	04 Jun 86	1.5	35.4	230.1	134.9	365.0	406.4	1270.0	
024	04 Jun 86	8.5	197.3	339.9	247.7	587.6	774.7	2013.0	1282.7
027	05 Jun 86	8.5	152.0	340.0	223.0	563.0	685.8	2120.9	1244.6
029	05 Jun 86	7.5	192.8	368.3	231.9	600.2	889.0	2184.4	
030	05 Jun 86	11.5	220.0	384.3	257.3	641.6	965.2	1676.4	1524.0
031	05 Jun 86	3.5	86.2	325.0	177.0	502.0	660.4	1778.0	927.1
031	04 Jun 87	4.5	102.1	335.0	193.7	528.7	577.9	1828.8	
031	08 Jun 88	5.5	140.6	357.1	204.7	561.8	596.9	1759.0	1155.7
034	07 Jun 86	5.5	140.6	342.9	209.6	552.5	660.4	1828.8	1117.6
034	05 Jun 88	7.5	172.3	368.3	220.7	589.0	673.1	1816.4	1168.4
035	07 Jun 86	5.5	97.5	342.0	187.0	529.0	558.8	1816.1	965.2
035	03 Jun 87	6.5	133.8	330.2	200.0	530.2		1778.0	
037	07 Jun 86	2.5		306.3	184.2	409.5	641.4	1612.9	
040	07 Jun 86	7.5	197.3	347.0	239.0	586.0	850.9	2184.4	1320.8
040	27 May 89	10.5	215.4	416.1	251.0	667.1	838.2	1905.0	1333.5
040	31 May 90	11.5	222.7	396.8	252.4	649.2	825.5	1943.1	1473.2
042	08 Jun 86	4.5	104.3	310.0	178.0	488.0	609.6	1778.0	1041.4

Table 3. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck circum. (mm)	Total length (mm)	Girth (mm)
042	27 May 89	7.5	165.6	371.6	260.4	632.0	711.2	1962.2	1308.1
044	08 Jun 86	7.5	197.3	365.3	230.1	595.4	876.3	1879.6	
045	09 Jun 86	8.5	176.9	365.3	222.3	587.6	673.1	1866.9	
046	09 Jun 86	8.5	183.7	365.3	230.1	595.4	736.6	1866.9	
046	27 May 89	11.5	204.1	400.1	244.6	644.7	825.5		
048	28 May 87	0.5	10.0						
050	28 May 87	5.5	136.1	371.5	208.0	579.5	660.4	1759.0	1219.2
050	09 Jun 88	6.5	142.8	381.0	223.0	604.0	635.0	2032.0	1231.9
056	29 May 87	4.5	181.4	342.9	190.5	533.4	660.4		1143.0
056	29 May 89	6.5	192.8	368.3	241.3	609.6	685.8	1828.8	1193.8
057	30 May 87	3.5	147.4	320.7	184.2	504.9	558.8	1524.0	990.6
064	30 May 87	12.5	222.3	398.5	238.1	636.6		2070.1	1422.4
064	01 Jun 90	15.5		385.7	241.3	627.0			
068	31 May 87	13.5	272.2E	374.7	260.4	635.1	863.6	2311.4	
072	02 Jun 87	6.5	179.2	360.4	222.3	582.7	736.6	1847.9	1295.4
072	27 May 89	8.5	204.1	379.5	242.8	622.3	781.1	1886.0	1676.4
073	04 Jun 87	5.5	126.1	360.4	204.8	565.2	685.8	1765.3	1257.3
073	08 Jun 88	6.5	165.5	369.8			673.1	1835.2	
076	06 Jun 88	0.5	10.4	171.5	101.6	273.1	254.0	876.3	457.2
078	06 Jun 88	0.5	13.2	174.8	104.9	279.7	279.4	762.0	457.2
082	07 Jun 88	2.5	72.6	279.4	165.1	444.5	508.0	1320.8	
083	07 Jun 88	9.5	231.3	400.1	251.0	651.1	863.6	2209.8	1422.4
084	07 May 88	0.5	11.3	168.4	098.6	266.0	241.3	800.1	
088	07 Jun 88	0.5	10.4	168.4	104.9	273.3	304.8	825.5	457.2
089	07 Jun 88	0.5	10.9	165.1	104.9	270.0	254.0	825.5	431.8
091	08 Jun 88	1.5	19.0	203.2	120.7	323.9	355.6	952.5	533.4
093	08 Jun 88	0.5	6.8						
094	08 Jun 88	0.5	6.8						
100	27 May 89	0.5	8.8	184.2	101.6	285.8	279.4	736.6	
101	27 May 89	0.5	11.3						

Table 3. (continued)

Bear ID	Date	Age (yrs)	Weight[a] (kg)	Head length (mm)	Head width (mm)	Head length plus width (mm)	Neck circum. (mm)	Total length (mm)	Girth (mm)
105	28 May 89	1.5	31.8	235.0	136.7	371.7	393.7	1117.6	
106	28 May 89	1.5	40.8	242.8	134.9	377.7	419.1	1200.2	711.2
108	29 May 89	6.5	172.4	369.0	214.0	583.0	863.6	1809.8	1219.2
110	29 May 89	1.5	43.1	247.7	139.7	387.4	406.4	1143.0	698.5
111	29 May 89	0.5	9.1	163.0	106.0	269.0	235.0	714.5	393.7
112	29 May 89	0.5	9.1	166.0	100.0	266.0	250.0	720.0	365.0
113	29 May 89	13.5	233.6	387.4	263.7	651.1	939.8	1917.7	1333.5
114	30 May 89	0.5	7.0	152.4	095.3	247.7	241.3	711.2	406.4
115	30 May 89	0.5	10.0	157.2	109.5	266.7	228.6	736.6	381.0
116	30 May 89	5.5		336.0	212.0	548.0	609.6	1701.8	1092.2
118	30 May 89	0.5	8.7	187.0	098.0	285.0	270.0	780.0	400.1
119	30 May 89	0.5	7.2	189.0	094.0	283.0	455.0	620.0	
121	31 May 89	0.5	9.0	168.4	115.8	284.2	254.0	689.1	406.4
122	31 May 89	0.5	9.3	198.4	109.5	307.9	247.7	663.7	419.1
176	28 May 90	0.5	7.3	174.6	101.6	276.2	254.0	647.8	393.7
177	28 May 90	0.5	7.7	161.9	104.7	266.6	254.0	609.6	400.0
179	28 May 90	1.5	25.5	209.5	123.8	333.3	412.7	1079.5	606.4
180	30 May 90	0.5	9.3	158.0	113.0	271.0	195.0	730.0	400.0
181	30 May 90	0.5	12.0	175.0	119.0	294.0		770.0	400.0
183	30 May 90	0.5	6.1	157.1	98.4	255.5	209.5	619.1	349.2
185	30 May 90	1.5	43.6	250.8	139.7	390.5	343.0	1092.2	584.2
187	30 May 90	1.5	45.5	228.6	146.0	374.6	381.0	1028.7	647.7
189	31 May 90	1.5	40.0	238.1	136.5	374.6	381.0	1104.9	698.5
192	31 May 90	0.5	10.2	166.6	103.1	269.7	247.6	736.6	425.4
199	01 Jun 90	2.5	72.8	285.7	165.1	450.8	571.5	1479.5	889.0

[a] Weight data denoted by an "E" represent estimate weights.

Table 4. Physical movements, reproductive status, blood values, and ear tag numbers of male grizzly bears immobilized in northwest Alaska during 1986 through 1990.

Bear ID	Date	Canine teeth: Upper Ant-Post[a] (mm)	Canine teeth: Upper Lab-ling[b] (mm)	Canine teeth: Lower Ant-Post (mm)	Canine teeth: Lower lab-ling (mm)	Con[c]	HB[d]	PCV[e]	Left ear tag[f]	Right ear tag	Drug used[g]
003	31 May 86	R21.5	R15.5	L20.4	L18.6	2	20.0	61.0	OD2530	OD2534	PHCL
003	28 May 89					2	20.0	65.0	R141	R142	TELA
007	02 Jun 86	L20.2	L14.9	L20.8	L14.7	1	16.0	46.5	OD2546	OD2526	PHCL
010	02 Jun 86	R23.0	R17.7	R21.9	R15.3		20.0	58.5	OD2589	OD2544	PHCL
010	29 May 87										TELA
012	02 Jun 86	L16.9	L20.8	L19.6	L15.7	1	17.5	47.5	OD2597	OD2536	PHCL
012	08 Jun 86										M 99
015	03 Jun 86					2	18.0	43.0	OD2595	OD2546	PHCL
016	03 Jun 86					2	17.0	39.5	OD2593	OD2538	PHCL
017	03 Jun 86					3	16.0	42.5	OD2548	OD2540	PHCL
019	04 Jun 86	U22.1	U16.0	U26.6	U17.0	3	17.5	47.0	OD2598	OD2533	PHCL
019	28 May 90					1			RD2598	BL1001	TELA
023	04 Jun 86					4	18.0	49.0	OD2559	OD2569	M 99
024	04 Jun 86	L20.1	L15.0	L20.6	L14.8	2	20.0	54.5	OD2591	OD2537	PHCL
027	05 Jun 86	L19.6	L18.8	L21.6	L14.1	3	20.0	53.5	OD2553	OD2558	PHCL
029	05 Jun 86	U21.4	U14.1	U22.8	U14.1	2	20.0	57.3	OD2582	OD2586	PHCL
030	05 Jun 86	L23.6	L17.5	L22.4	L14.7	2	15.0	57.5	OD2532	OD2542	PHCL
031	05 Jun 86	L19.3	L13.7	L21.4	L14.4	3	20.0	59.5	OD2529	OD2531	M 99
031	04 Jun 87					4	20.0	53.0	OD2529	OD2531	TELA
031	08 Jun 88					3	20.0	55.0	R113	R114	TELA
034	07 Jun 86	L16.8	L12.0	L15.0	L12.0	4	17.5	54.0	OD2528	OD2592	M 99
034	05 Jun 88					1	20.0	54.0	R2528	R2592	TELA
035	07 Jun 86	L19.7	L17.8	L20.4	L19.5	3	20.0	50.5	OD2590	OD2596	M 99
035	03 Jun 87					4	18.0	46.0	OD2590	OD2596	TELA
037	07 Jun 86	U17.7	U15.4	U17.6	U15.7	3			OD2549	OD2547	M 99
040	07 Jun 86					2	20.0	55.0	OD2572	OD2585	M 99
040	27 May 89	R21.36	R14.32	R18.05	R15.62	1	17.0	50.0	R027	R026	TELA

Table 4. (continued)

Bear ID	Date	Canine teeth: Upper Ant-Post[a] (mm)	Upper Lab-ling[b] (mm)	Lower Ant-Post (mm)	Lower lab-ling (mm)	Con[c]	HB[d]	PCV[e]	Left ear tag[f]	Right ear tag	Drug used[g]
040	31 May 90	L22.9	L14.0	L23.1	L13.6	1			R27	R26	TELA
042	08 Jun 86	R14.9	R13.0	R20.0	R13.2	3	17.5	54.0	OD2527	OD2600	M 99
042	27 May 89					2	20.0	49.0	R2527	R145	TELA
044	08 Jun 86					2	18.5	48.5	OD2555	OD2554	M 99
045	09 Jun 86	R21.1	R18.4	R23.4	R13.8	3	18.5	57.0	OD2588	OD2535	M 99
046	09 Jun 86	R20.0	R14.4	R21.8	R13.4	4	20.0	52.5	OD2575	OD2562	M 99
046	27 May 89								R2575	R2562	TELA
048	28 May 87						17.8	42.3			TELA
050	28 May 87	L19.8	L18.3	L20.4	L13.4	1	19.5	47.5	BL0773	BL0774	TELA
050	09 Jun 88					3	20.0	51.0	BL773	R148	TELA
056	29 May 87					2	20.0	42.5	BL0771	BL0756	TELA
056	29 May 89	R20.5	R18.4	17.0	12.8	3	18.5	49.0	BL771	BL756	TELA
057	30 May 87					4	18.5	53.3	BL0734	BL0735	TELA
064	30 May 87					4	20.0	53.0	BL0746		TELA
064	01 Jun 90					5			BL1025		TELA
068	31 May 87					4	20.0	50.0	BL0740	BL0730	TELA
072	02 Jun 87					3	20.0	46.0	RD0571	RD0575	TELA
072	27 May 89	R20.2	R14.0	20.4	15.0	1	18.0	43.0	R571	R575	TELA
073	04 Jun 87					4	20.0	51.5	BL0726	BL0743	TELA
073	08 Jun 88					2	19.0	53.0	BL726	BL743	TELA
076	06 Jun 88								R544	R545	TELA
078	06 Jun 88						15.0	39.0	R546	R547	TELA
082	07 Jun 88					3	16.5	43.0	R197	R198	TELA
083	07 Jun 88					2	19.5	53.0	R183	R182	TELA
084	07 May 88						17.0	43.0	R1255	R542	TELA
088	07 Jun 88					3	17.0	39.0	R B175	R1298	TELA
089	07 Jun 88						17.0	42.0	R1297	R1272	TELA
091	08 Jun 88					3	17.0	46.0	193	194	TELA

Table 4. (continued)

Bear ID	Date	Canine teeth: Upper Ant-Post[a] (mm)	Canine teeth: Upper Lab-ling[b] (mm)	Canine teeth: Lower Ant-Post (mm)	Canine teeth: Lower lab-ling (mm)	Con[c]	HB[d]	PCV[e]	Left ear tag[f]	Right ear tag	Drug used[g]
093	08 Jun 88					1			R107	R106	TELA
094	08 Jun 88								R102	R101	TELA
100	27 May 89						6.0	33.0	R130	R130	TELA
101	27 May 89								R132	R131	TELA
105	28 May 89					3	13.0	34.0	R30	R31	TELA
106	28 May 89	R7.2	R7.9	R9.6	R8.7	3	16.0	52.0	R138	R126	TELA
108	29 May 89	R17.8	R14.9	R20.0	R17.7	2			R37	R38	TELA
110	29 May 89					2	16.0	43.0			TELA
111	29 May 89						15.0	36.0	R33	R32	TELA
112	29 May 89						14.5	39.0	R45	R43	TELA
113	29 May 89	L22.76	L16.65	R20.53	R18.83	1	17.0	50.0	R47	R49	TELA
114	30 May 89						14.0	41.0	R12	R11	TELA
115	30 May 89						14.5	41.0	R14	R13	TELA
116	30 May 89	17.1	11.1								TELA
118	30 May 89								R20	R19	TELA
119	30 May 89					3			R18	R17	TELA
121	31 May 89						18.0	46.0	R02	R01	TELA
122	31 May 89						15.0	40.0	R13	R14	TELA
176	28 May 90								BL1027	BL1026	TELA
177	28 May 90								BL1029	BL1028	TELA
179	28 May 90						17.0	36.0	BL1013	BL1014	TELA
180	30 May 90					2				R3050	TELA
181	30 May 90									R3036	TELA
183	30 May 90						12.0	38.0	BL3037	BL3039	TELA
185	30 May 90					3	13.0	44.0	BL1036	BL1030	TELA
187	30 May 90						14.5	44.0	BL1049	BL1048	TELA
189	31 May 90	L 9.5	L 5.9	L 7.3	L 4.5	4			BL1016	BL1019	TELA
192	31 May 90								BL1023	Bl1011	TELA

Table 4. (continued)

Bear ID	Date	Canine teeth: Upper Ant-Post[a] (mm)	Canine teeth: Upper Lab-ling[b] (mm)	Canine teeth: Lower Ant-Post (mm)	Canine teeth: Lower lab-ling (mm)	Con[c]	HB[d]	PCV[e]	Left ear tag[f]	Right ear tag	Drug used[g]
199	01 Jun 90					3	15.0	45.0	BL1047	BL3030	TELA

a Ant. = anterior, Post. = posterior.
b lab. = labial, ling. = lingual.
c Condition = subjective evaluation from 1 = excellent through 5 = poor.
d % hemoglobin.
e Packed cell volume.
f OD = orange duflex, WD = white duflex, BL = blue roto, RD = red roto.
g PHCL = Phencylindine Hydrocholoride (Sernylan); TELA = Tiletamine Hydrocholoride/zolazepan hydrochloride mixture (Telazol); M99 = Etorphine Hydrochloride.

Table 5. Sex ratios by age class of grizzly bears immobilized in northwest Alaska during 1986 through 1990.

Age	COY			1.5			2.5			3.5-4.5			≥5.5		
Sex	(n)	F	M	(n)	F	M	(n)	F	M	(n)	F	M	(n)	F	M
Year															
1986	(5)	60	40	(1)	0	100	(2)	0	100	(6)	67	33	(32)	53	47
1987	(5)	80	20							(7)	71	29	(15)	67	33
1988	(14)	50	50	(2)	50	50	(3)	67	33				(5)	80	20
1989	(10)	0	100	(6)	50	50							(6)	50	50
1990	(10)	40	60	(6)	33	67	(1)	0	100	(1)	100	0	(3)	100	0
Totals	(44)	41	59	(15)	40	60	(6)	33	67	(14)	71	29	(61)	61	39

Table 6. Summary of litter sizes and subsequent losses of offspring for radio-collared adult (≥3 yr-olds) female grizzly bears captured in the southwest Brooks Mountain Range of GMU 23 during 1986 through 1990.

			Barren		Cubs		Yearlings		2.5 yr olds	
Bear ID	Year	Age	EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]	EM[a]	ENT[b]
001	1986	5.5			2	2				
	1987	6.5					2	2		
	1988	7.5	x	x						
	1989	8.5			3	3-Dead				
002	1986	5.5	x	x						
	1987	6.5	x	x						
	1988	7.5	x	x						
	1989	8.5	x	Slipped						
004	1986	6.5			2	2				
	1987	7.5					2	2		
	1988	8.5		x					2	0
	1989	9.5	x	x						
	1990	10.5		x	1	0				
008	1986	13.5	x	x						
	1987	14.5	x	x						
	1988	15.5			1	1				
	1989	16.5					1	1		
	1990	17.5		x					1	0
009	1986	14.5	x	x						
	1987	15.5	x	x						
	1988	16.5			2	2				
	1989	17.5					2	2-Dead		
013	1986	7.5	x	Dead						

Table 6. Continued.

Bear ID	Year	Age	Barren EM[a]	Barren ENT[b]	Cubs EM[a]	Cubs ENT[b]	Yearlings EM[a]	Yearlings ENT[b]	2.5 yr olds EM[a]	2.5 yr olds ENT[b]
014	1986	9.5			3[c]	1				
	1987	10.5		x			1	0		
	1988	11.5	x	x						
	1989	12.5			3	2				
	1990	13.5		x			2	0		
018	1986	8.5	x	Dead						
020	1986	5.5	x	x						
	1987	6.5	x	x						
	1988	7.5			2	2				
	1989	8.5					1	1		
	1990	9.5							1	1
021	1986	12.5	x	x						
	1987	13.5			4	3				
	1988	14.5					2	2		
	1989	15.5		x					2	0
	1990	16.5			3	3				
022	1986	8.5					1	1		
	1987	9.5		x					1	0
	1988	10.5			2	1				
	1989	11.5					1	1		
	1990	12.5	?	Dead						
025	1986	12.5	x	x						
	1987	13.5	x	x						
	1988	14.5			2	2				
	1989	15.5					2	2		
	1990	16.5							2	2
026	1986	3.5	x							

Table 6. Continued.

Bear ID	Year	Age	Barren EM[a]	Barren ENT[b]	Cubs EM[a]	Cubs ENT[b]	Yearlings EM[a]	Yearlings ENT[b]	2.5 yr olds EM[a]	2.5 yr olds ENT[b]
028	1986	9.5	x	x						
	1987	10.5		x	2	0				
	1988	11.5	x	x						
	1989	12.5			3	3				
	1990	13.5					3	3		
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						
	1988	10.5			3	3				
	1989	11.5					3	3		
	1990	12.5		x					3	0
041	1986	6.5	x	x						
	1987	7.5	x	x						
	1988	8.5			2	2				
	1989	9.5					2	2		
	1990	10.5	x	x						
043	1986	17.5	x	x						
	1987	18.5	x	x						
	1988	19.5	x	x						
	1989	20.5	x	x						
047	1986	Unk							2[d]	

Table 6. 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]
051	1987	4.5	x							
052	1987	14.5					2[d]	2		
	1988	15.5		x					2	0
	1989	16.5	x	x						
	1990	17.5			2	2				
053	1987	7.5					1[d]	1		
	1988	8.5		x					1	0
	1989	9.5			2	2				
	1990	10.5					2	2		
054	1987	5.5	x							
055	1987	6.5					3[d]	2		
	1988	7.5		x					1	0
	1989	8.5			2	2				
058	1987	6.5					3[d]	3		
	1988	7.5		x					3	0
	1989	8.5	x	x						
059	1987	15.5			3	3				
	1988	16.5					3	3		
	1989	17.5							3	3
	1990	18.5		x					3[e]	0
063	1987	12.5					2[d]	2		
	1988	13.5		x					2	0
	1989	14.5	x	x						

Table 6. 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	9.5	x	x						
	1988	10.5	x	x						
	1989	11.5	x	x						
	1990	12.5			2	2				
066	1987	3.5	x	x						
067	1987	4.5	x	x						
	1988	5.5			2	2				
	1989	6.5		x			2	0		
	1990	7.5			3	3				
069	1987	10.5	x	x						
	1988	11.5			2	2				
	1989	12.5					2	2		
	1990	13.5		x					1	0
070	1987	3.5	x	x						
	1988	4.5	x	x						
	1989	5.5		x	2	0				
071	1987	3.5	x	x						
074	1987	9.5	x	x						
	1988	10.5			3	3				
	1989	11.5					3	2		
	1990	12.5		x					2	0
081	1988	10.5	x	x						
	1989	11.5			1	1				
	1990	12.5					1	1		
087	1988	2.5	x							

Table 6. 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]
095	1988	6.5	x	x						
	1989	7.5	x	x						
	1990	8.5	x	x						
096	1988	14.5	x	x						
	1989	15.5	x	x						
	1990	16.5			2	Missing				
097	1988	13.5E	x	x						
	1989	14.5E			2	2				
098	1988	15.5			1	1				
	1989	16.5					1	1		
	1990	17.5							1	1
102	1989		x	x						
	1990				3	3				
103	1989	8.5	x	x						
	1990	9.5	x	x						
117	1989	13.5			2	2				
	1990	14.5					2	2		
120	1989	8.5			2	2				
	1990	9.5					2	2		
178	1990	13.5	x	x						
194	1990	16.5	x	x						
195	1990	12.5					1	1		
198	1990	11.5	x	x						

Table 6. 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]
			Mean =		2.17	2.06[f]	1.93	1.88	1.76	1.75
			SD =		0.71	0.68	0.72	0.67	0.75	0.96
			_n_ =		35	31	28	25	17	4

[a] EM = Size of litter at emergence from den in spring.

[b] ENT = Size of litter at den entrance in autumn.

[c] Capture related mortalities.

[d] Offspring age estimated.

[e] 3-3.5-yr-olds.

[f] Excluding two capture related mortalities $\bar{X}$=2.10, SD=0.66, _n_=30.

Table 7. Minimum intervals between successful weaning of 2.5 year-old young by radio-collared adult female grizzly bears in northwest Alaska during 1986 through 1990.

Bear ID	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Reproductive Interval (Yrs)
001		COY	Yrls	Weaned	COY						3
004		COY	Yrls	Weaned		COY					4
008		Weaned		COY	Yrls	Weaned					4
009		Weaned		COY	Yrls	Weaned					4
014	Weaned	COY			COY		COY	Yrls	Weaned		8
020		Weaned		COY	Yrls	2.5 yrs	Weaned				5
021		Weaned	COY	Yrl	Weaned	COY	Yrl	Weaned			3,3
022			Weaned	COY	Yrls	Weaned					3
025		Weaned		COY	Yrls	2.5 yrs	Weaned				5
028		Weaned	COY		COY	Yrls	Weaned				5
039		Weaned		COY	Yrls	Weaned					4
041		Weaned		COY	Yrls	Weaned					4
043		Weaned				COY	Yrls	Weaned			6
052				Weaned		COY	Yrls	Weaned			4
053				Weaned	COY	Yrls	Weaned				3
055				Weaned	COY	Yrls	Weaned				3
058				Weaned		COY	Yrls	Weaned			4
059		Weaned	COY	Yrls	2.5yrs	Weaned	COY	Yrls	Weaned		3,4*
063				Weaned		COY	Yrls	Weaned			4
065			Weaned			COY	Yrls	Weaned			5
067			Weaned	COY		COY	Yrls	Weaned			5
069				Weaned	COY	Yrls	Weaned				3
070					COY		COY	Yrls	Weaned		4*
074			Weaned	COY	Yrls	Weaned					3
081				Weaned	COY	Yrls	Weaned				3
095				Weaned			COY	Yrls	Weaned		5
096				Weaned		COY	Yrls	Weaned			4*
097				Weaned	COY	Yrls	Weaned				3
098			Weaned	COY	Yrls	2.5 yrs	Weaned	Coy	Yrls	Weaned	3,4*
102					Weaned	COY	Yrls	Weaned			3
103					Weaned		COY	Yrls	Weaned		4*

Table 7. (continued).

Bear ID	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Reproductive Interval (Yrs)
117			Weaned	COY	Yrls	Weaned					3
120			Weaned	COY	Yrls	Weaned					3

* Included only if greater than mean. Average without was 3.90.

$x = 3.92$
SD = 1.08
$\underline{n} = 36$

Table 8. Weights (Kgs) of grizzly bears by sex and age class captured in northwest Alaska during 1986 through 1990.

Sex	Age	COY	Yrls.	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	≥10.5
<u>Females</u>												
	<u>n</u>	18	8	2	6	5	3	6	4	8	7	38
	x	7.4	30.9	47.5	72.4	93.5	71.8	98.4	89.2	113.8	105.9	106.9
	S.D.	2.4	6.7	8.9	13.4	10.4	16.8	11.1	15.7	14.6	12.9	12.2
	Min.	2.7	20.5	38.6	56.7	75.0	56.7	84.4	70.3	97.5	79.5	81.6
	Max.	12.7	40.9	56.3	90.7	104.3	95.3	117.9	106.6	145.2	117.9	140.9
<u>Males</u>												
	<u>n</u>	26	9	3	2	3	5	6	6	6	1	13
	x	9.0	35.1	60.6	116.8	129.2	128.1	164.4	185.3	181.8	231.3	217
	S.D.	1.9	8.5	17.2	0.0	36.9	162.2	20.4	12.3	16.7		23.5
	Min.	6	19	36.3	86.2	102.1	97.5	133.8	165.6	152.0	231.3	170.1
	Max.	13.2	45.5	72.8	147.4	181.4	140.6	192.8	197.3	204.1	231.3	272.2

Table 9. Summary of numbers of relocations, and status of female grizzly bears captured in the southwest Brooks Mountain Range of GMU 23 during 1986 - 1990.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations					Status
			1986	1987	1988	1989	1990	
001*	05/31/86	5.5	13	10	11	6		Hunting mortality 08/89.
002*	05/31/86	5.5	12	15	11	2		Slipped collar 5/26 and 6/13/89, unknown.
004*	06/01/86	6.5	13	18	11	12	6	Active.
005	06/01/86	0.5						Cub of sow 04, separated by 06/08/88.
006	06/01/86	0.5						Cub of sow 04, separated from sow by 06/08/88.
008*	06/02/86	4.5	14	19	10	8	5	Hunting mortality 09/90.
009*	06/02/86	13.5	11	14	6	7		Hunting mortality 09/89.
011	06/03/86	0.5						Missing after capture (possible post-capture mortality).
013	06/03/86	7.5						Capture mortality 06/86.
014*	06/03/86	9.5	11	15	14	7	5	Active.

Table 9. Continued

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	1989	1990	Status
018*	06/30/86	8.5	10					Hunting mortality 10/02/86.
020*	06/04/86	8.5	10	22	13	5	9	Active.
021*	06/03/86	12.5	8	11	10	5	9	Active.
022*	06/04/86	8.5	10	21	13	8	1	Hunting mortality 5/90 (subsistence).
025*	06/04/86	12.5	11	8	7	7	4	Active.
026	06/04/88	3.5						Unknown after capture.
028*	06/05/86	9.5	13	22	9	9	8	Active.
032*	06/05/86	3.5		7				Recap 6/87 w/breakaway collar, off by 8/12/87. Unknown.
033	06/06/86	7.5						Unknown after capture.
036	06/07/86							Capture mortality.
038	06/07/86	3.5						Unknown after capture.
039*	06/07/86	8.5	9	16	12	7	6	Active.
041*	06/08/86	6.5	8	13	12	9	6	Active.

Table 9. Continued

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	1989	1990	Status
0043*	06/09/86	17.5	5	20	11	5	1	Natural mortality - avalanche 05/90.
047	05/30/86							Unknown after capture.
049	05/28/87	0.5						Cub of sow 28, unknown in 1988.
051*	05/28/87	4.5		2				Slipped collar between 5/30 and and 6/4/87, unknown.
052*	05/29/87	14.5		7	4	5	8	Active.
053*	05/29/87	7.5		15	7	7	6	Active.
054	05/29/87	5.5						Capture mortality 5/87.
055*	05/29/87	6.5		17	11	10		Hunting mortality 10/89.
058*	05/30/87	6.5		16	10	5		Missing after 11/13/89.
059*	05/30/87	15.5		9	7	6	5	Active.
060	05/30/87	0.5						Cub of sow 059.
061	05/30/87	0.5						Cub of sow 059.
062	05/30/87	0.5						Cub of sow 059.

Table 9. Continued

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	1989	1990	Status
063	05/30/87	12.5		19	11	3		Missing after 06/13/89.
065*	05/31/87	9.5		16	5	7	5	Active.
066*	05/31/87	3.5		9				Breakaway collar, dropped 8/12 and 9/8/87, unknown.
067*	05/31/87	4.5		17	10	10	6	Active.
069*	06/02/87	10.5		16	12	8	7	Hunting mortality 09/90.
070*	06/02/87	3.5		16	8	9		Missing after 05/26/90.
071*	06/02/87	3.5		12				Missing after 09/15/87.
074*	06/04/87	9.5		14		10	6	Active.
075	06/05/88	2.5						2.5 yr old of sow 58, unknown after capture.
077	06/06/88	0.5						Cub of sow 69.
079	06/06/88	0.5						Cub of sow 25.
080	06/06/88	0.5						Cub of sow 25.
081*	06/06/88	10.5			7	7	7	Active.

Table 9. Continued

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	1989	1990	Status
085	06/07/88	0.5						Cub of sow 20.
086	06/07/88	0.5						Cub of sow 20.
087	06/07/88	2.5						Unknown after capture.
092	06/08/88	1.5						Yrl. of sow 21.
095*	06/08/88	6.5			4	5	7	Active.
096*	06/09/88	14.5			5	7	3	Missing after 05/31/90.
097*	06/09/88	13.5E			4	9	1	Slipped collar 05/24/90.
098*	06/09/88	15.5			3	6	3	Active.
099	06/09/88	0.5						Cub of sow 98.
102*	05/28/89					9	6	Active.
103*	05/28/89	8.5				8	6	Active.
104	05/28/89	1.5						Yrl. of sow 67.
107	05/28/89	1.5						Yrl. of sow 74.
109	05/29/89	1.5						Yrl. of sow 09.
117*	05/30/89	13.5				9	7	Active.
120*	05/31/89	8.5				5	3	Active.

Table 9. Continued

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations					Status
			1986	1987	1988	1989	1990	
178*	05/28/90	13.5					5	Active.
182	05/30/90	0.5						Cub of sow 21.
184	05/30/90	0.5						Cub of sow 21.
186	05/30/90	1.5						Yrl. of sow 28.
188	05/31/90	1.5						Yrl. of sow 81.
190	05/31/90	0.5						Cub of sow 4.
191	05/31/90	0.5						Cub of sow 4.
193	06/01/90	4.5						Unknown after capture.
194*	05/31/90	16.5					5	Active.
195*	06/01/90	12.5					3	Active.
196	06/01/90	1.5						Yrl. of sow 195.
197	06/01/90	1.5						Yrl. of sow 195.
198*	06/01/90	11.5					4	Active.
Total			158	416	258	242	163	

* Radio-collared
[a] Observed copulating with unmarked male on 5/21/88

Table 10. Summary of number of relocations and status of male grizzly bears in the southwest Brooks Mountain Range of GMU 23 during 1986 - 1990.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations			Status of den entrance 1988
			1986	1987	1988	
003*	05/31/86	7.5	11	15	9	Hunting mortality 09/06/89.
007*	06/02/86	8.5	10	1		Hunting mortality 09/16/87.
010*	06/02/86	11.5	10	9		Slipped collar 5/87, recap 5/87, slipped 10/87.
012*	06/02/86	12.5	5			Slipped collar 6/86, recap 6/86, slipped 8/86.
015	06/03/86	0.5				Cub of sow 14, missing after capture - capture mortality.
016	06/03/86	0.5				Cub of sow 14, assumed dead, missing after 5/28/87, see sow 014.
017	06/30/86	2.5				Unknown after capture.
019*	06/04/86	11.5	2			Slipped collar by 6/8/86.
023	06/04/86	1.5				Unknown after capture.
024*	06/04/86	8.5	6	9		Slipped collar 8/12/87.
027*	06/05/86	8.5	4			Missing after 7/3/86.
029*	06/05/86	7.5	10			Hunting mortality 4/21/87.
030*	06/05/86	11.5	3			Hunting mortality 4/19/87.
031*	06/05/86	3.5		10	1	Hunting mortality 09/16/89.
034*	06/07/86	5.5	10	21	1	Collar removed on 6/5/88.

Table 10. Continued.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	No. of relocations 1987	No. of relocations 1988	Status of den entrance 1988
035*	06/07/86	5.5	6	6		Natural mortality probably from wolves by 10/9/87.
037	06/07/86	2.5				Hunting mortality 9/87.
040*	06/07/86	7.5	10	16	9	Collar removed 05/27/89.
042*	06/08/86	4.5	10	18	11	Collar removed 05/27/89.
044*	06/08/86	7.5	5			Hunting mortality 4/23/87.
045*	06/09/86	8.5	8	13		Slipped collar 7/1 and 7/6/87.
046*	06/09/86	8.5	10	15	10	Collar removed on 05/27/89.
048	05/28/87	0.5				Cub of sow 28, killed by hunter on 9/19/88.
050*	05/28/87	5.5		2	3	Collar removed on 6/9/88.
056*	05/29/87	4.5		15	12	Collar removed on 05/29/89.
057*	05/30/87	3.5		10		Hunting mortality 9/88.
064*	05/30/87	12.5		18	6	Slipped collar between 7/15 and 7/27/88
068*	05/31/87	13.5				Slipped collar between 6/2 and 6/3/87.
072*	06/02/87	6.5		10	5	Collar removed on 05/27/89.
073*	06/04/87	5.5		9	4	Collar removed on 6/8/88.
076	06/06/88	0.5				Cub of sow 69.

Table 10. Continued.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	Status of den entrance 1988
078	06/06/88	0.5				Cub of sow 22.
082	06/07/88	2.5				Unknown after capture.
083	06/07/88	9.5				Unknown after capture.
084	05/07/88	0.5				Cub of sow 8.
088	06/07/88	2.5				Cub of sow 39.
089	06/07/88	0.5				Cub of sow 39.
090	06/07/88	0.5				Cub of sow 39.
091	06/08/88	1.5				Yrl. of sow 21.
093	06/08/88	0.5				Cub of sow 41.
094	06/08/88	0.5				Cub of sow 41.
100	05/27/89	0.5				Cub of sow 53.
101	05/27/89	0.5				Cub of sow 53.
105	05/28/89	1.5				Yrl. of sow 74.
106	05/28/89	1.5				Hunting mortality 09/30/90.
108	05/29/89	6.5				Adult, marked 05/29/89.
110	05/29/89	1.5				Yrl. of sow 09.
111	05/29/89	0.5				Cub of sow 55.
112	05/29/89	0.5				Cub of sow 55.

Table 10. Continued.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	Status of den entrance 1988
113	05/29/89	13.5				Adult, marked 05/29/89.
114	05/30/89	0.5				Cub of sow 70.
115	05/30/89	0.5				Cub of sow 70.
116	05/30/89	5.5				Adult, marked 05/30/89.
118	05/30/89	0.5				Cub of sow 117.
119	05/30/89	0.5				Cub of sow 117.
121	05/31/89	0.5				Cub of sow 120.
122	05/31/89	0.5				Cub of SOw 120.
176	05/28/90	0.5				Cub of sow 96.
177	05/28/90	0.5				Cub of sow 96.
179	05/28/90	1.5				Yrl. of sow 178.
180	05/30/90	0.5				Cub of sow 52.
181	05/30/90	0.5				Cub of sow 52.
183	05/30/90	0.5				Cub of Sow 21.
185	05/30/90	1.5				Yrl. of sow 28.
187	05/30/90	1.5				Yrl. of sow 28.
188	05/31/90	1.5				Yrl. of sow 14.
192	05/31/90	0.5				Cub of sow 04.

Table 10. Continued.

Bear ID (tattoo)	Capture date	Age at capture	No. of relocations 1986	1987	1988	Status of den entrance 1988
199	06/01/90	2.5				Unknown after capture.
Total			120	197	71	

*Radio-collared

Table 11. Average elevational (meters) use by grizzly bears by sex and family class in northwest Alaska during 1986 through 1990.

Time period	Sows w/COY			Sows w/yearlings			Single females			Boars		
	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n
April	933	483	3	1400	0	1	1275	317	6	871	346	7
1-14 May				1975	1025	2	791	260	6	1128	462	7
15-28 May	1410	749	29	878	763	23	1031	650	41	928	631	33
29 May-11 Jun	1235	771	46	873	533	38	773	470	114	914	647	67
12 Jun-25 Jun	1123	930	19	946	623	21	877	527	65	876	598	34
26 Jun-9 Jul	1027	783	18	1061	517	15	818	332	46	766	594	32
10-23 Jul	673	781	13	978	244	7	907	651	28	488	314	17
24 Jul-6 Aug	507	712	20	602	418	12	580	337	34	409	322	16
7 Aug-20 Aug	588	878	21	945	609	24	627	474	44	427	401	29
21 Aug-3 Sep	426	637	24	705	663	10	576	494	40	380	242	15
4-17 Sep	240	480	10	387	352	8	521	414	41	347	328	34
18 Sep-1 Oct	330	697	20	879	985	16	662	593	26	429	544	12
2-15 Oct	464	743	7	779	650	11	939	632	33	597	434	27
>16 Oct	1203	826	19	1826	1553	17	1491	686	41	1205	512	24

Table 12. Relative frequency of occurrence of use of slopes by radio-collared grizzly bears by sex and family status in northwest Alska, 1986-1990.

	Flat	Gentle	Moderate	Steep	Riverbank	Totals
Cows w/o young	238	173	106	33	25	575
Sows w/COY	72	50	67	46	4	239
Sows w/yearlings	85	48	40	17	7	197
Males	171	93	59	19	21	363
Totals	566	364	272	115	57	1374

Table 13. Relative frequency of use of compass aspects by radio-collared grizzly bears by sex and family status in northwest Alaska, 1986-1990.

Sex-family status	Aspect											
	Flat	Gully	Ridge	N	NE	E	SE	S	SW	W	NW	Totals
Sows w/o young	256	37	26	53	15	32	47	136	30	40	21	693
Sow w/COY	71	11	13	43	13	19	27	60	8	21	8	294
Sow w/yrl.	87	12	8	34	14	19	8	33	17	8	7	247
Males	172	26	11	24	5	22	23	75	20	28	9	415
Totals	586	86	58	154	47	92	105	304	75	97	45	1649

Table 14. Relative frequency of use of habitat types of radio-collared grizzly bears by sex and family status in northwest Alaska, 1986-1990.

Sex-family status	Habitat types[a]								
	1	2	3	4	5	6	7	8	9
Sows w/o young	21	13	3	142	61	28	0	1	1
Sows w/COY	8	2	0	26	17	11	0	3	1
Sows w/yearlings	9	5	3	33	19	8	0	1	0
Males	15	7	1	118	37	14	0	0	1
Totals	53	27	7	319	134	61	0	5	3

	10	11	12	13	14	15	16	17	18	Totals
Sows w/0 young	7	131	45	29	23	39	7	1	2	554
Sows w/COY	3	76	12	29	7	19	7	0	0	221
Sows w/yearlings	0	48	15	16	10	19	4	1	0	191
Males	7	57	17	13	10	15	4	2	0	318
Totals	17	312	89	87	50	92	22	4	2	1284

Table 14. (continued)

[a] 1 = tall (> 6m) spruce (*Picea* sp.), 2 = moderate height (3.3-6m) spruce, 3 = short (<3.3m) spruce, 4 = riparian willows (*Salix* sp.), 5 = upland willow, 6 = willow/birch (*Betula* sp.), 7 = aspen (*Populus* sp.), 8 = riparian hardwood, 9 = marsh, 10 = alder (*Alnus* sp.), 11 = Rock/ice/snow, 12 = sedge/grass, 13 - alpine herbaccous, 14 = short shrub, 15 = mat and cushion tundra, 16 = gravel bar, 17 = mixed birch-spruce, and 18 = birch.

Table 15. Comparison of radio-collared adult (≥3.5 years-old) female grizzy bear home range sizes in northwest Alaska during 1986 through 1990 as determined by 4 methods of calculation.

Bear no.	Age at capture	Period of coverage	n	Home range size by method (Km^2) Convex polygon	Concave polygon	95% ellipse	Harmonic mean (80%)[a]
01	5.5	05/86-08/89	40	927.6	59.5	1588.0	333.3
02	5.5	05/86-06/89	39	657.8	99.2	1172.6	411.3
04	6.5	06/86-09/90	59	1809.3	205.7	3096.4	796.5
08	4.5	06/86-09/90	56	1368.4	254.1	2465.3	606.8
09	13.5	06/86-09/89	38	469.3	105.2	925.0	232.1
14	9.5	06/86-09/90	51	1345.8	284.3	1786.1	424.3
20	5.5	06/86-09/90	55	479.6	90.2	536.4	136.8
21	12.5	06/86-09/90	41	827.9	33.0	1364.9	211.4
22	8.5	06/86-05/90	53	819.8	124.6	1251.7	229.7
25	12.5	06/86-09/90	35	269.1	36.7	396.8	114.4
28	9.5	06/86-09/90	54	1439.6	150.5	2139.5	524.9
39	8.5	06/86-09/90	50	3465.2	10.7	9384.9	512.8
41	6.5	06/86-09/90	42	1058.2	139.1	1652.8	272.6
43	17.5	06/86-05/90	41	1785.8	369.8	2874.3	678.6
52	14.5	05/87-09/90	19	758.7	25.2	2516.1	181.7
53	7.5	05/87-09/90	26	1999.9	57.6	3009.5	400.3
55	6.5	05/87-10/89	37	874.4	92.0	1240.3	245.1
58	6.5	05/87-11/89	24	2499.7	25.1	8561.4	947.2
59	15.5	05/87-09/90	23	517.0	32.1	1094.9	169.3
63	12.5	05/87-06/89	29	601.3	118.0	827.7	118.8
65	9.5	05/87-09/90	32	572.1	69.1	1181.7	262.3
67	4.5	05/87-09/90	40	1338.5	32.1	1486.7	374.4
69	10.5	06/87-09/90	37	699.0	3.2	949.0	287.6
70	3.5	06/87-05/90	32	1298.5	47.9	2731.1	457.4
71	3.5	06/87-09/87	10	1010.0	0.0	5109.0	288.5
74	9.5	06/87-09/90	37	483.2	97.7	865.1	257.8
81	10.5	06/88-09/90	15	1058.6	16.5	3072.0	257.5
95	6.5	06/88-09/90	12	214.3	28.7	820.5	12.4

Table 15. Continued.

Bear no.	Age at capture	Period of coverage	n	Home range size by method (Km^2) Convex polygon	Concave polygon	95% ellipse	Harmonic mean (80%)[a]
96	14.5	06/88-05/90	13	167.5	33.0	628.0	57.7
97	13.5E	06/88-05/90	13	297.4	12.4	1190.6	28.0
102		05/89-09/90	13	257.1	41.7	986.2	19.6
103	8.5	05/89-09/90	11	629.7	5.6	2691.0	221.4
117	13.5	05/89-09/90	15	765.7	8.6	2666.4	66.1
$\bar{X}$				993	82.1	2159	307.2
SD				709	87.4	2017	221.7
Median				820	47.9	1487	257.8

[a] If more than one contour was defined only the largest contour was reported here.

Table 16. Comparison of radio-collared adult ($\geq$3.5 years-old) male grizzy bear home range sizes in northwest Alaska during 1986 through 1990 as determined by 4 methods of calculation.

				Home range size by method (Km^2)			
Bear no.	Age at capture	Period of coverage	n	Convex polygon	Concave polygon	95% ellipse	Harmonic mean (80%)[a]
03	7.5	05/86-09/86	38	2183.4	228.9	3850.3	995.6
07	8.5	06/86-09/87	13	243.0	1.2	627.8	40.8
10	11.5	06/86-06/88	21	527.6	5.4	1264.7	87.0
24	8.5	06/86-08/87	13	1281.4	0.3	4849.1	360.4
31	4.5	06/86-09/89	12	1065.6	0.0	5446.9	104.8
34	5.5	05/86-06/88	28	1138.0	38.1	2505.0	252.6
35	5.5	06/86-10/87	12	1885.6	23.1	6208.8	483.8
40	7.5	06/86-05/89	36	915.2	85.1	1806.2	282.8
42	4.5	06/86-05/89	39	1802.0	120.4	3156.9	798.0
45	8.5	06/86-07/87	16	1774.6	87.5	5568.2	236.9
46	8.5	06/88-05/89	37	999.6	68.4	1615.7	395.3
56	6.5	05/87-05/89	26	4341.6	99.3	13170.0	751.0
64	15.5	05/87-08/88	23	519.5	80.8	1269.5	168.0
72	6.5	06/87-05/89	17	1421.3	50.6	3460.0	368.3
73	5.5	06/87-06/88	12	1458.0	130.6	5883.8	124.3
$\bar{X}$				1437	68.0	4046	363.3
SD				973	62.8	3138	284.3
Median				1281	68.4	3460	282.8

[a] If more than one contour was defined only the largest contour was reported here.

Table 17. Description of location quality index (QQ) used with locations obtained from PTT's with regular, non-quaranteed, and special animal processing by Service Argos.

nl or LQ	QQ Index	Description
3	9	Equivalent to NQ=3. 5 messages received used in calculation of position over 420 second duration. Internal consistency >0.15 Hz, satellite must achieve a maximum elevation between 22-55 degrees above horizon relative to PTT. Location reportedly accurate within 150 meters or 68% of occasions.
2	8	Equivalent to NQ=2. At least 5 messages must be received and used in calculation position over 420 second duration. The satellite must achieve maximum elevation of 17-78 degrees above horizon relative to ptt. Location reportedly accurate within 350 meters or 68% of occasions.
1	7	Equivalent to NQ=1. At least 5 messages must be received 240 second or 4 messages over 420 seconds. Provides a non-quaranteed location but not necessarily of low quality.
0	6	$\geq$4 messages but a pass duration less than 240 seconds.
0	5	Doppler point of inflection does not belong to the pass or mid-term oscillator drift is high.
0	4	3 messages. Previous location <12 hours old.
0	3	3 messages. Previous location <12 hours old.
0	2	2 messages. Previous location <12 hours old.
0	1	2 messages. Previous location >12 hours old.
	0	Location impossible. Geometric initialization failed.
	-1	Location rejected. Distance from ground track.

Table 17. (continued)

nl or LQ	QQ Index	Description
	-2	Location rejected. Internal consistency of the least square fit too high.
	-3	Location rejected. Long term oscillator drift too high.
	-4	Location rejected. Location computation failed or choice of correct solution uncertain.

Table 18. Summary of numbers of overpasses (collar visible to satellite), relocations (fixes) and behavioral data sets (hits) obtained from platform transmitter terminals (satellite radio-collar) deployed on female grizzly bears in northwest Alaska from early June through October 1988.

PTT	Argos bear ID	Study ID	Initiation - termination of transmission	Months	Year	Overpasses	Fixes	Hits
100900	01	14	Jun 05	Jun	88	172	119	942
				Jul	88	144	96	558
				Aug	88	123	9	390
				Sep	88	114	62	354
			Oct 10	Oct	88	40	21	100
			Subtotal			593	307	2,344
10901	02	63	Jun 05	Jun	88	163	103	779
				Jul	88	163	111	688
				Aug	88	149	19	478
			Sep 30	Sep	88	115	67	368
				Oct	88	0	0	0
			Subtotal			590	300	2,313
10902	03	58	Jun 05	Jun	88	158	77	556
				Jul	88	135	69	420
				Aug	88	107	4	281
				Sep	88	144	76	411
			Oct 09	Oct	88	42	26	114
			Subtotal			586	252	1,782

Table 18. (continued)

PTT	Argos bear ID	Study ID	Initiation - termination of transmission	Months	Year	Overpasses	Fixes	Hits
10903	04	28	Jun 05	Jun	88	125	81	556
				Jul	88	155	104	566
				Aug	88	154	17	453
				Sep	88	115	65	315
			Oct 11	Oct	88	28	12	54
			Subtotal			577	279	1,944
10904	05	43	Jun 05	Jun	88	192	122	953
				Jul	88	178	126	726
				Aug	88	140	12	479
			Sep 22	Sep	88	86	49	289
				Oct	88	0	0	0
			Subtotal			596	309	2,447
10905	06	69	Jun 06	Jun	88	176	117	858
				Jul	88	193	144	828
				Aug	88	200	20	863
				Sep	88	171	105	634
			Oct 11	Oct	88	55	32	207
			Subtotal			795	418	3,390
			Grand Total			3,737	1,865	14,220

Table 19. Numbers and quality of relocations obtained from satellite transmitters deployed on grizzly bears in northwest Alaska during 1988.

PTT	Quality of relocation[a]	May[b]	Jun	Jul	Aug	Sep	Oct	Totals
		Month						
10900	3	9	9	3	0	0	0	12
	2	11	32	12	0	1	0	45
	1	0	47	45	6	29	5	132
	0		31	36	3	32	16	118
	Subtotal	20	119	96	9	62	21	307
10901	3	9	7	1	0	0	0	8
	2	12	29	23	2	2	0	56
	1	0	42	49	8	33	0	132
	0		25	38	9	32	0	104
	Subtotal	21	103	111	19	67	0	300
10902	3	1	1	0	0	0	0	1
	2	11	17	2	0	3	0	22
	1	0	28	30	0	30	6	94
	0		31	37	4	43	20	135
	Subtotal	12	77	69	4	76	26	252
10903	3	0	1	0	0	0	0	1
	2	23	23	12	1	2	0	38
	1	0	28	42	3	18	1	92
	0		29	50	13	45	11	148
	Subtotal	23	81	104	17	65	12	279

Table 19. (Continued)

PTT ID	Quality of relocation[a]	Month						Totals
		May[b]	Jun	Jul	Aug	Sep	Oct	
10904	3	0	3	0	0	0	0	3
	2	12	27	22	1	2	0	52
	1	0	64	60	3	27	0	154
	0		28	44	8	20	0	100
	Subtotal	12	122	126	12	49	0	309
10905	3	1	1	0	0	1	0	2
	2	19	17	30	5	8	4	64
	1	0	69	64	8	56	16	213
	0		30	50	7	40	12	139
	Subtotal	20	117	144	20	105	32	418
Totals	3	20	22	4	0	1	0	27
	2	88	145	101	9	18	4	277
	1	0	278	290	28	193	28	817
	0		174	255	44	212	59	744
	Totals	108	619	650	81	424	91	1,865

[a] Refer to Table 17.
[b] Collars yet not deployed; not included in totals.

Table 20. Location error of 6 satellite PTT's at sea level at Nome, Alaska during Julian days 147 through 152 prior to deployment on grizzly bears in northwest Alaska in 1988.

	Bear ID Number						
Relocations	B900	B901	B902	B903	B904	B905	Total
n	20	21	19	21	10	18	109
x	1,000	686.4	663.5	2,220.8	1,659.4	1,040.9	1,110.3
SD	553.9	422.5	436.5	1,069.88	1,365.9	432.9	869.7
Min.	240.2	72.1	72.1	364.1	234.3	634.4	72.1
Max.	2,161.8	1,476.4	1,476.4	4,081.0	4,135.8	1,941.6	4,135.8
<60%[a]	1,000	800	800	1,600	1,200	1,100	1,200
<90%[a]	2,000	1,400	1,400	3,600	4,000	1,700	2,000
LQ = 0	0	0	0	0	0	0	0
LQ = 1	0	0	0	0	0	0	0
LQ = 2	11	12	10	21	10	16	80
LQ = 3	9	9	9	0	0	2	29

[a] Approximate value see Figs. 29 and 30.

Table 21. Comparison of home range sizes (convex polygons) for 6 grizzly bears as determined by 2 methods of data collection during a 3-5 year period in northwest Alaska.

Bear No.	Satellite-1988 Km^2	Satellite-1988 n	Conventional telemetry-1988 Km^2	Conventional telemetry-1988 n	Conventional telemetry[a] 3-5 years Km^2	Conventional telemetry[a] 3-5 years n
B014	755.5	207	545.9	14	1345.8	51
B028	975.2	138	620.3	8	1439.6	54
B043	1758.8	231	1071.1	11	1785.8	40
B058	3984.4	139	644.2	8	2499.7	17
B063	907.3	224	451.7	10	601.3	26
B069	335.0	314	108.7	12	699.0	35
$\bar{X}$	1453	208.8	574	10.5	1395	37.2
SD	1340	65.8	312	2.3	706	14.3
Median	941		583		1393	

[a] Bears 014 and 028 located during 1986 through 1990, bear 043 1986 through May 1990, bear 058 1987 through 1989, bear 063 1987 through June 1989, and bear 069 1987 through 1990.

Table 22. Comparison of home range sizes (concave polygons) of 6 grizzly bears in northwest Alaska as determined by 2 methods during a 3-5 year period.

Bear No.	Satellite 1988	$\underline{n}$	Conventional telemetry 1988	$\underline{n}$	Conventional telemetry[a] 3-5 years	$\underline{n}$
B014	305.9	207	28.5	14	284.3	51
B028	166.7	138	19.2	8	150.5	54
B043	491.6	231	54.2	11	369.8	40
B058	438.2	139	0.0	8	25.1	17
B063	207.7	224	0.0	10	118.0	26
B069	212.4	314	6.2	12	3.2	35
$\bar{X}$	303.7	208.8	18.0	10.5	158.5	37.2
SD	134.0	65.8	21.0	2.3	144.3	14.3
Median	259.1		12.7	10.5	134.2	

[a] Bears 014 and 028 located during 1986 through 1990, bear 043 1986 through May 1990, bear 058 1987 through 1989, bear 063 1987 through June 1989, and bear 069 1987 through 1990.

Table 23. Comparison of home range sizes (95% ellipse) of 6 grizzly bears in northwest Alaska as determined by 2 methods of data collection during a 3-5 year period.

Bear No.	Satellite-1988	(n)	Conventional telemetry 1988	(n)	Conventional telemetry 3-5 years	(n)
B014	996.8	207	1425.7	14	1786.1	51
B028	1551.5	138	4083.2	8	2139.5	54
B043	2255.6	231	4713.9	11	2874.3	40
B058	9104.8	139	4521.1	8	8561.4	17
B063	983.2	224	1915.1	10	827.7	26
B069	485.4	314	429.5	12	949.0	35
$\bar{X}$	2563	208.8	2848	10.5	2856	37.2
SD	3261	65.8	1819	2.3	2897	14.3
Median	1274		2999		1963	

[a] Bears 014 and 028 located during 1986 through 1990, bear 043 1986 through May 1990, bear 058 1987 through 1989, bear 063 1987 through June 1989, and bear 069 1987 through 1990.

Table 24. Area of home range contours (Km^2) including 80, 90 and 95% of relocations of satellite equipped female grizzly bears as determined by harmonic mean method of calculation in northwest Alaska during 1988.

% Contour	Bear no.	B014	B063	B058	B028	B043	B069
80%		349.8	208.5	77.6	210.7	253.7	159.5
		2.1		306.6	46.6	148.3	
				545.3			
				734.7			
90%		467.1	480.9	107.5	342.0	378.0	218.7
		6.6		1286.1	88.4	243.0	
				882.7			
95%		735.4	2005.7	181.8	452.1	1206.9	264.1
			4.5	2759.4	132.7		
			0.6				

Table 25. Average time, distance and rate of travel for 6 female grizzly bears as determined by satellite telemetry during 5 June through mid-October 1988 in northwest Alaska.

	Bear ID numbers					
	900	901	902	903	904	905
No. relocations	180	188	110	117	200	265
Mean hours between relocation (SD)	16.68(34.86)	13.78(25.24)	26.00(78.14)	23.59(45.45)	12.12(42.46)	10.59(17.55)
Minimum hours	0.01	0.01	0.12	0.02	0.009	0.009
Maximum hours	335.94	239.67	813.60	405.14	574.49	141.83
Mean distance between relocations (SD)	3.86(3.77)	3.55(3.76)	8.25(10.76)	4.93(4.67)	3.89(5.01)	2.80(2.12)
Minimum distance	0.04	0.11	0.33	0.23	0.125	0.119
Maximum distance	26.96	21.61	80.54	31.77	45.01	12.45
Mean rate of travel between relocations (SD)	2.74(7.67)	5.21(21.86)	2.69(5.72)	3.07(7.55)	4.98(27.69)	2.95(9.14)
Minimum rate	0.002	0.01	0.01	0.01	0.018	0.018
Maximum rate	51.69	186.07	42.66	55.85	366.91	129.26

Table 26. Distance and time between consecutive daily relocations and rate of daily travel for 6 grizzly bears equipped with satellite transmitters (PTT's) during 1988 in northwest Alaska.

	Bear ID numbers					
	900	901	902	903	904	905
No. relocations	54	68	39	42	63	90
Mean hours between relocation (SD)	23.93(2.03)	23.94(1.97)	24.33(1.90)	24.10(2.50)	23.92(1.93)	24.03(2.01)
Minimum hours	18.93	20.02	19.66	19.18	19.06	18.83
Maximum hours	28.17	28.67	27.17	28.11	28.75	28.84
Mean distance between relocations (SD)	5.94(3.56)	6.03(3.76)	9.82(9.36)	4.54(2.85)	5.77(4.86)	3.70(2.14)
Minimum distance	0.12	0.53	1.40	1.17	0.42	0.46
Maximum distance	15.01	17.69	57.20	12.51	22.00	10.30
Mean rate of travel between relocations (SD)	0.25(0.15)	0.68(0.40)	0.41(0.38)	0.19(0.12)	0.24(0.20)	0.16(0.09)
Minimum rate	0.01	0.06	0.06	0.05	0.02	0.02
Maximum rate	0.59	1.61	2.26	0.47	0.95	0.44

Table 27. 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	1189	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 28. Summary of observations and survey effort during day number 1 (May 29, 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)	Age	Sex	Young	Unmarked bears observed 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)				0					(6 AD-?/ 3 AD-F)			

Table 29. 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 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	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			0	2	AD	F	3-yrlgs
8	76	McNay-Sandegren	1405-1515 1650-1750 1900-1950	0			0				
9	77	Rood-Patten	Approx. 1400-1700	1 (46) 1 (22)	AD AD	M F	0 0	0			
10	69	McNay-Sandegren	1950-2120 2150-2305	0				1	AD	F	3-cubs
Total	719 (total by sex-age)			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 30. 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	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	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 1342-1500 1625-1655	1 (43)	AD	F	0	1 1	AD AD	F ?	0 0
6	70	McNay-Ayres	PM	0				0			
7	70	Schoen-Larsen	1310-1518 1525-1556	1 (63)	AD	F	2-yrlg	0			
8	76	Schoen-Larsen Kemp-Roney	2045-2300 PM	0				1 1	AD AD	M F	0 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)				(3 AD-M 1 AD-F)			(2 yrlgs)	(3 AD-F 1 AD-M 1 AD?)			

Table 31. 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 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-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 (41) 1 (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 32. Summary of observations and survey effort during survey day number 5 (June 2, 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	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-Rooney	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 yrlgs)	5 (3 AD-F 1 AD-M)	AD		0 (1 AD?)

Table 33. 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	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-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 (total by sex-age)	719			9 (6 AD-F) 3 AD-M)	AD		0	0			

Table 34. Summary of observations and survey effort during survey day number 7 (June 4, 1987) of the 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	Larsen-Roney	1600-1815	0				0			
2	78	Machida-Schoen	1000-1245	0				0			
3	74	McNay-Sandegren Larsen-Roney	1800-1845 1930-2035	0				0			
4	71	Larsen-Roney	0945-1145 1230-1255 1525-1546	0				0			
5	72	McNay-Sandegren	1000-1025 1100-1200 1240-1330 1455-1515 1720-1750	1 (31)	AD	M	0	1	AD	M	0
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) 1 (34)	AD AD	F M	0 0	1 1	AD AD	F M	0 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 35. 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	5.5	Alone	Out	Out	Out	Out	Out	Out	Out
56	M	4.5	Alone	Out	Out	Out	Out	In	In	Out
57	M	3.5	Alone	New	In	In[a]	In	In	In	In
64	M	12.5	Alone		New	In	In	In[a]	In[a]	In
68	M	13.5	Alone			New	In	In[a]		
72	M	6.5	Alone					New	In	In[a]
73	M	5.5	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[a]	In[a]	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	4.5	Alone	Out	Out	Out	Out	Out	Out	Out
65	F	9.5	Alone			New	In	In[a]	Out	In
66	F	3.5	Alone			New	Out	Out	Out	In
67	F	4.5	Alone			New	In	In	In[a]	In
69	F	10.5	Alone					New	In	In
70	F	3.5	Alone					New	In	In

Table 35. (Continued).

Bear ID	Sex	Age	Family Status	Days 1	2	3	4	5	6	7
71	F	3.5	Alone					New	In	In
74	F	9.5	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	15.5	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	2/1 yrl	Out	Out	Out	Out	Out	Out	Out
52	F	14.5	w/2 yrls	Out	Out	Out	Out	Out	Out	Out
53	F	7.5	w/1 yrl	New	In	In	In	In	Out	Out
55	F	6.5	w/3 yrls	Out	Out	Out	Out	Out	Out	Out
63	F	12.5	w/2 yrls		New	In[a]	In	In[a]	In	In[a]
58	F	6.5	w/3 2.5 yrls		New	In	In[a]	In	In	In

[a] Observed by search aircraft.

Table 36. 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 years 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 total days	N = est. avg. # bears	80% CI, bear-days N up.	N low.	80% CI, bears N up.	+% bears	N low.	% Bears	range	Density km^2/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 total days	N = est. avg. # bears	80% CI, bear-days N up.	N low.	80% CI, bears N up.	+% bears	N low.	% Bears	range	Density km^2/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 37. 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 years 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

Date	Sight	Cum. n_1	Cum. m_2	Cum. n_2	Estimated total days	N = est. avg. # bears	95% CI, bear-days N up.	N low.	95% CI, bears N up.	+% bears	N low.	% Bears	range	Density km^2/bear 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	41.2	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

Date	Sight	Cum. n_1	Cum. m_2	Cum. n_2	Estimated total days	N = est. avg. # bears	95% CI, bear-days N up.	N low.	95% CI, bears N up.	+% bears	N low.	% Bears	range	Density km^2/bear 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 38. 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 years age) and bears of all ages assuming no new bears were captured during 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

		Cum.	Cum.	Cum.	Estimated	N = est. avg.	95% CI, bear-days		95% CI, bears					Density km²/bear		
Date	Sight	n_1	m_2	n_2	total days	# 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	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

		Cum.	Cum.	Cum.	Estimated	N = est. avg.	95% CI, bear-days		95% CI, bears					Density km²/bear		
Date	Sight	n_1	m_2	n_2	total days	# 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	.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 39. 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-12-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.

Table 40. Comparison of reported grizzly bear densities in arctic areas of North America.

Area	Density (Km^2/bear)	Source
Northern Yukon	33-39	Nagy et al. 1983[a]
Northern Yukon	48	Pearson 1976
Western Brooks Range, AK	42-44	Reynolds 1984
NW Alaska	50(44-57)[a]	This study
Eastern Brooks Range, AK	83-304	Quimby 1974 Quimby and Snarshi 1974 Curatolo and Moore 1975 Reynolds 1976
Northwest Territories	211-262	Nagy et al. 1983b

[a] 80% confidence interval.

Table 41. Summary of known status of 146 marked grizzly bears from 1986 through 1990 in the southwest Brooks Mountain Range, Alaska.

	Alive	Status unknown: Slipped collars	Status unknown: Missing	Collars removed	Capture mortality	Hunting mortality	Natural mortality
Radio-collared adults							
Males		7	1	8	0	7	1
Females	25	2	8	0	0	7	1
Marked adults (uncollared)							
Males	0	0	8	0	0	1	0
Females	0	0	7	0	3	0	0
Marked young (uncollared)							
Males	27	N/A	6	N/A	0	2	0
Females	19	N/A	6	N/A	0	0	0
Totals							
All males	27	7	15	8	0	10	1
All females	44	2	21	0	3	7	1
All bears	71	9	36	8	3	17	2

Table 42. Survival rates of grizzly bear cubs of the year (COY) from den emergence to den entrance in northwest Alaska 1986 though 1990.[a]

Year	n	Rate	Variance	95% CI
1986	7	1.0000	0.0000	1.0000-1.0000
1987	9	0.6667	0.0247	0.3587-0.9747
1988	22	0.9545	0.0020	0.8675-1.0416
1989	22	0.8021	0.0085	0.6216-0.9827
1990	16	0.9286	0.0047	0.7937-1.0635
Totals	76	0.8743	0.0016	0.7959-0.9528

[a] Survival rates determined at 2-week intervals with methods described by Pollock et al. (1989).

Table 43. Overwinter survival rates of grizzly bear cubs at den entrance to den emergence as yearlings in northwest Alaska during 1986 through 1990.[a]

Year	n	Rate	Variance	95% CI
1986-87	5	1.0000	0.0000	1.0000-1.0000
1987-88	6	0.8333	0.0231	0.5351-1.1315
1988-89	20	0.9500	0.0024	0.8545-1.0455
1989-90	13	1.0000	0.0000	1.0000-1.0000
Totals	44	0.9545	0.0100	0.8930-1.0161

[a] Survival rates determined by methods described by Pollock et al. (1990).

Table 44. Survival rates of yearling grizzly bears from den emergence to den entrance in northwest Alaska during 1986 through 1990.[a]

Year	n	Rate	Variance	95% CI
1986	1	1.0000	0.0000	1.0000-1.0000
1987	16	0.8750	0.0068	0.7129-1.0371
1988	5	1.0000	0.0000	1.0000-1.0000
1989	20	0.9000	0.0045	0.7685-1.0315
1990	11	0.8182	0.0135	0.5903-1.0461
Totals	53	0.8868	0.0019	0.8015-0.9721

[a] Survival rates estimated at 2-week intervals by methods described by Pollock et al. (1989).

Table 45. Annual survival rates of radio-collared adult ($\geq$3.5 years-old) female grizzly bears in northwest Alaska during 1986 through 1990.[a]

Year	n	Rate	Variance	95% CI
1986	16	0.9375	0.0037	0.8189-1.0561
1987	28	1.0000	0.0000	1.0000-1.0000
1988	30	1.0000	0.0000	1.0000-1.0000
1989	34	0.9063	0.0027	0.8053-1.0072
1990	32	0.8681	0.0040	0.7445-0.9917
Totals	140	0.9406	0.0004	0.9002-0.9809

[a] Survival rates estimated at 2-week intervals with methods described by Pollock et al. (1990).

Table 46. Annual survival rates of radio-collared adult ($\geq$ 3.5 years-old) female grizzly bears in northwest Alaska during 1986 through 1990 assuming all missing radio-collared bears were shot and not reported.[a]

Year	n	Rate	Variance	95% Confidence interval
1986	16	0.9375	0.0037	0.8189-1.0561
1987	28	0.8929	0.0034	0.7783-1.0074
1988	30	1.0000	0.0000	1.0000-1.0000
1989	34	0.8235	0.0041	0.6976-0.9494
1990	32	0.7813	0.0053	0.6380-0.9245
Totals	140	0.8786	0.0008	0.8247-0.9325

[a] Survival rates estimated at 2-week intervals with methods described by Pollock et al. (1990).

Table 47. Annual survival rates of radio-collared adult ($\geq$ 3.5 years-old) male grizzly bears in northwest Alaska during 1986 through 1988.[a]

Year	n	Rate	Variance	95% Confidence interval
1986	16	0.9286	0.0044	0.7986-1.0580
1987	20	0.8382	0.0076	0.6676-1.0089
1988	13	0.8889	0.0110	1.6836-1.0942
Total	49	0.9055	0.0021	0.8158-0.9952

[a] Survival rates estimated at 2-week intervals with methods described by Pollock et al. (1990).

APPENDIXES

Appendix A. Abstract of manuscript published in The Journal of Wildlife Management.

IMMOBILIZATION OF GRIZZLY BEARS WITH TILETAMINE HYDROCHLORIDE AND ZOLAZEPAM HYDROCHLORIDE.

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Abstract: We successfully immobilized 185 grizzly bears (*Ursus arctos horribilis*) with tiletamine hydrochloride (HCl) and zolazepam HCl during May-June 1986-87. One hundred eighty bears were captured in several areas in Alaska by darting from a helicopter; 5 were immobilized from traps or snares in Banff National Park in Alberta, Canada. Use of the recommended dose for immobilizing grizzly bears (7-9 mg/kg) resulted in a mean induction time of 4.1 $\pm$ 1.8 (SD) minutes and a safe handling period of 45-75 minutes. Tiletamine HCl/zolazepam HCl was an excellent drug for immobilizing grizzly bears because of rapid induction, timely and predictable recovery, wide safety margin, and few adverse side effects.

J. WILDL. MANAGE. 00(0):000-000

Appendix B. Abstract of manuscript published in the 8th International Conference on Bear Research and Management held at Victoria, British Columbia during 20-25 February 1989.

APPLICATION OF MARK-RECAPTURE TECHNIQUES AND RADIOTELEMETRY FOR ESTIMATING GRIZZLY BEAR DENSITY IN RELATION TO MINING DEVELOPMENT AND HUMAN EXPLOITATION IN NORTHWEST ALASKA

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Abstract: Grizzly bear (*Ursus arctos*) densities within a 1,862 km^2 study area surrounding a lead/zinc mine in northwest Alaska were estimated using mark-recapture methods during late May and early June 1987. Radio collars were used to mark bears and assess population closure. Density estimates were 1 bear/66.0 km^2 for adults (>3 yrs age) and 1 bear/50.5 km^2 for bears of all ages. Some of the biases and problems associated with the mark-recapture method were discussed. Density estimates were used to estimate population size within and near the bear study area, and this estimate was compared with reported and suspected annual harvests. Estimated annual harvest rates in recent years ranged from 7.5 to 15.7%. Current bear density and population estimates will be compared with estimates obtained after the mine is developed to assess impacts on the bear population.

Int. Conf. Bear Res. and Manage. 8:000

Appendix C. Sequential relocations of radio-collared grizzly bears monitored from fixed-wing aircraft in northwest Alaska during 1986 through 1990. Annual den sites for each bear are identified as follows: solid dots = 1986, solid diamonds = 1987, solid squares = 1988, and solid triangles = 1989.

SCALE 1:425,000

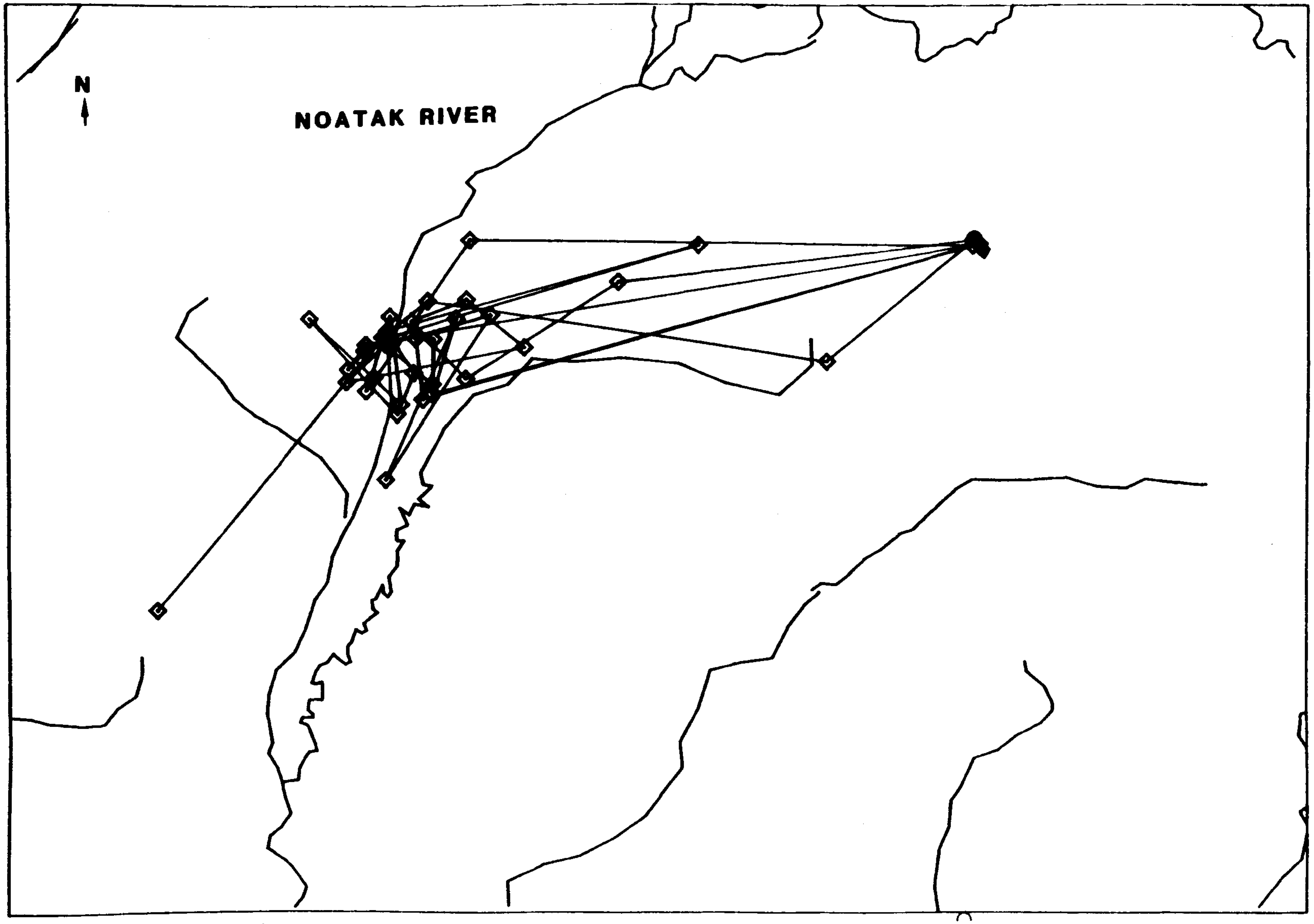

Figure 1. Relocations of female grizzly bear 001 from 31 May 1986 through 30 August 1989 in northwest Alaska using conventional radio

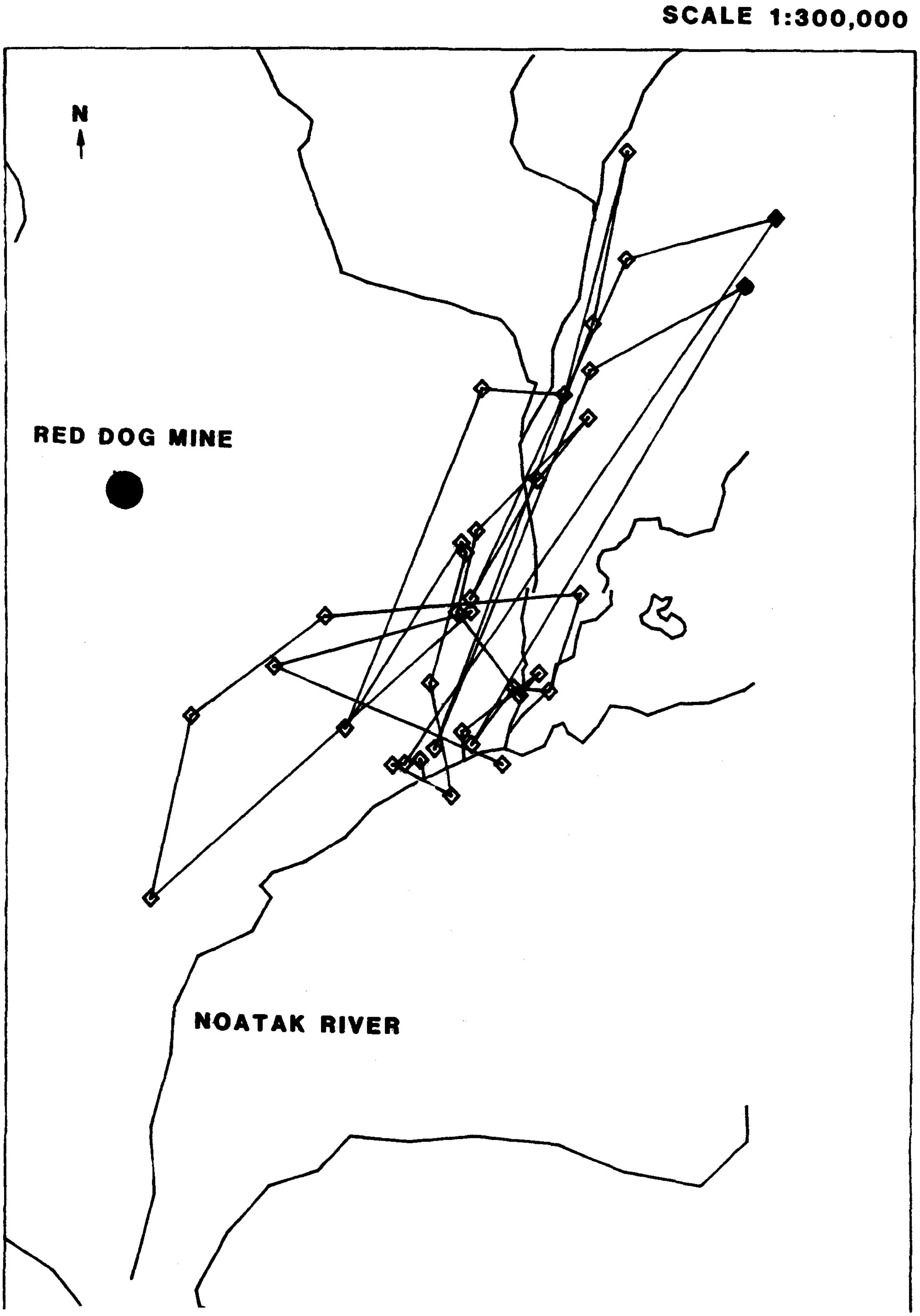

Figure 2. Relocations of female grizzly bear 002 from 31 May 1986 through 13 June 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:600,000

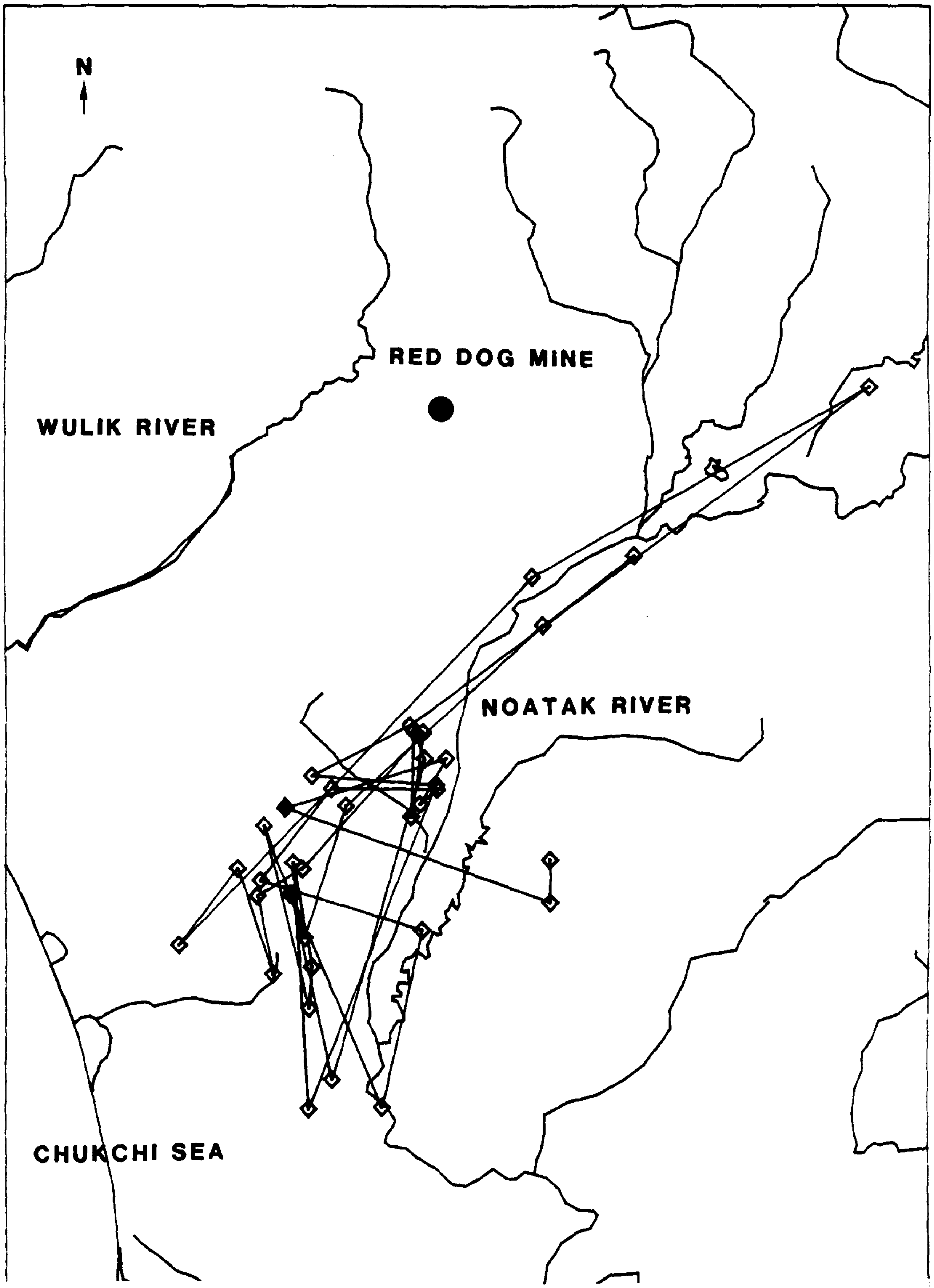

Figure 3. Relocations of male grizzly bear number 003 from 31 May 1986 through 6 September 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:600,000

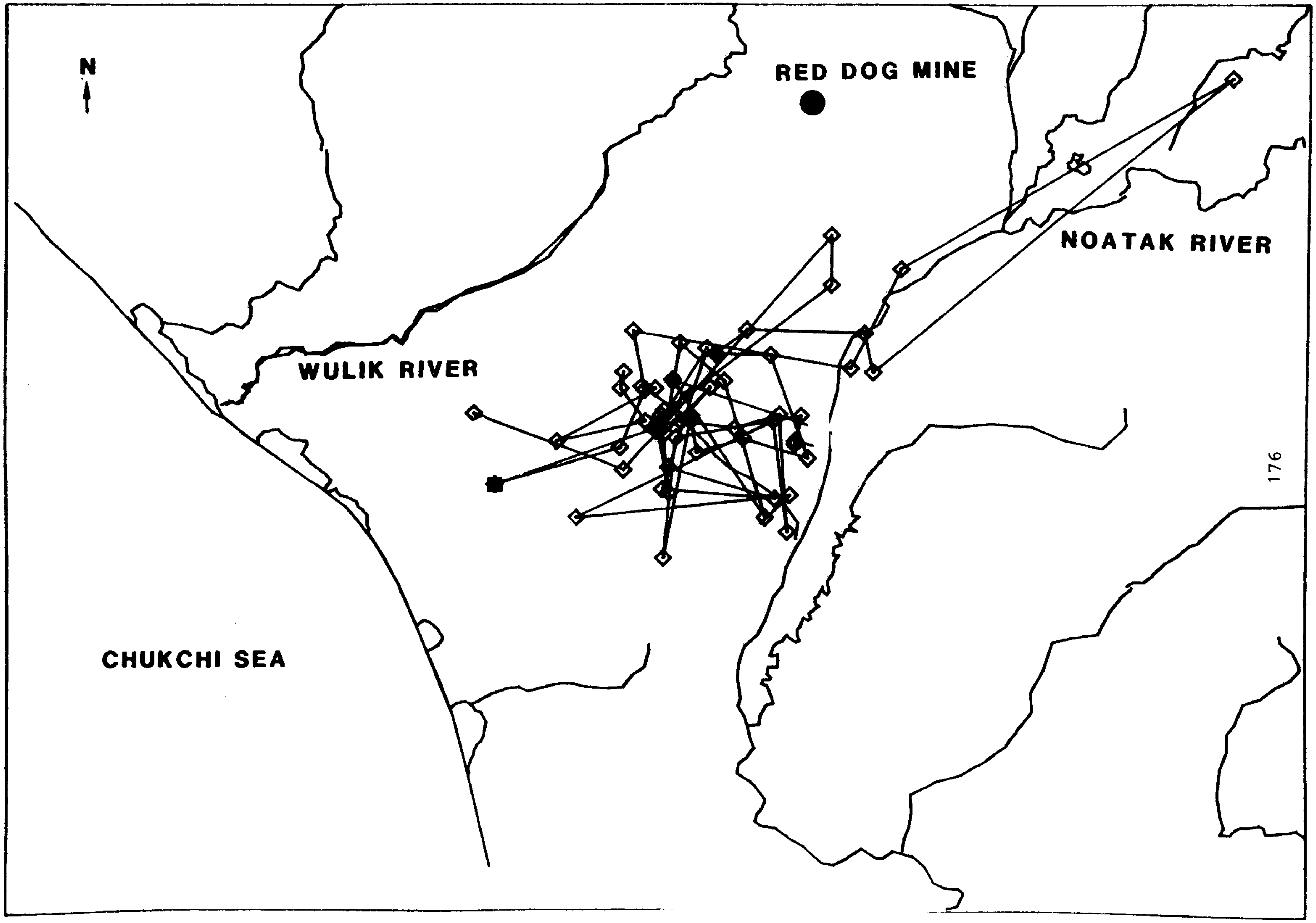

Figure 4. Relocations of female grizzly bear 004 from 2 June 1986 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

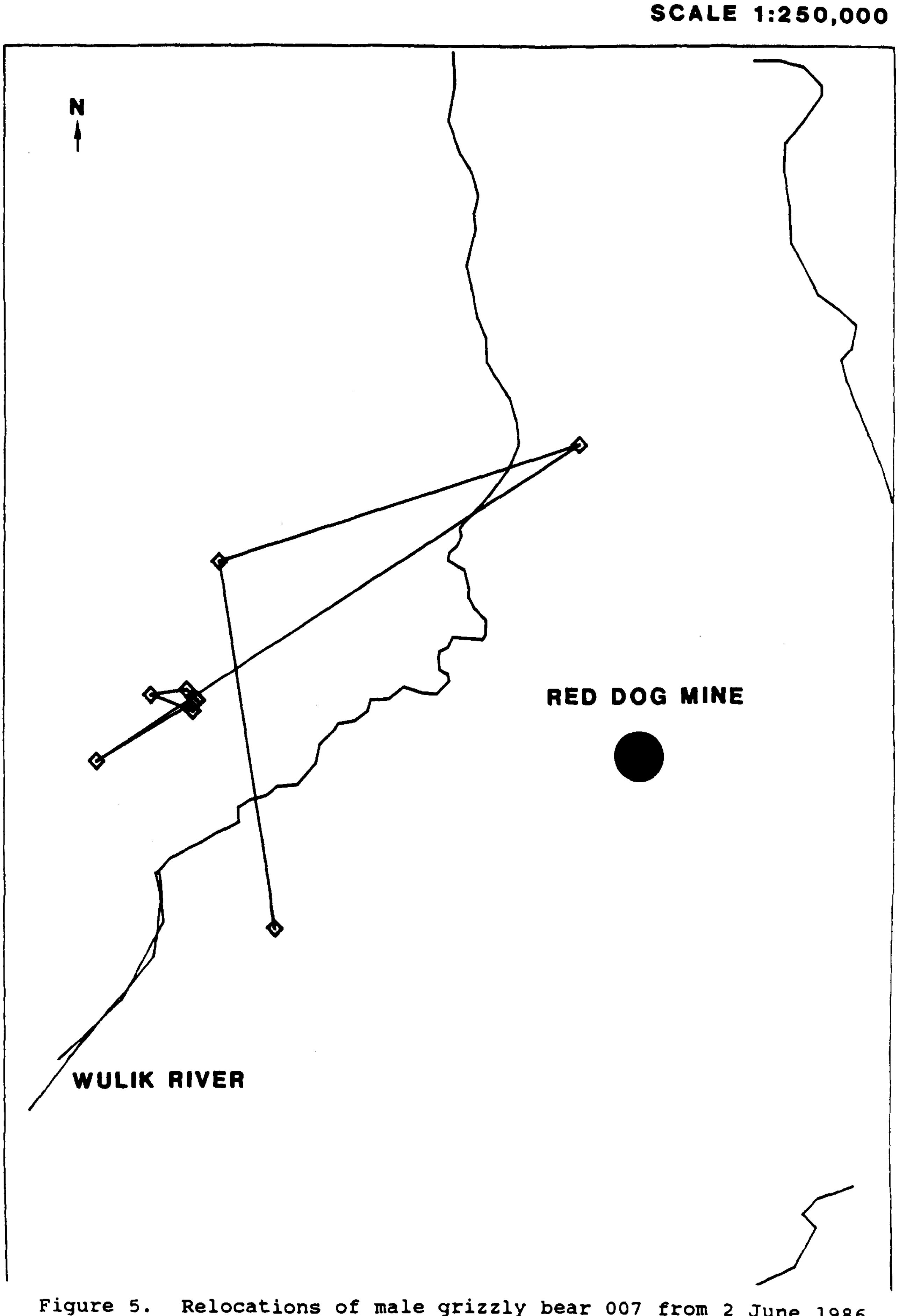

Figure 5. Relocations of male grizzly bear 007 from 2 June 1986 through 16 September 1987 in northwest Alaska using conventional radio telemetry.

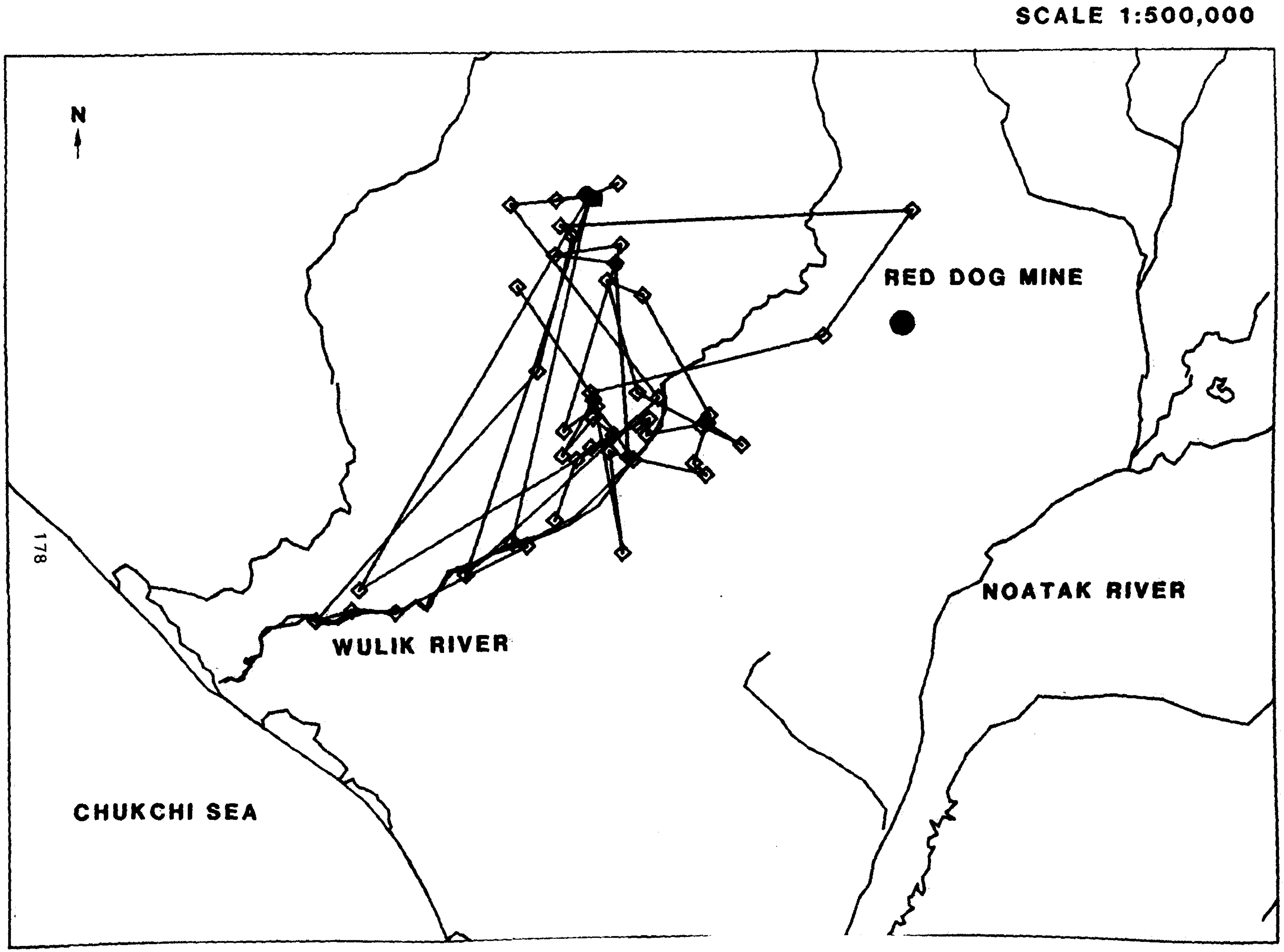

Figure 6. Relocations of female grizzly bear 008 from 2 June 1986 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

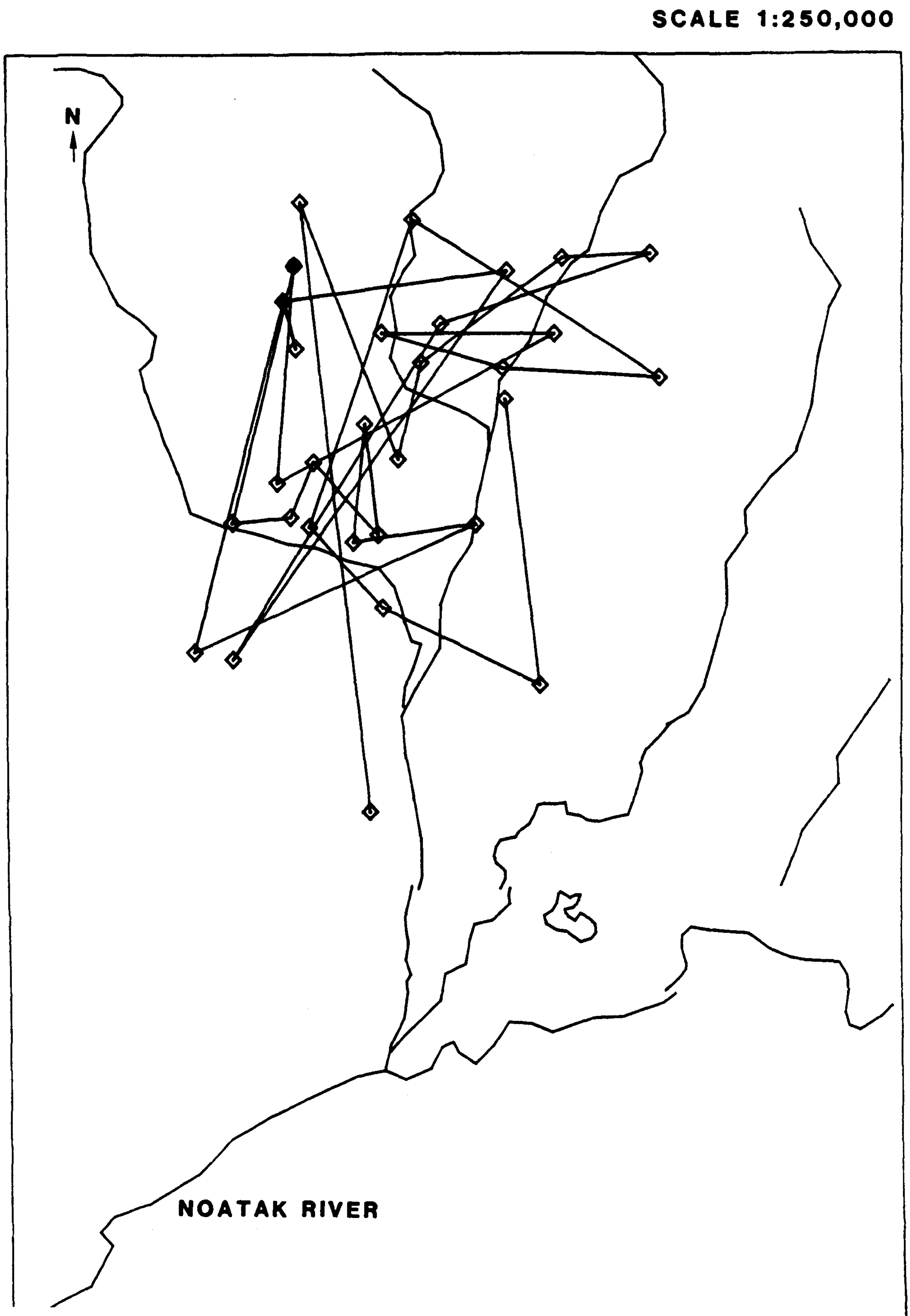

Figure 7. Relocations of female grizzly bear 009 from 2 June 1986 through 4 September 1990 in northwest Alaska using conventional radio telemetry.

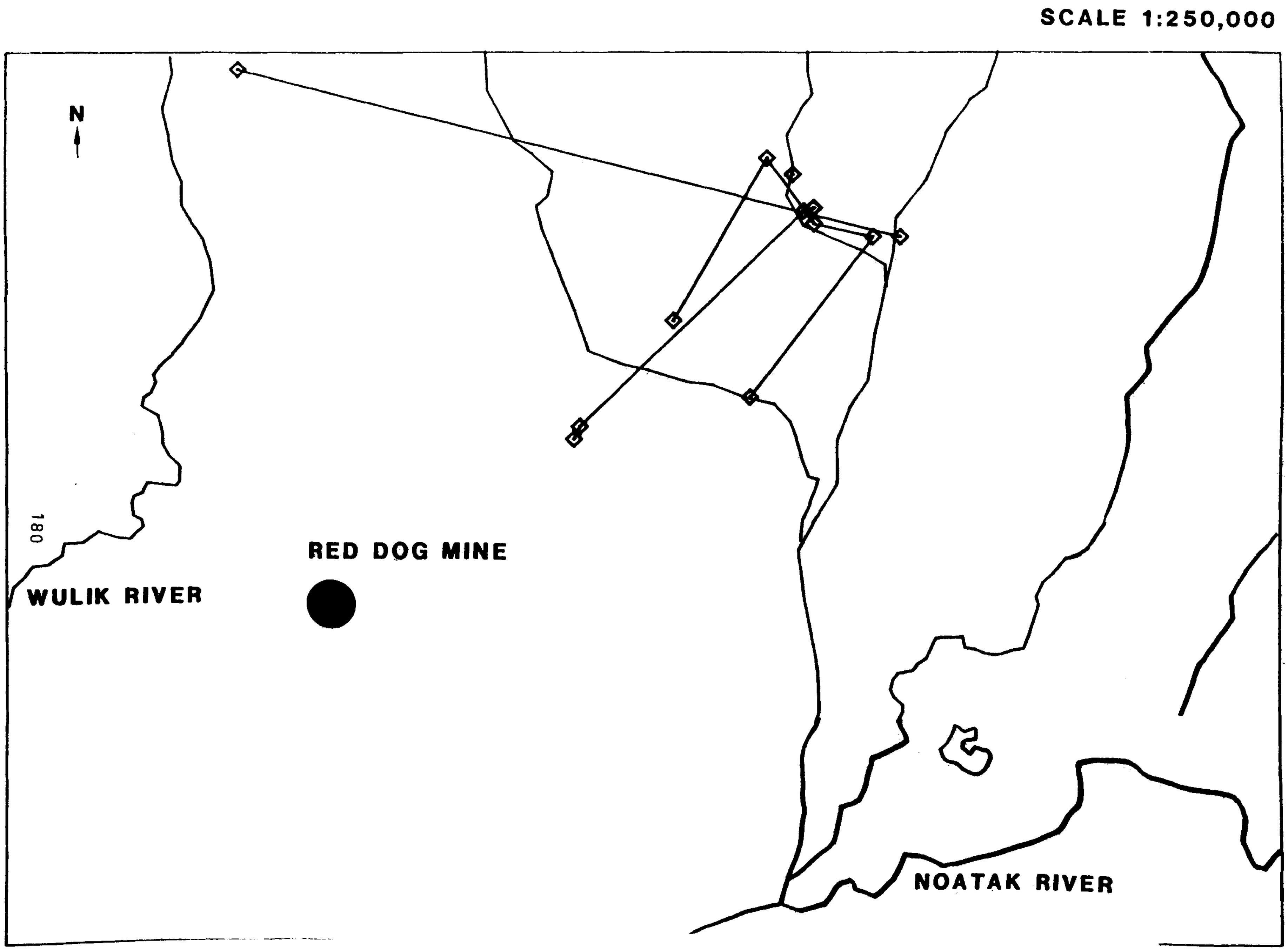

Figure 8. Relocations of male grizzly bear 010 from 2 June 1986 through 6 June 1988 in northwest Alaska using conventional radio telemetry.

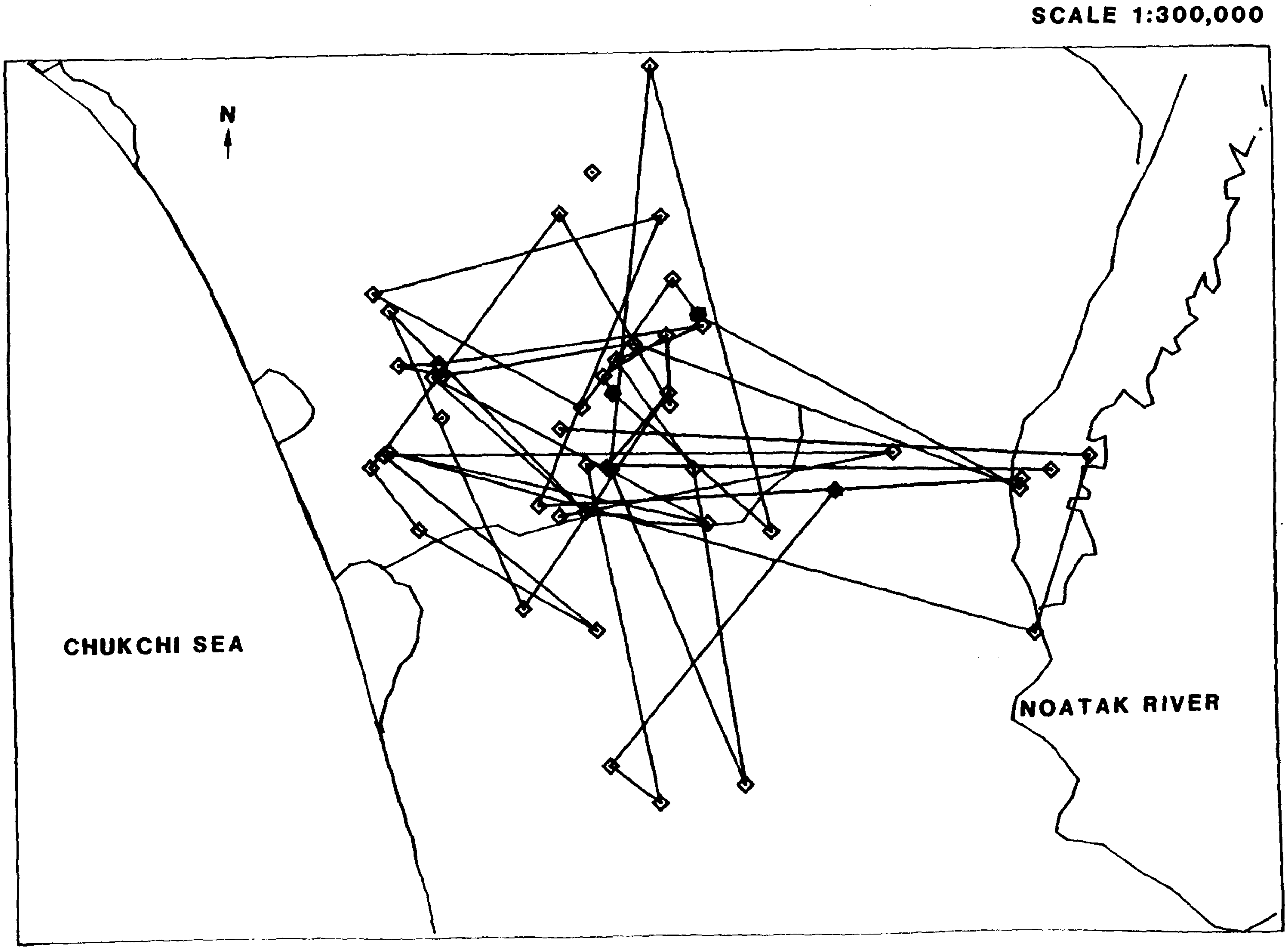

Figure 9. Relocations of female grizzly bear 014 from 3 June 1986 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

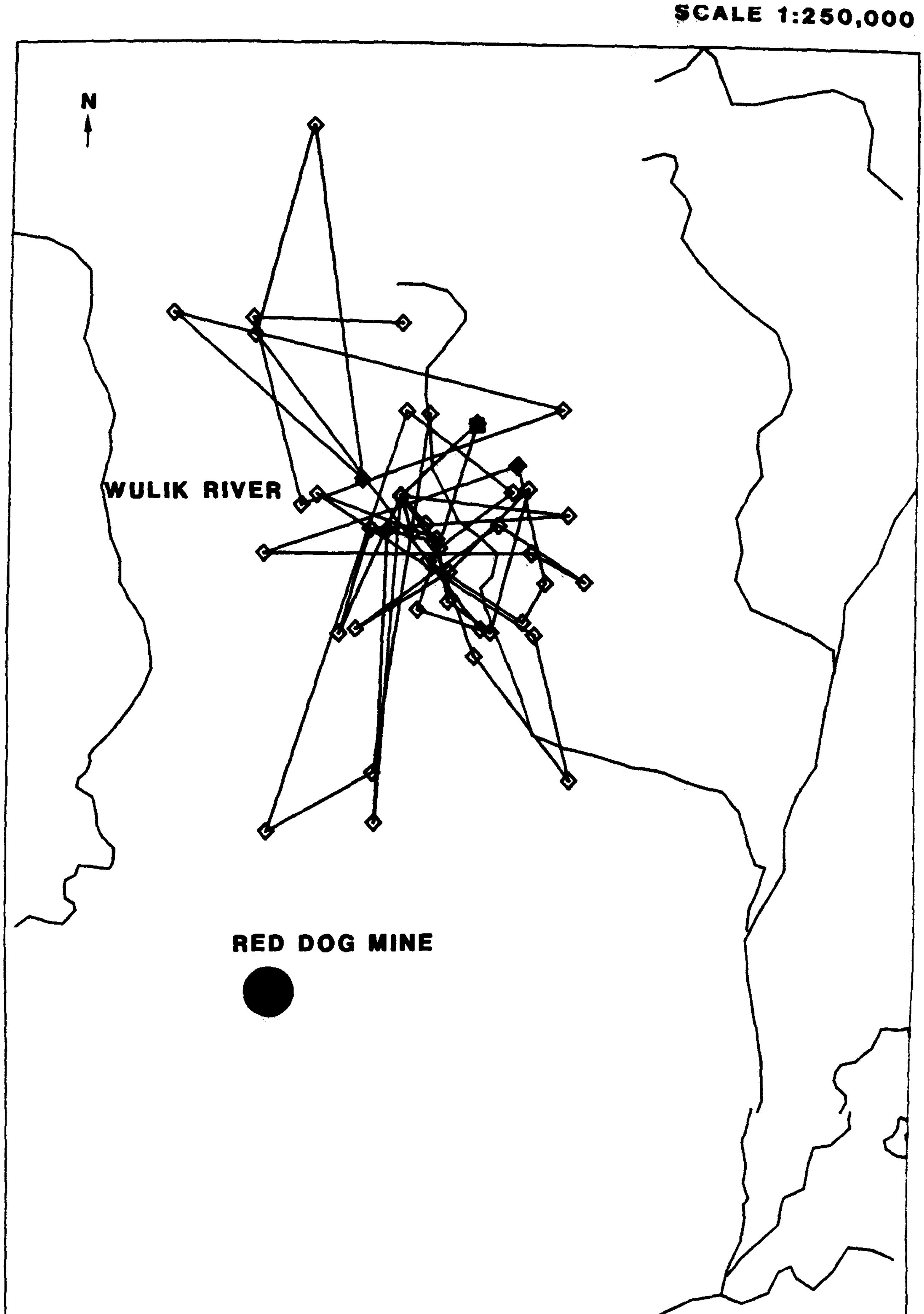

Figure 10. Relocations of female grizzly bear 020 from 3 June 1986 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

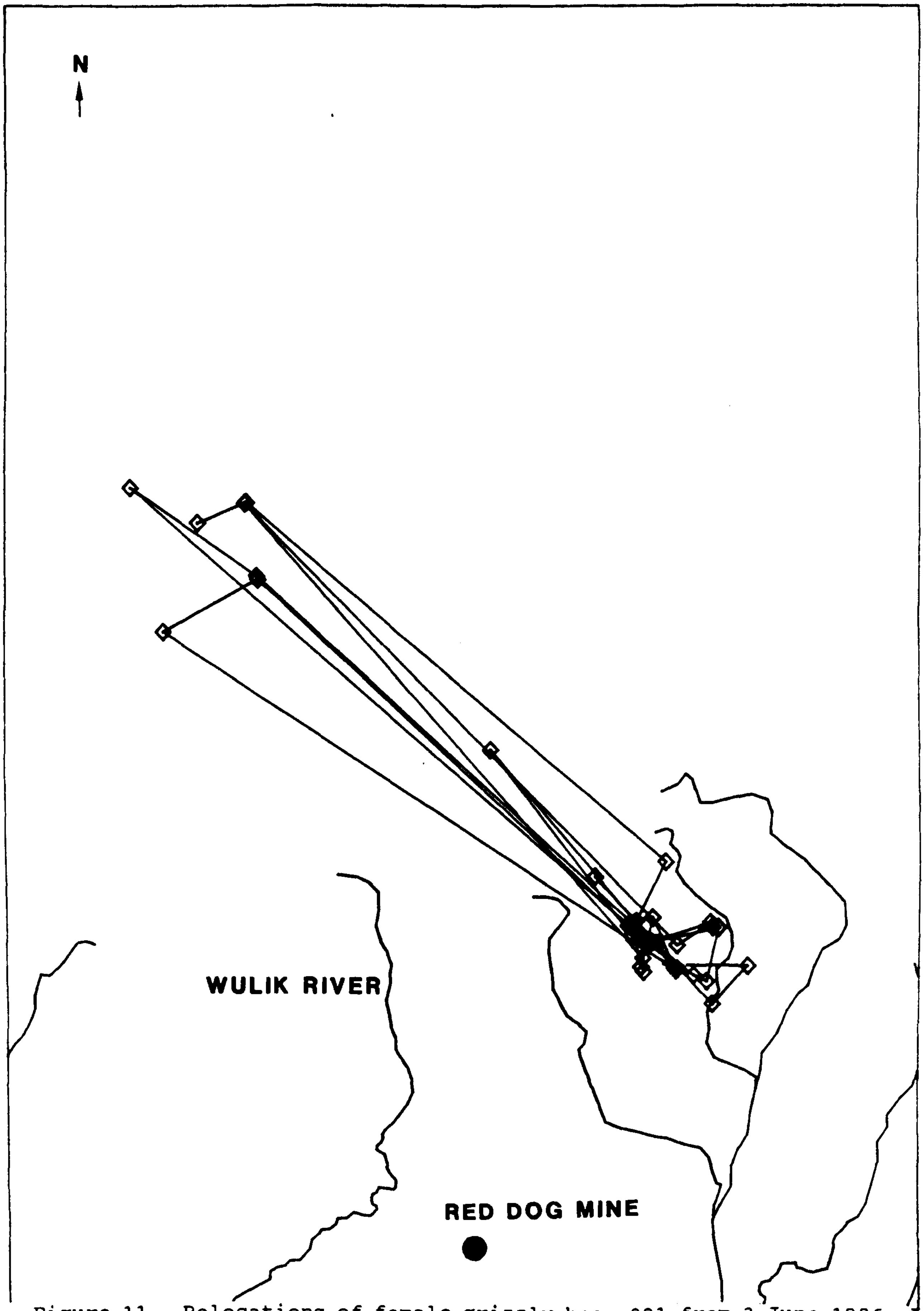

Figure 11. Relocations of female grizzly bear 021 from 3 June 1986 through 27 September 1990 in northwest Alaska using conventional radio telemetry.

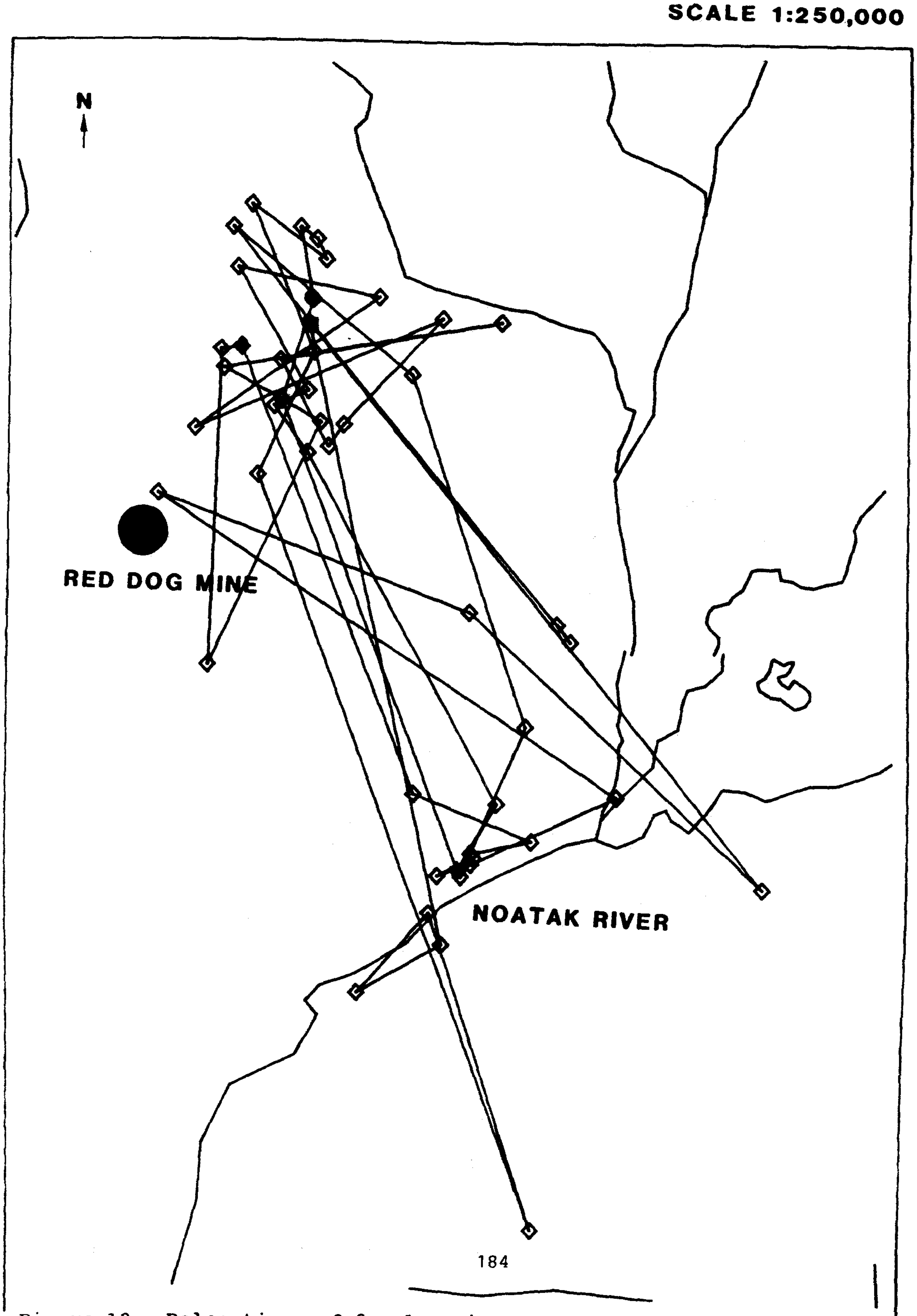

Figure 12. Relocations of female grizzly bear 022 from 4 June 1986 through 24 May 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:500,000

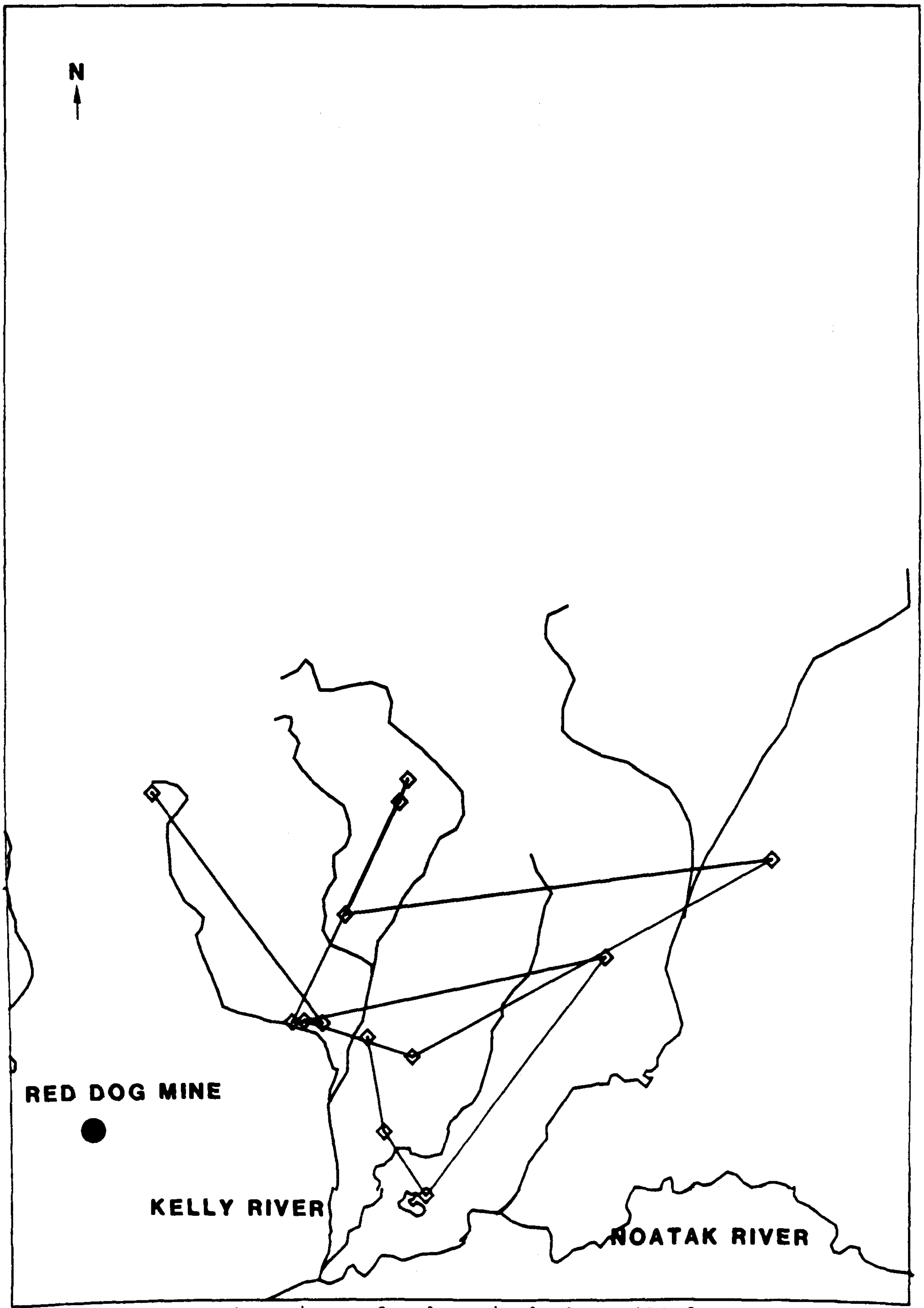

Figure 13. Relocations of male grizzly bear 024 from 4 June 1986 through 19 August 1987 in northwest Alaska using conventional radio telemetry.

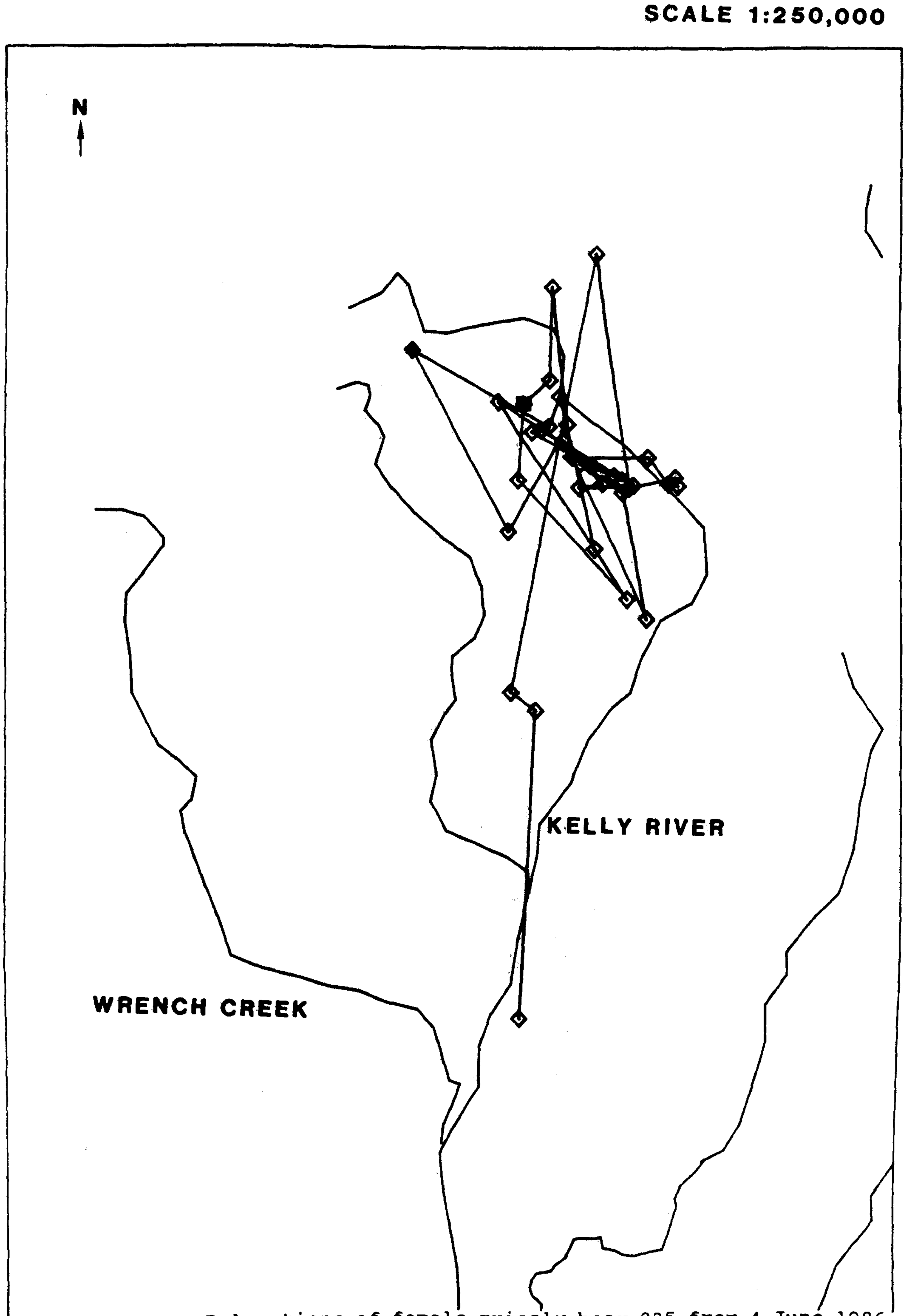

Figure 14. Relocations of female grizzly bear 025 from 4 June 1986 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

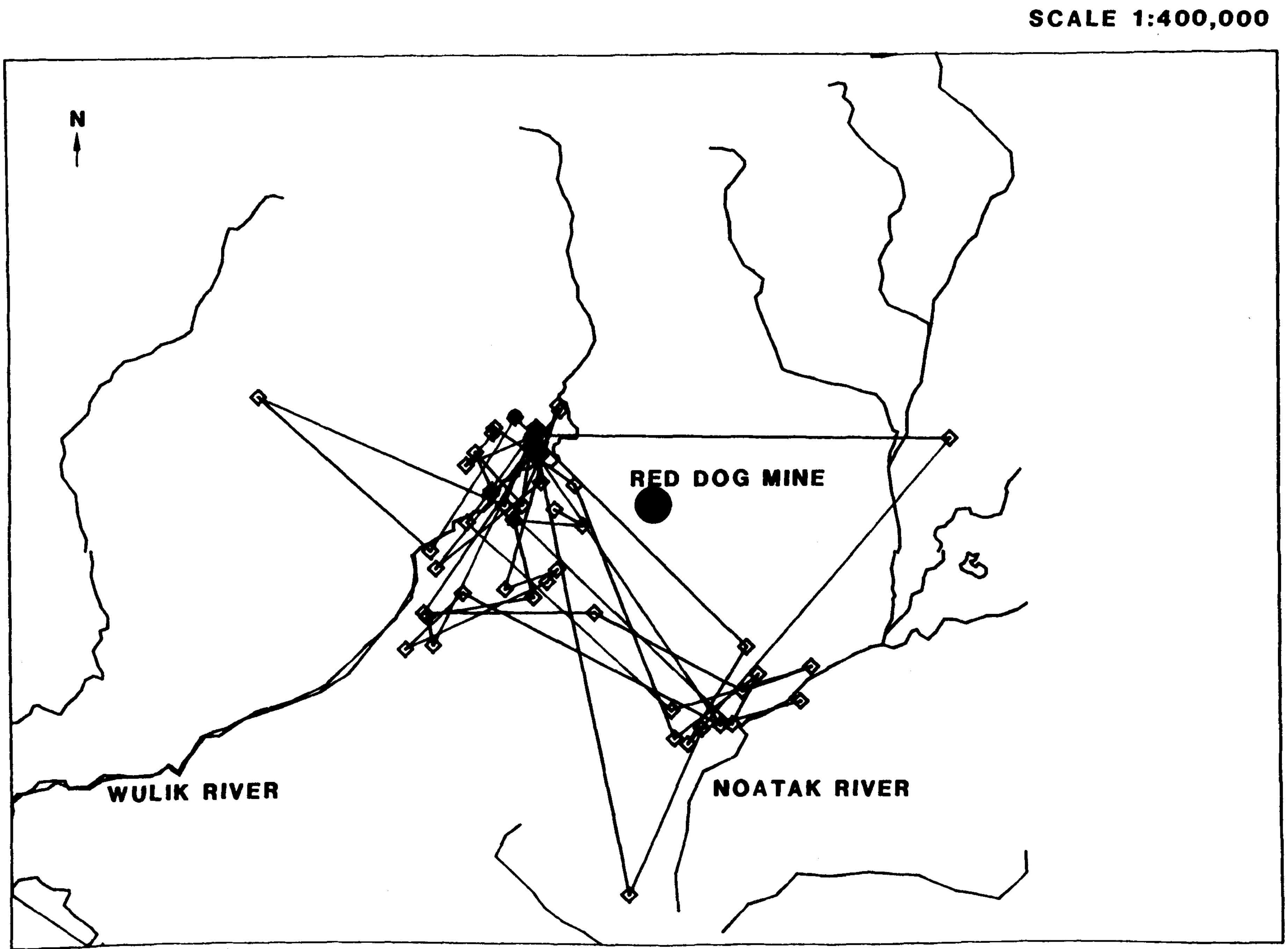

Figure 15. Relocations of female grizzly bear 028 from 4 June 1986 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

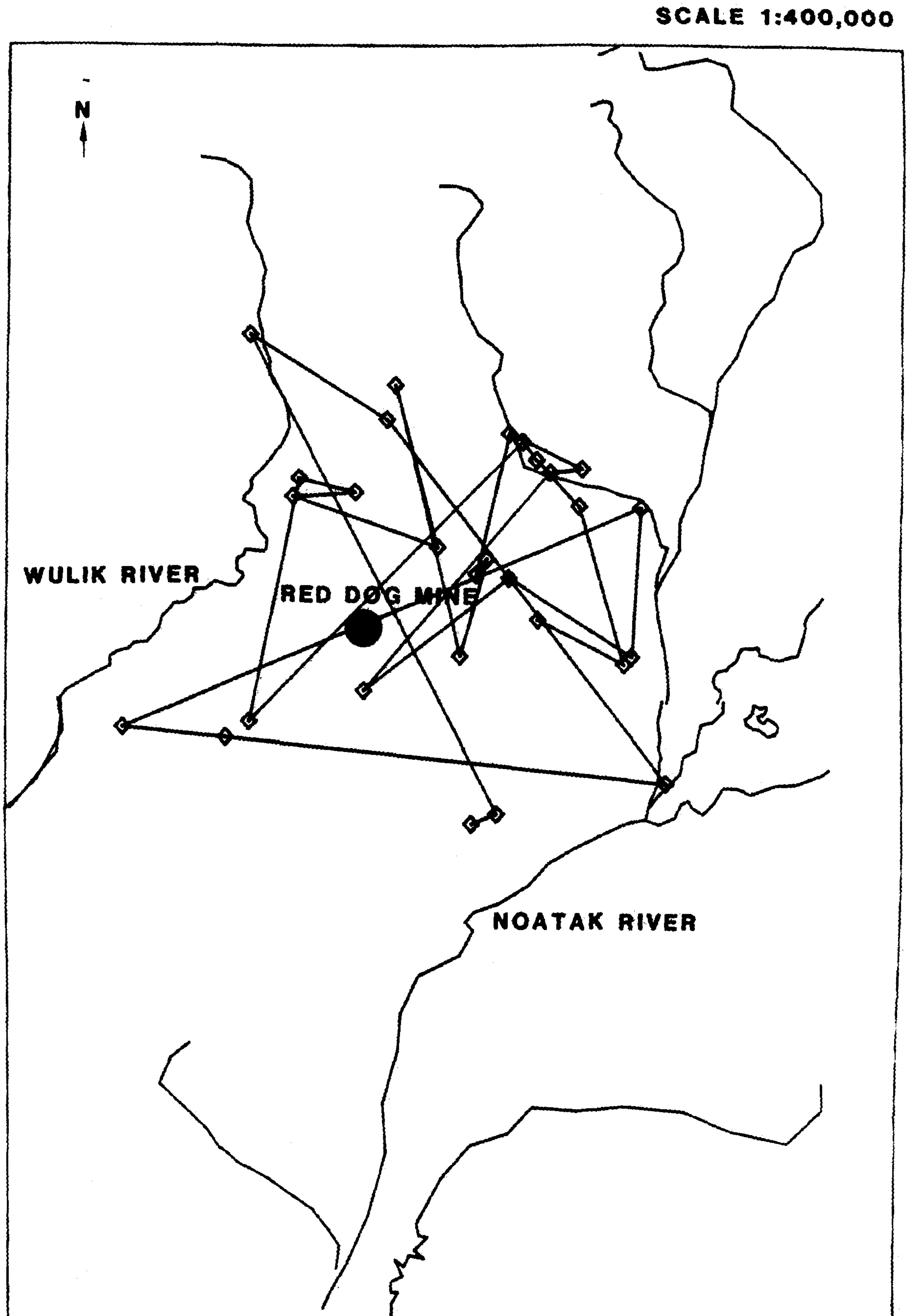

Figure 16. Relocations of male grizzly bear 034 from 7 June 1986 through 5 June 1988 in northwest Alaska using conventional radio telemetry.

SCALE 1:500,000

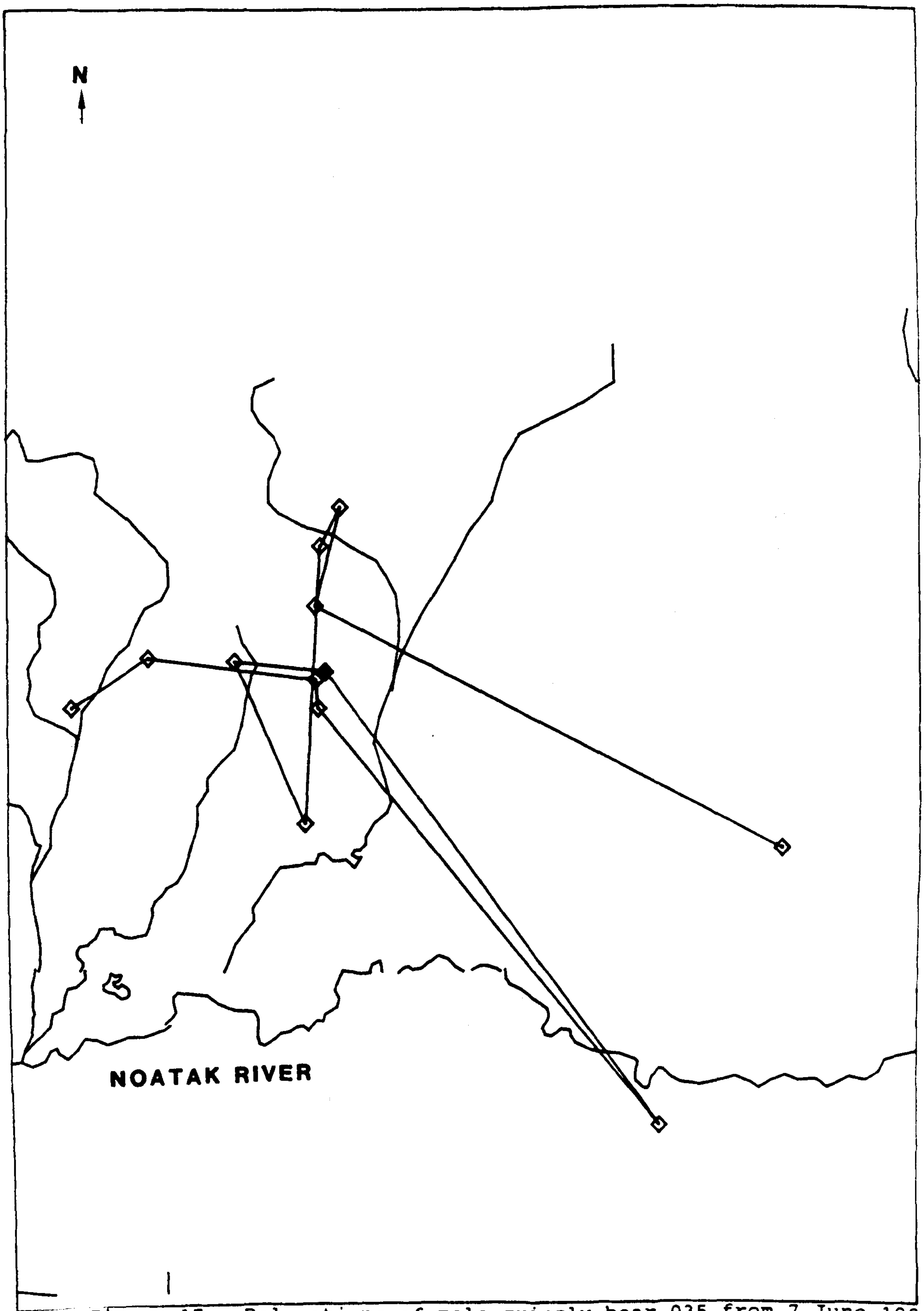

Figure 17. Relocations of male grizzly bear 035 from 7 June 1986 through 9 October 1987 in northwest Alaska using conventional radio telemetry.

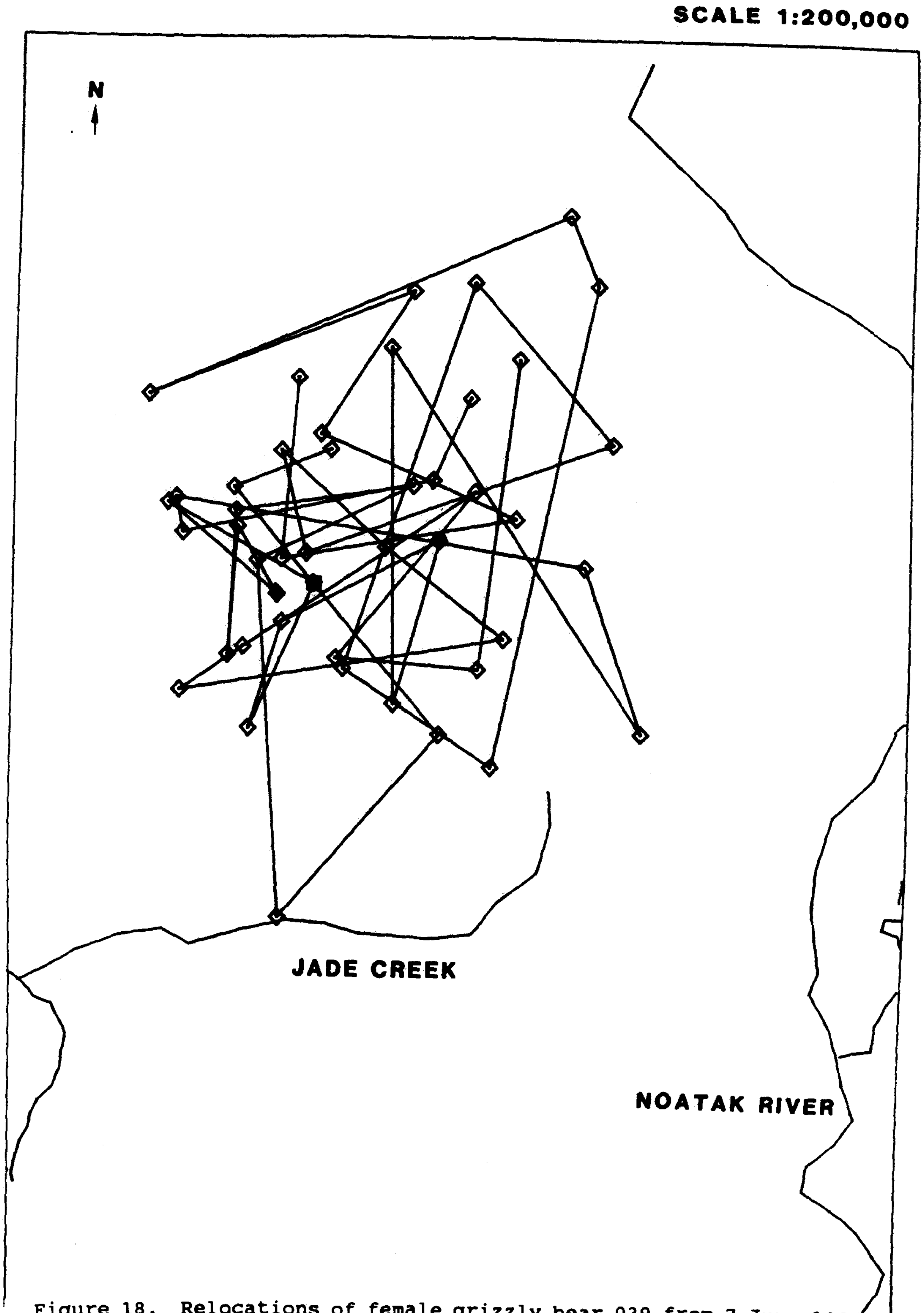

Figure 18. Relocations of female grizzly bear 039 from 7 June 1986 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

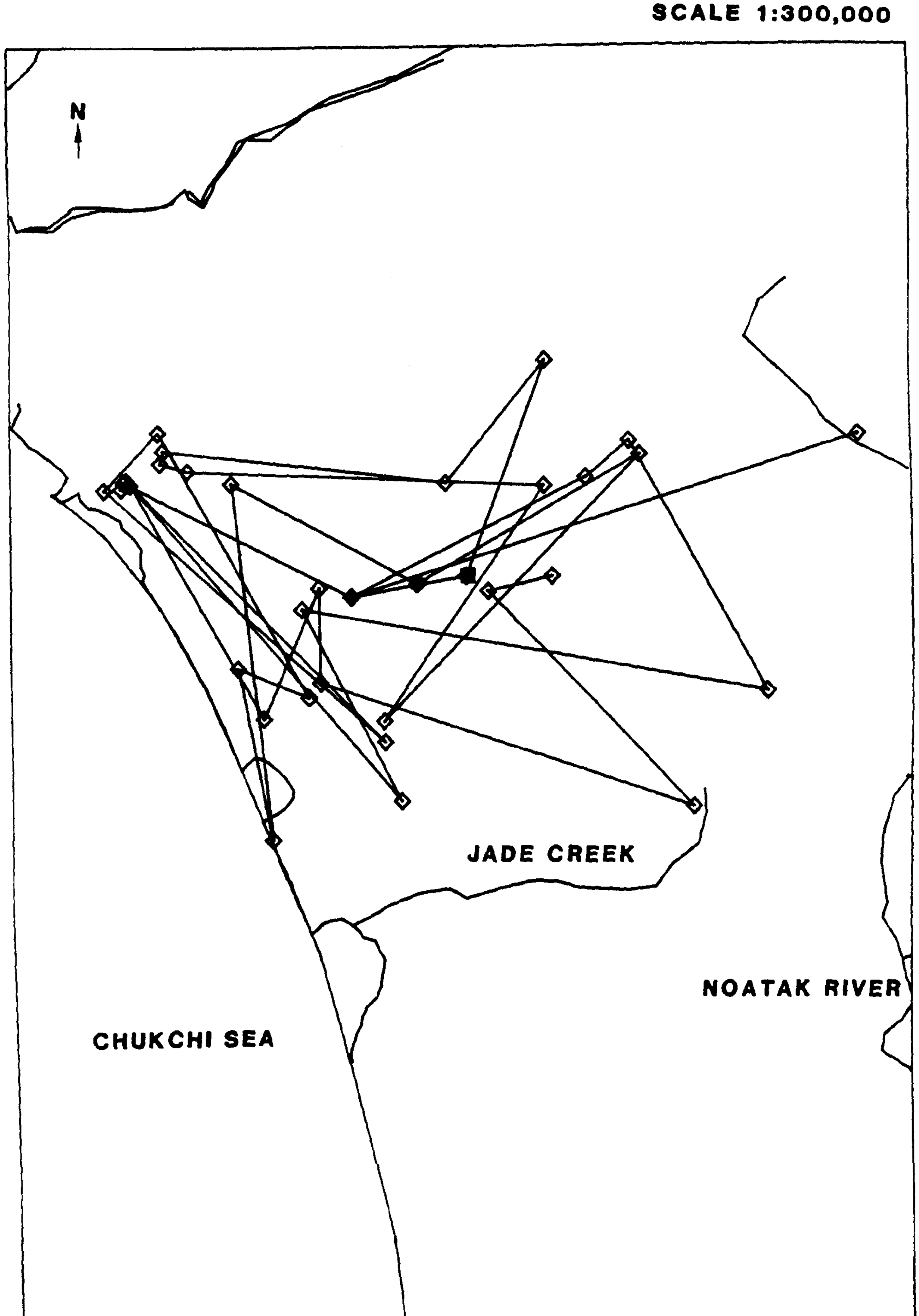

Figure 19. Relocations of male grizzly bear 040 from 7 June 1986 through 27 May 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:500,000

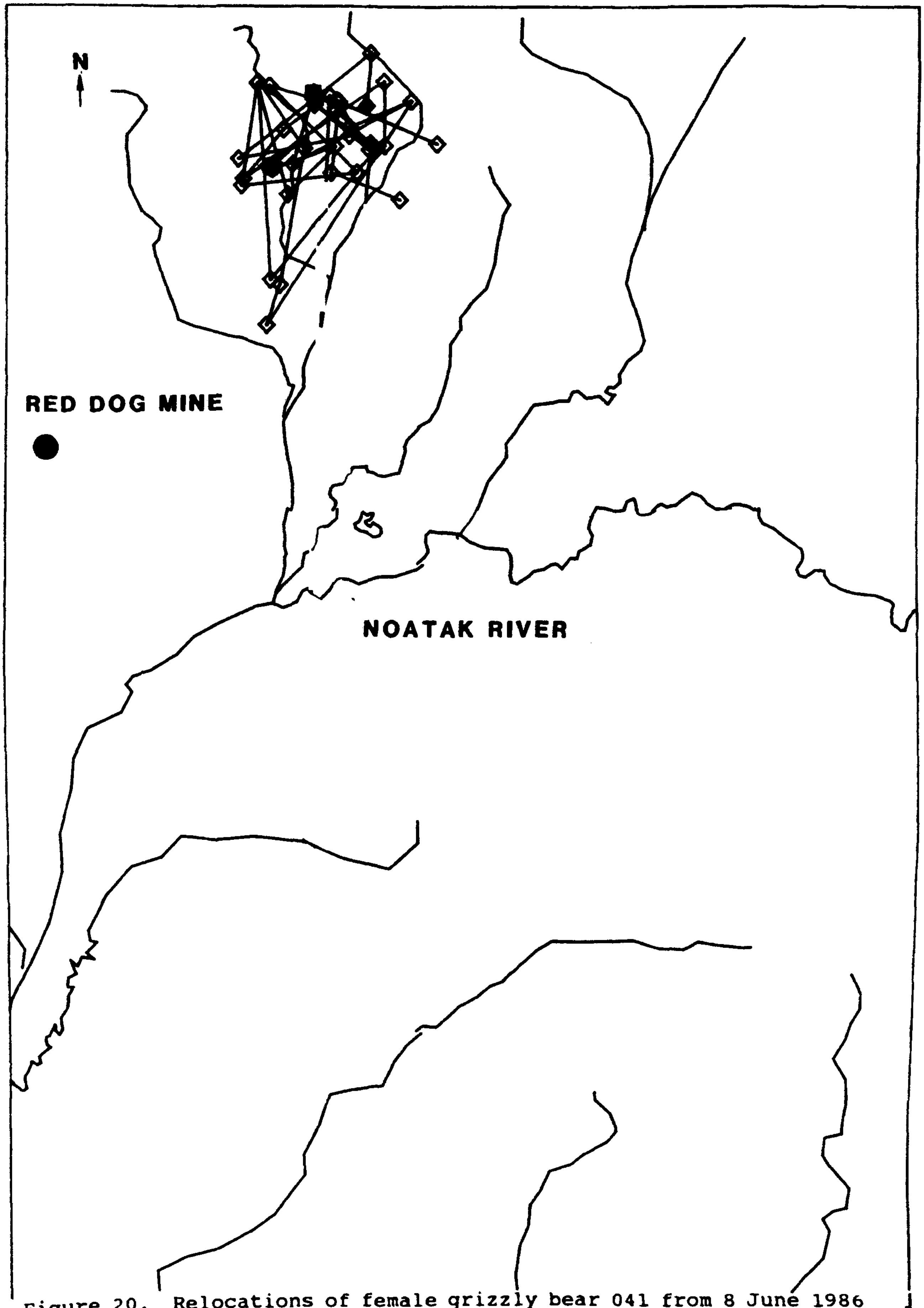

Figure 20. Relocations of female grizzly bear 041 from 8 June 1986 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

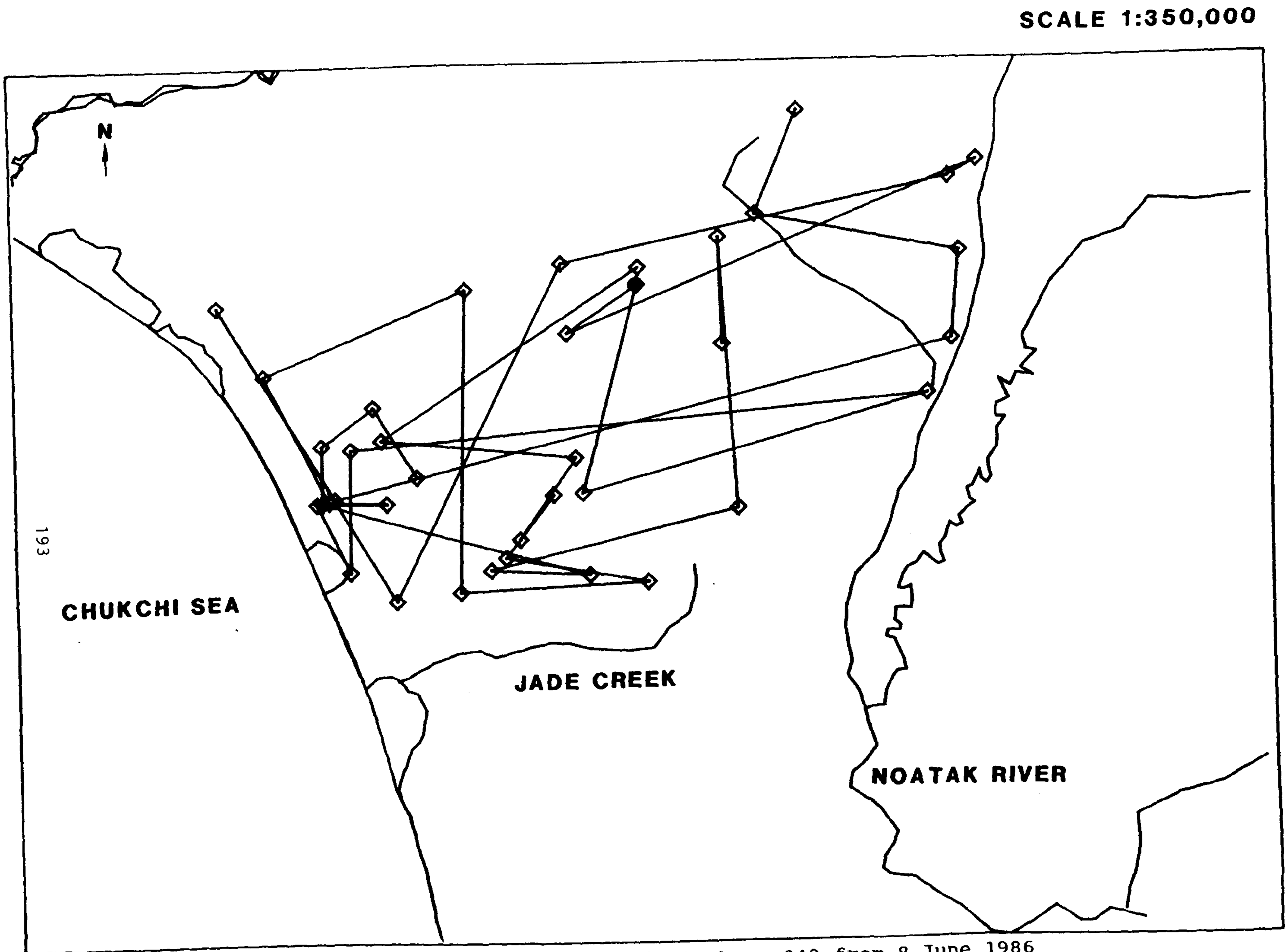

Figure 21. Relocations of male grizzly bear 042 from 8 June 1986 through 27 May 1989 in northwest Alaska using conventional radio telemetry.

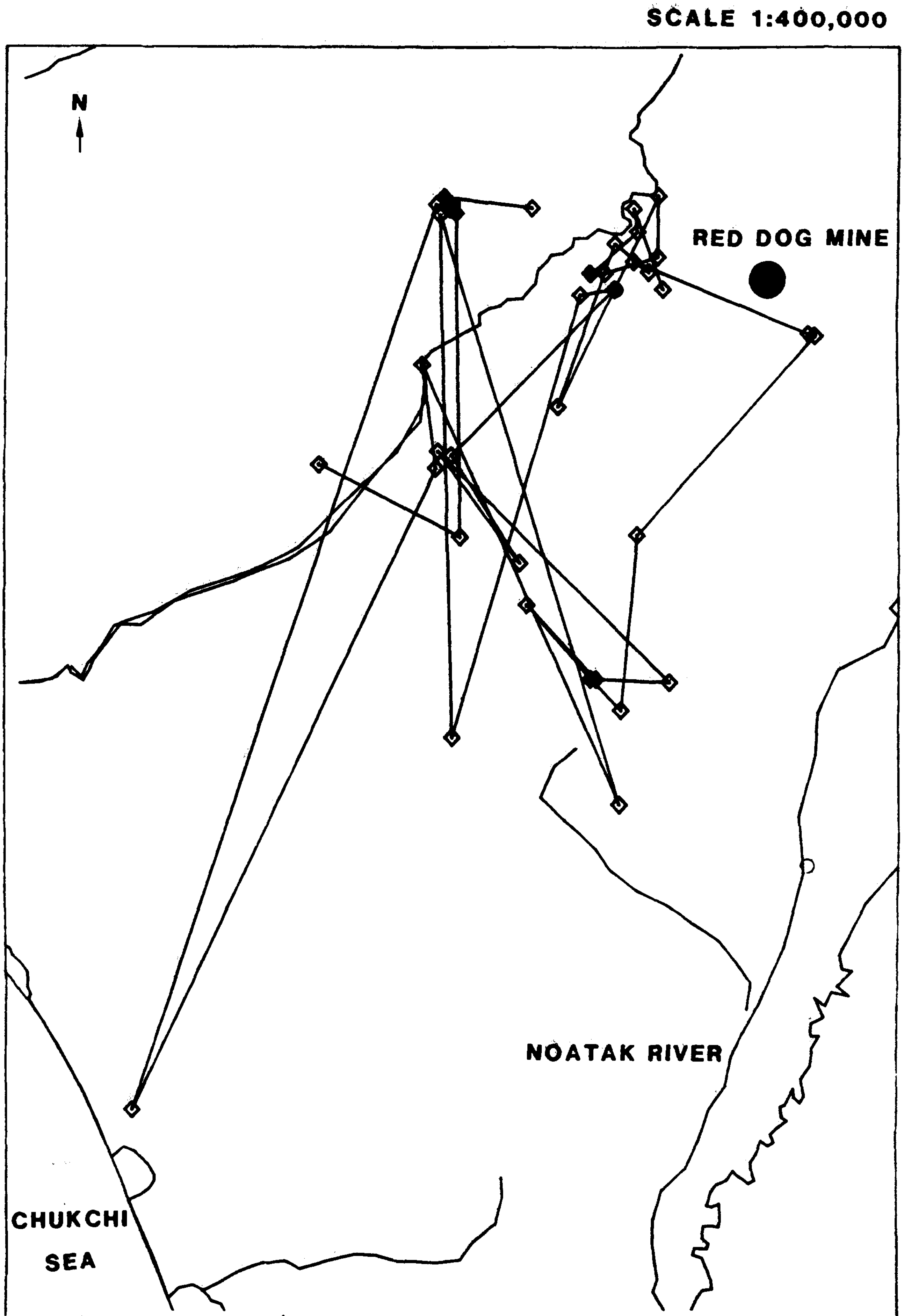

Figure 22. Relocations for female grizzly bear 043 from 8 June 1986 through 26 May 1990 in northwest Alaska using conventional radio telemetry.

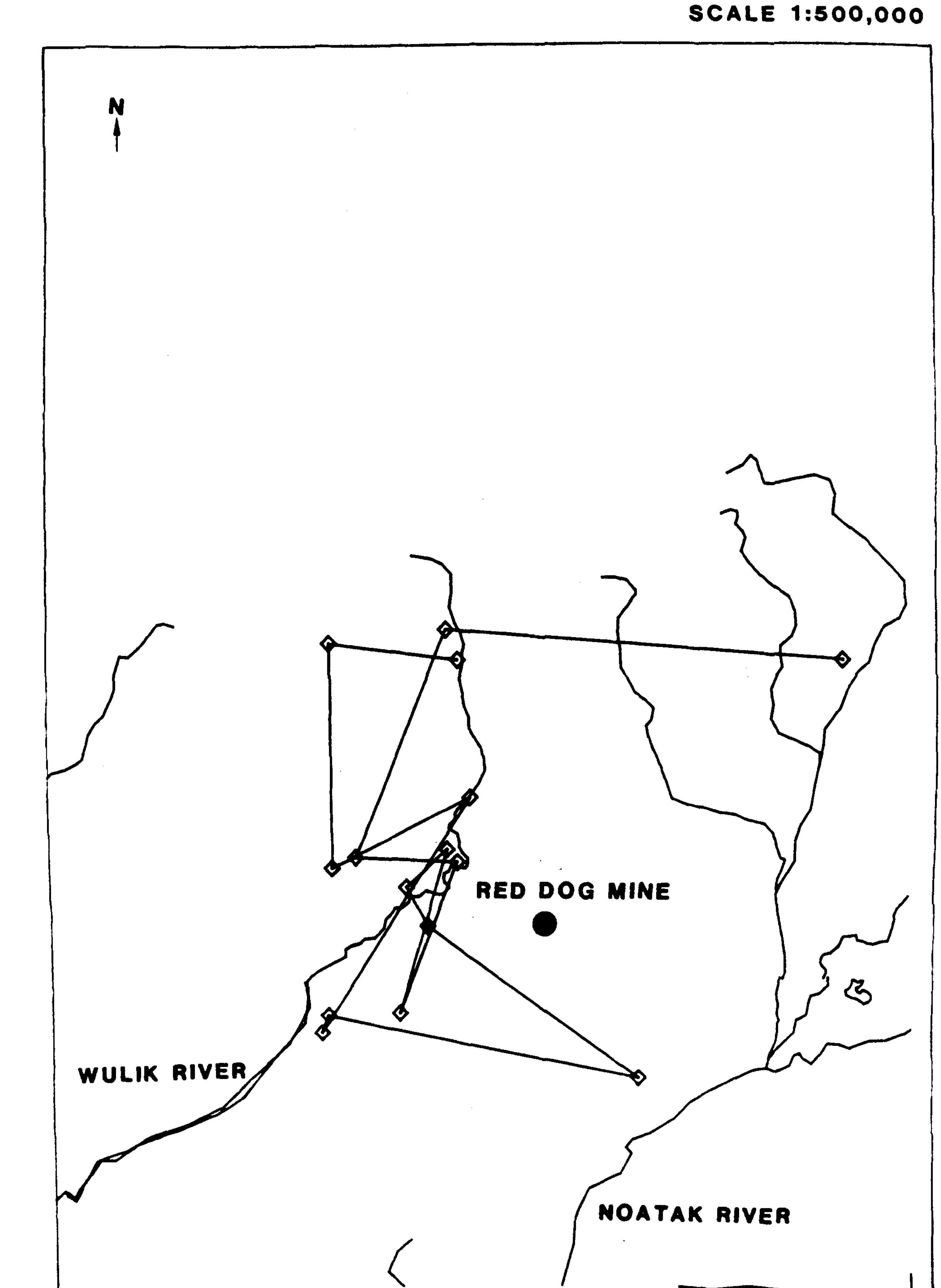

Figure 24. Relocations of male grizzly bear 045 from 9 June 1986 through 6 July 1987 in northwest Alaska using conventional radio telemetry.

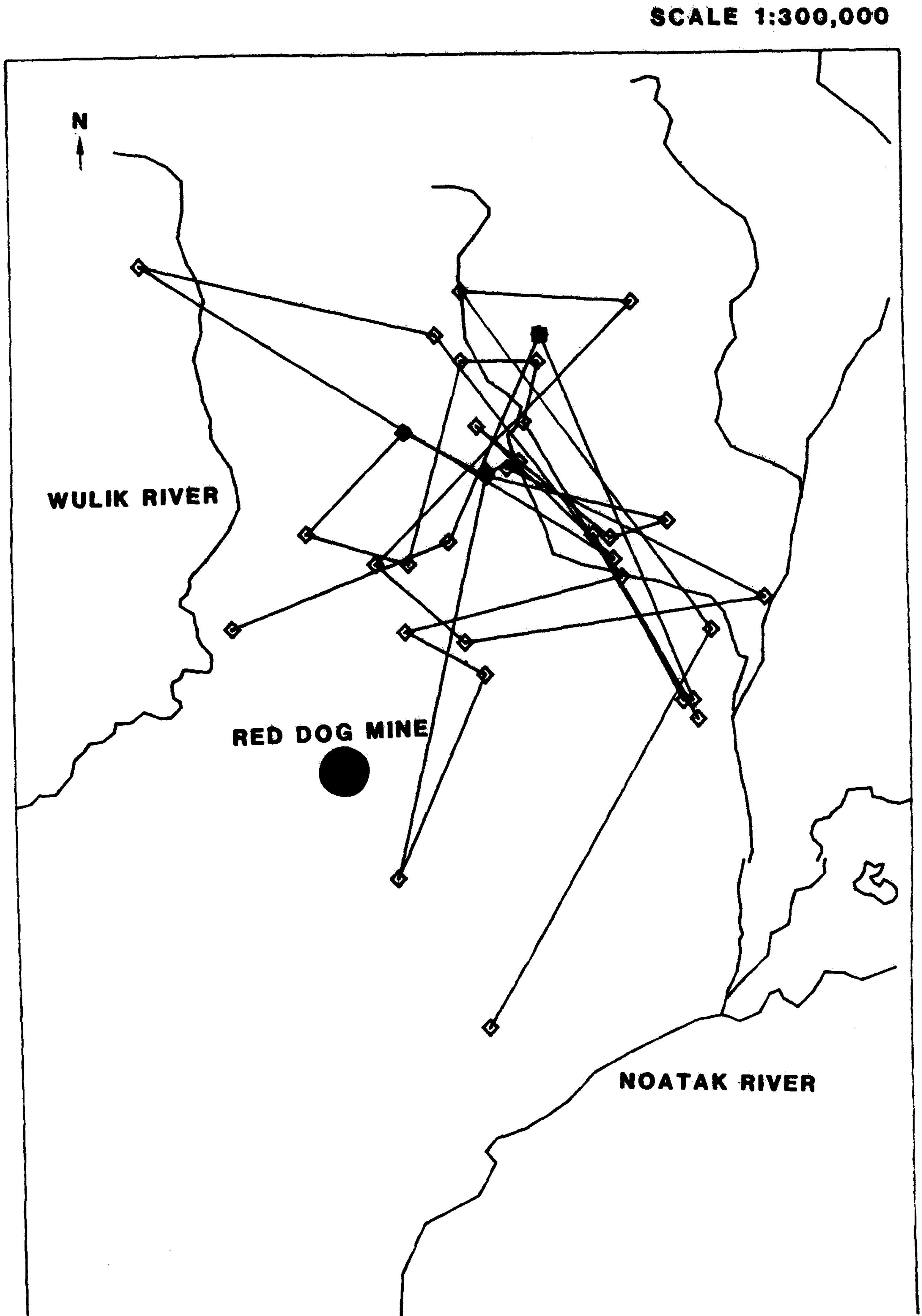

Figure 25. Relocations of male grizzly bear 046 from 8 June 1986 through 27 May 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:450,000

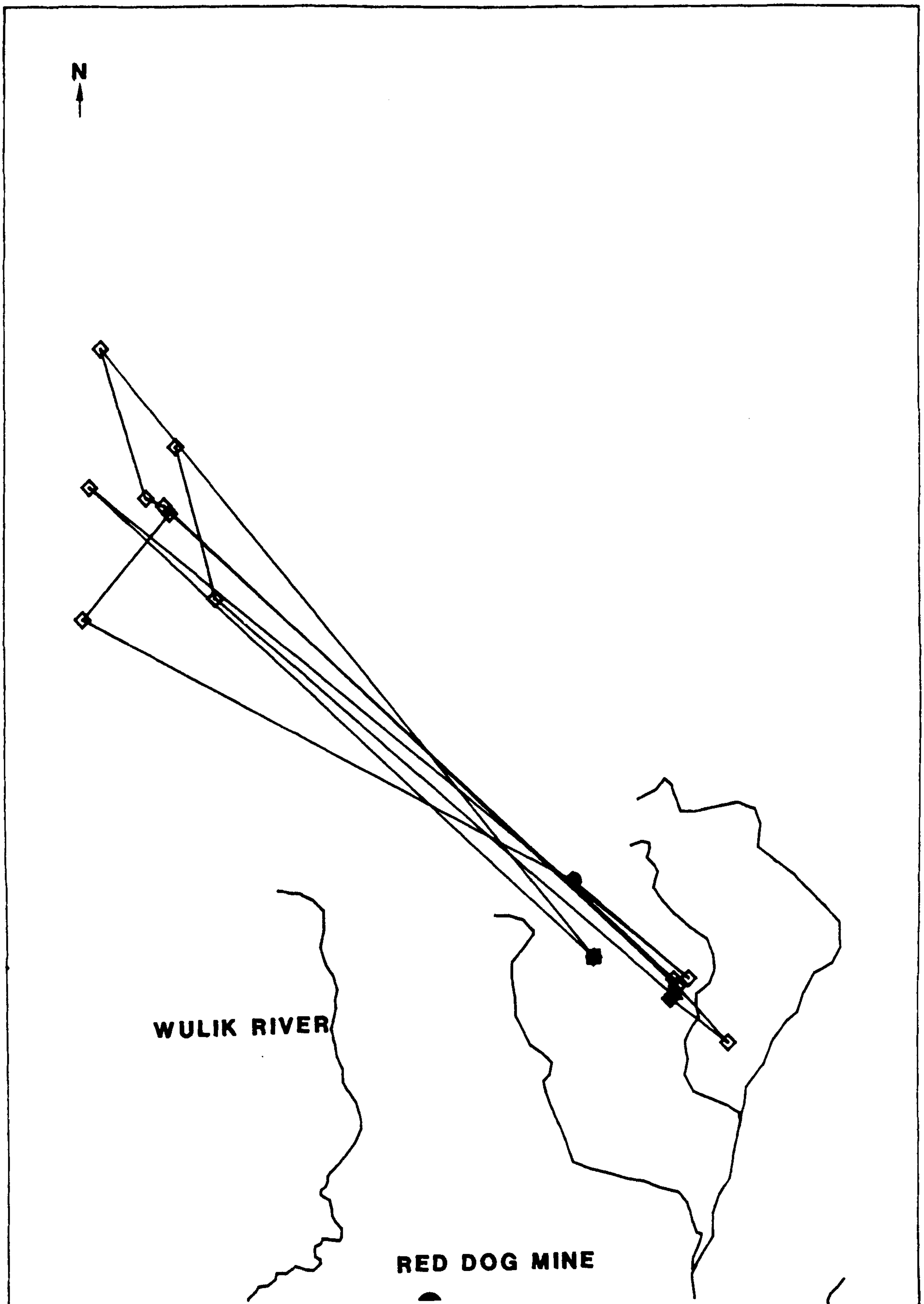

Figure 26. Relocations of female grizzly bear 052 from 29 May 1987 through 27 September 1990 in northwest Alaska using conventional radio telemetry.

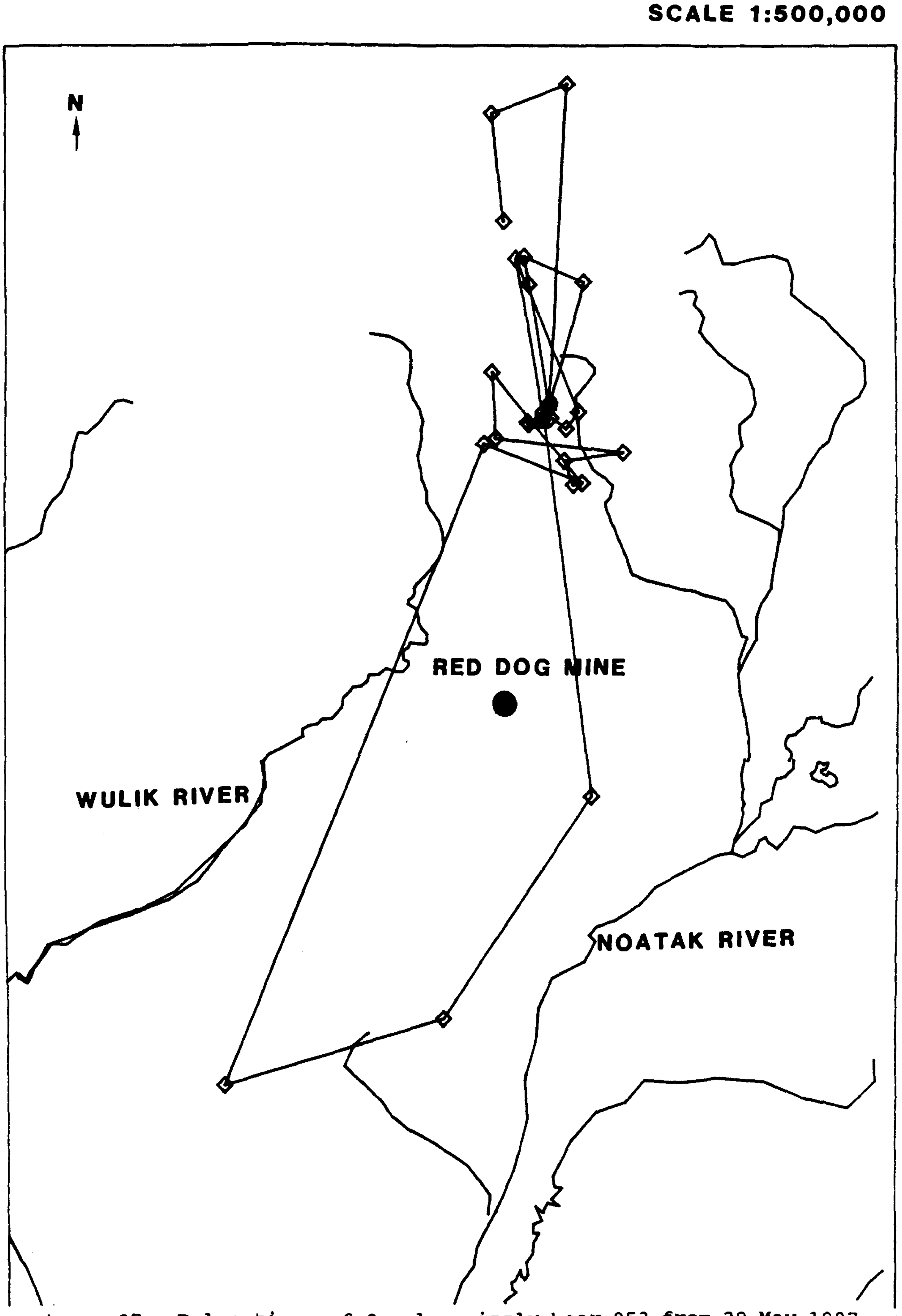

Figure 27. Relocations of female grizzly bear 053 from 29 May 1987 through 27 September 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:250,000

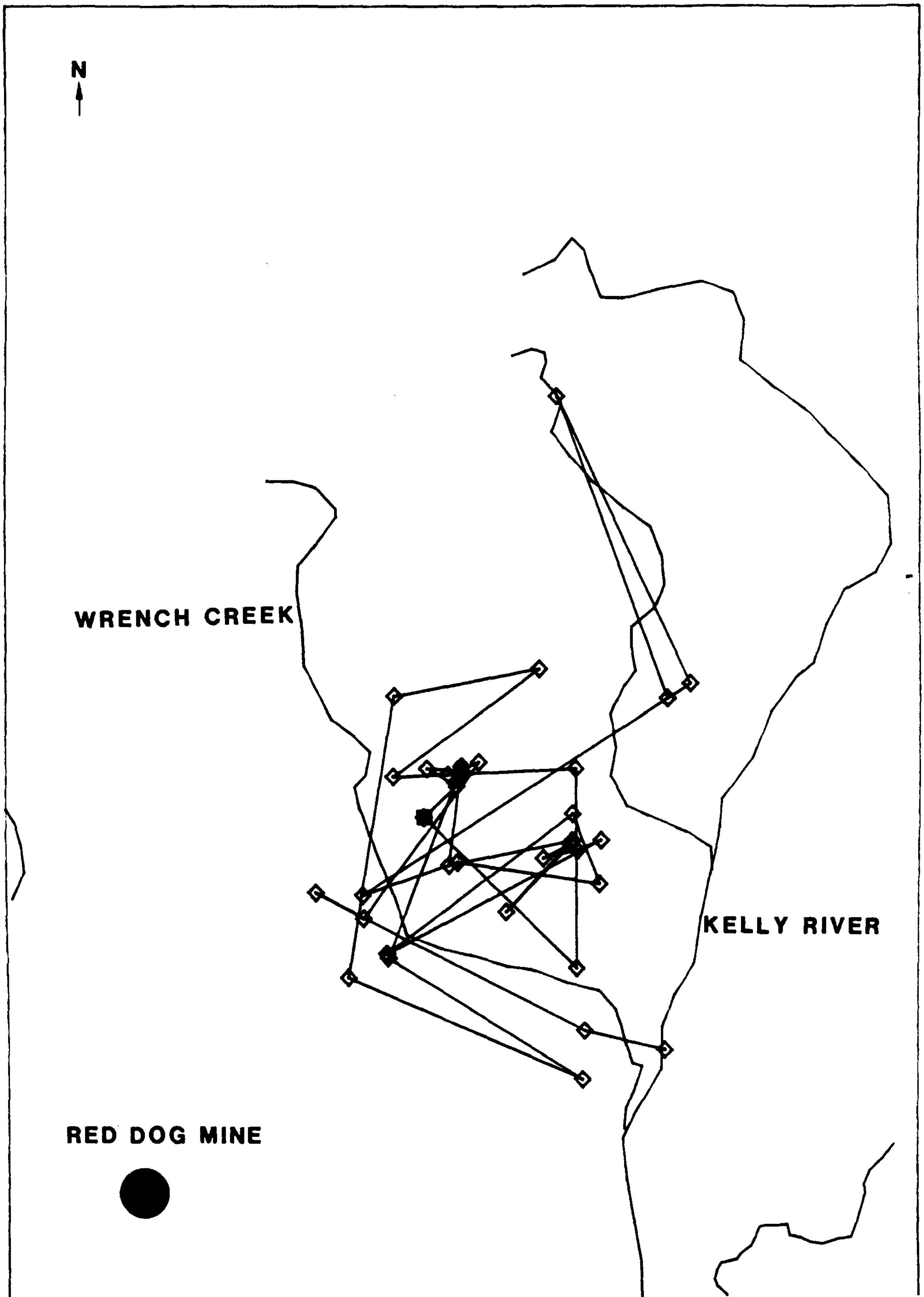

Figure 28. Relocations of female grizzly bear 055 from 29 May 1987 through 29 May 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:600,000

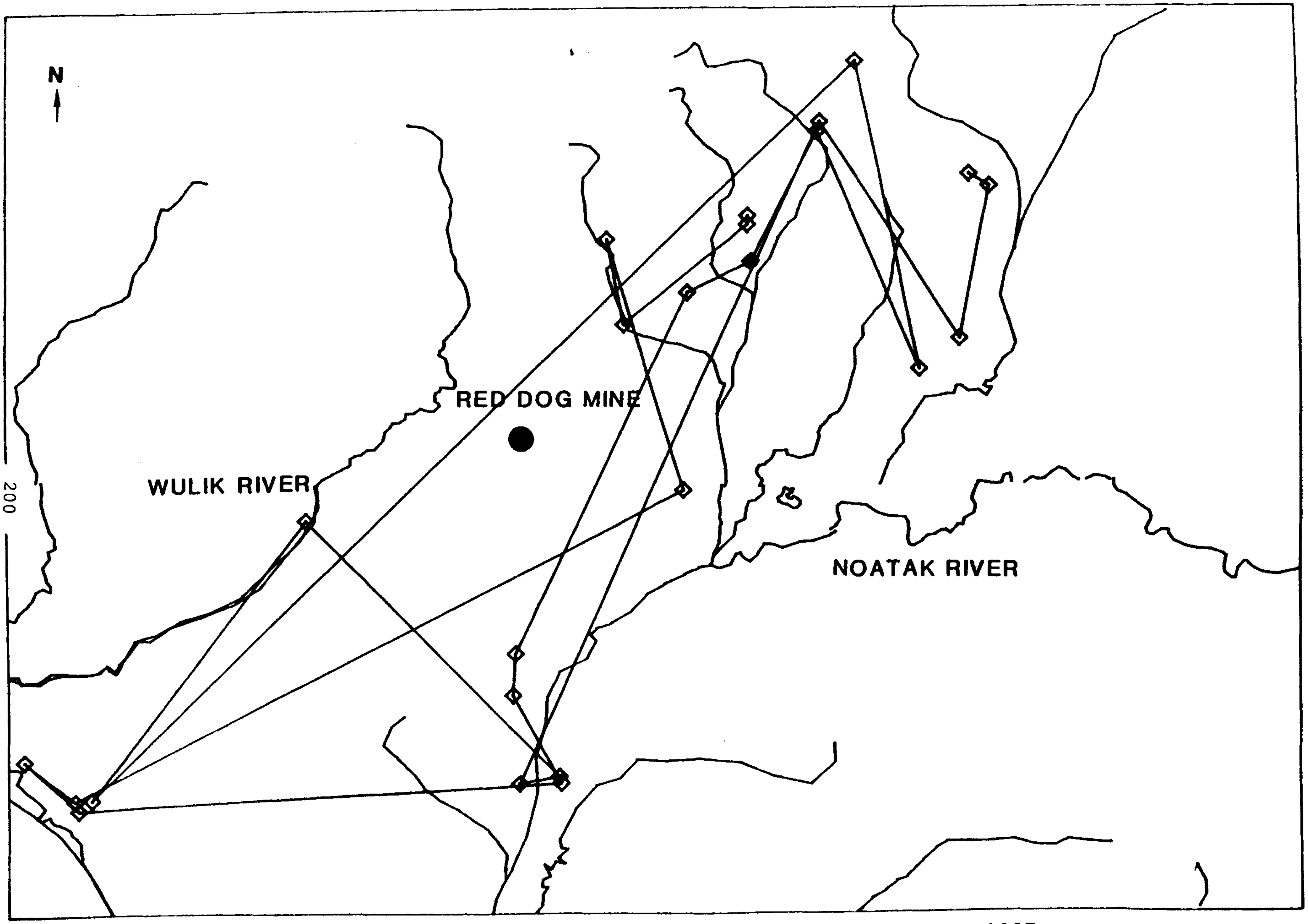

Figure 29. Relocations of female grizzly bear 056 from 29 May 1987 through 29 May 1989 in northwest Alaska using conventional radio telemetry.

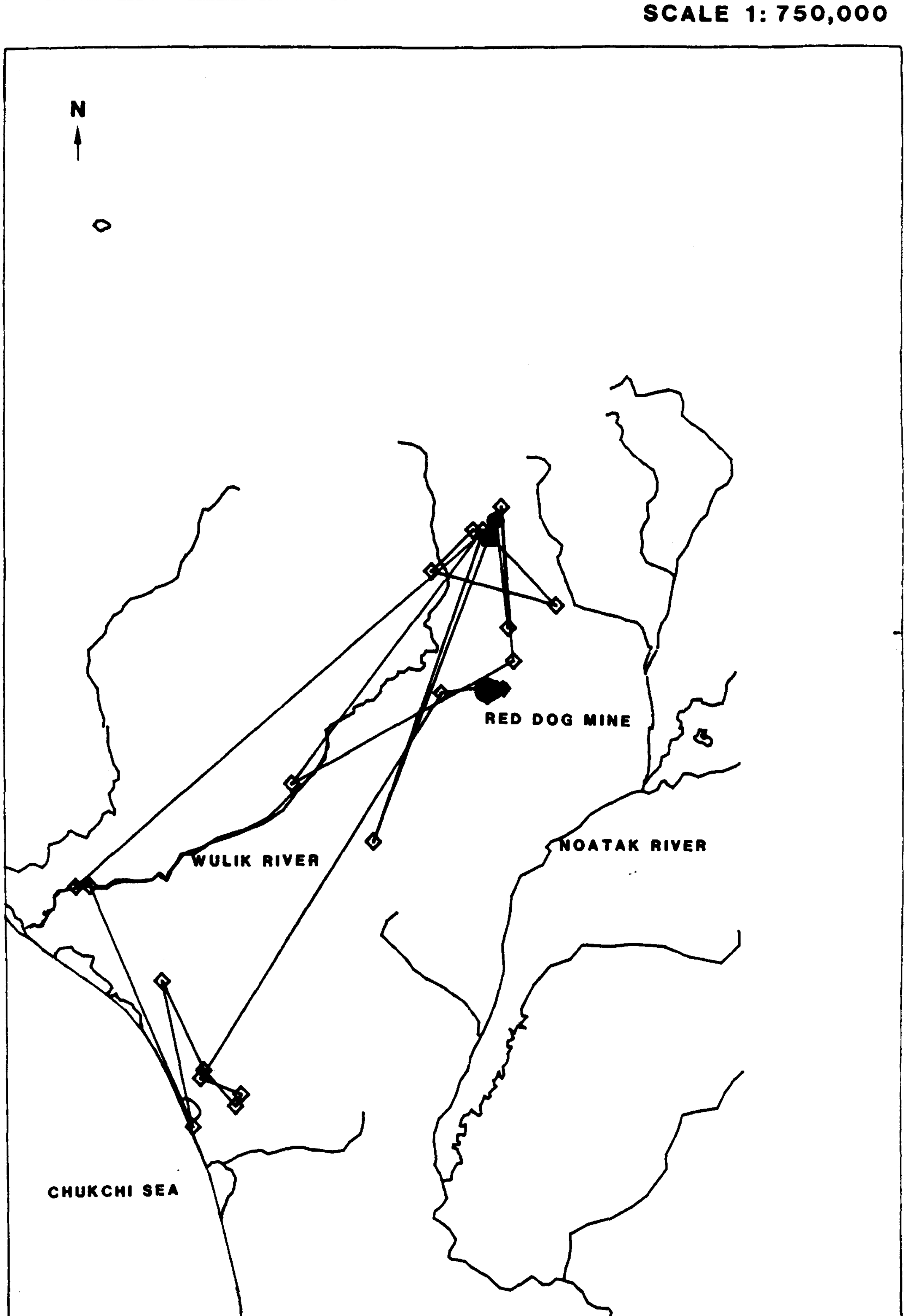

Figure 30. Relocations of female grizzly bear 058 from 30 May 1987 through 13 November 1989 in northwest Alaska using conventional radio telemetry.

SCALE 1:500,000

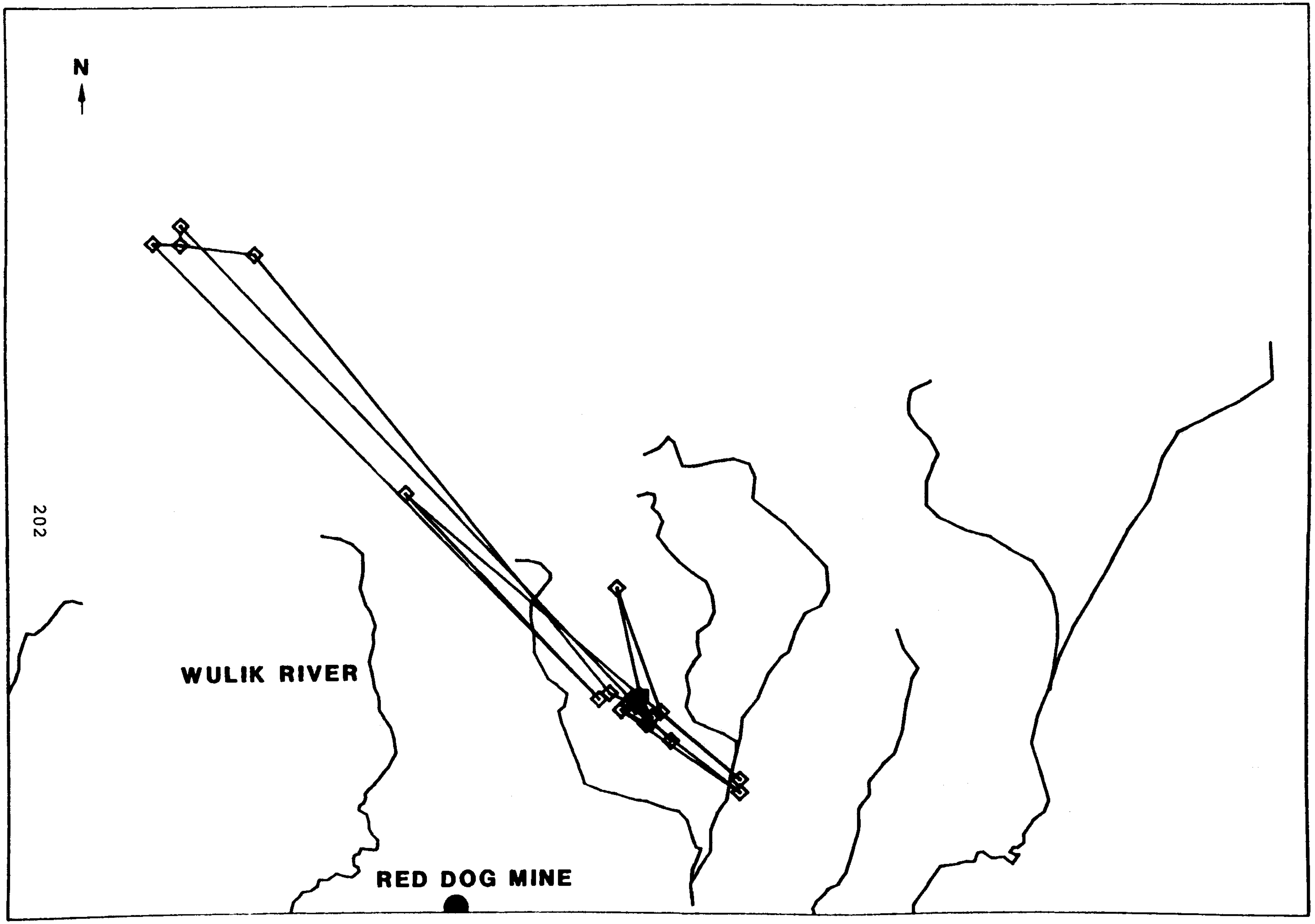

Figure 31. Relocations of female grizzly bear 059 from 30 May 1987 through 27 September 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:250,000

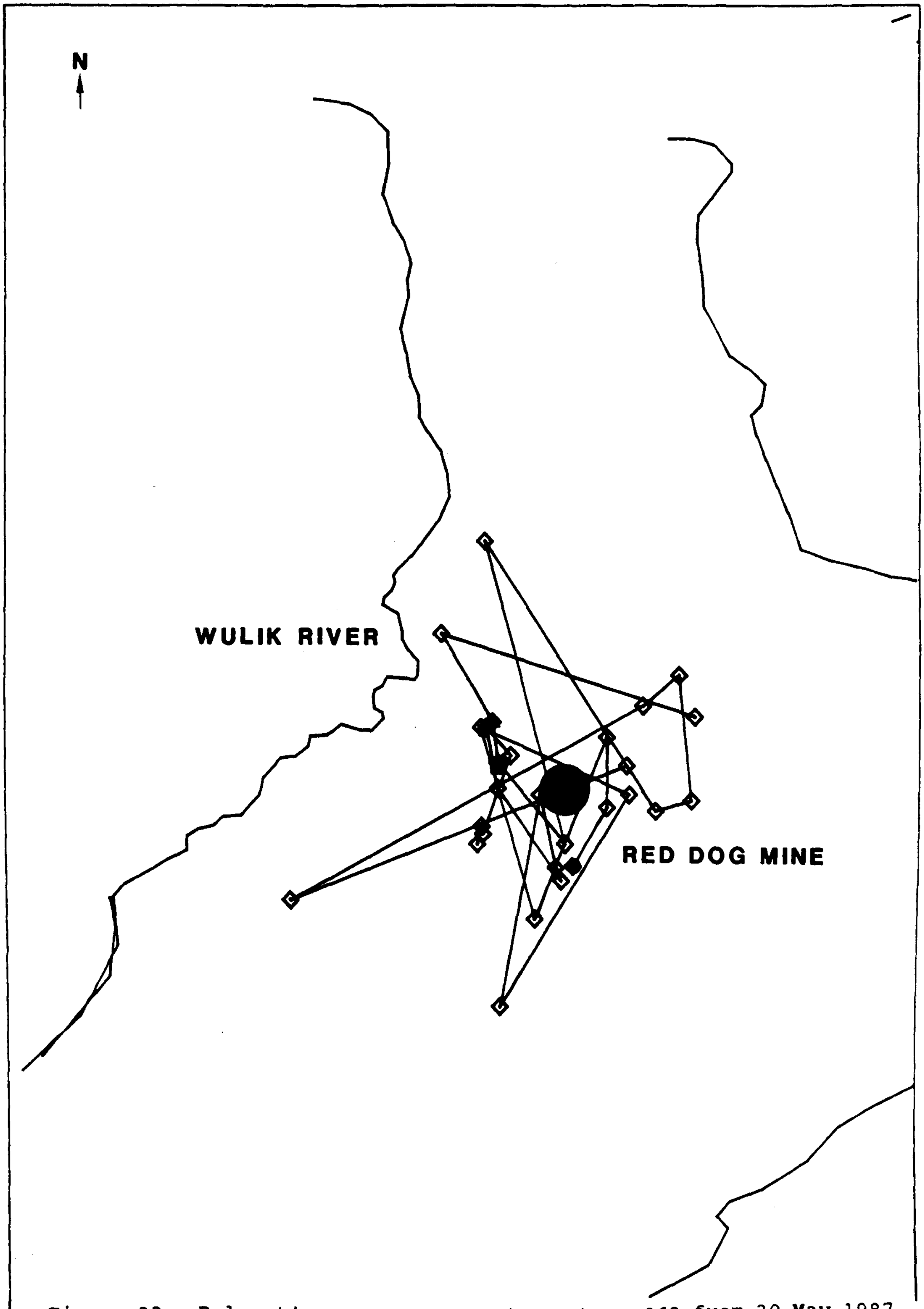

Figure 32. Relocations of female grizzly bear 063 from 30 May 1987 through 13 June 1989 in northwest Alaska using conventional radio telemetry.

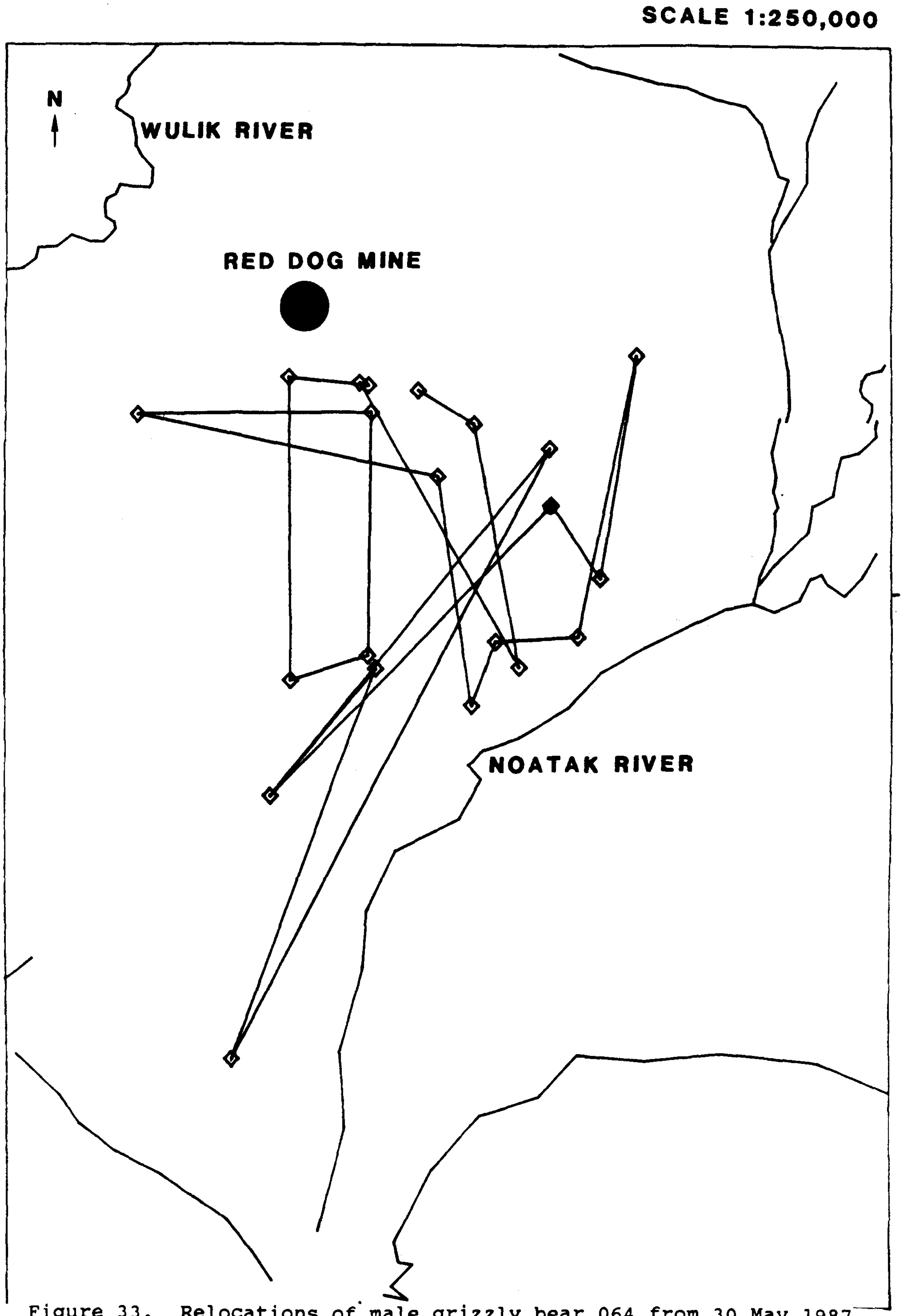

Figure 33. Relocations of male grizzly bear 064 from 30 May 1987 through 24 August 1988 in northwest Alaska using conventional radio telemetry.

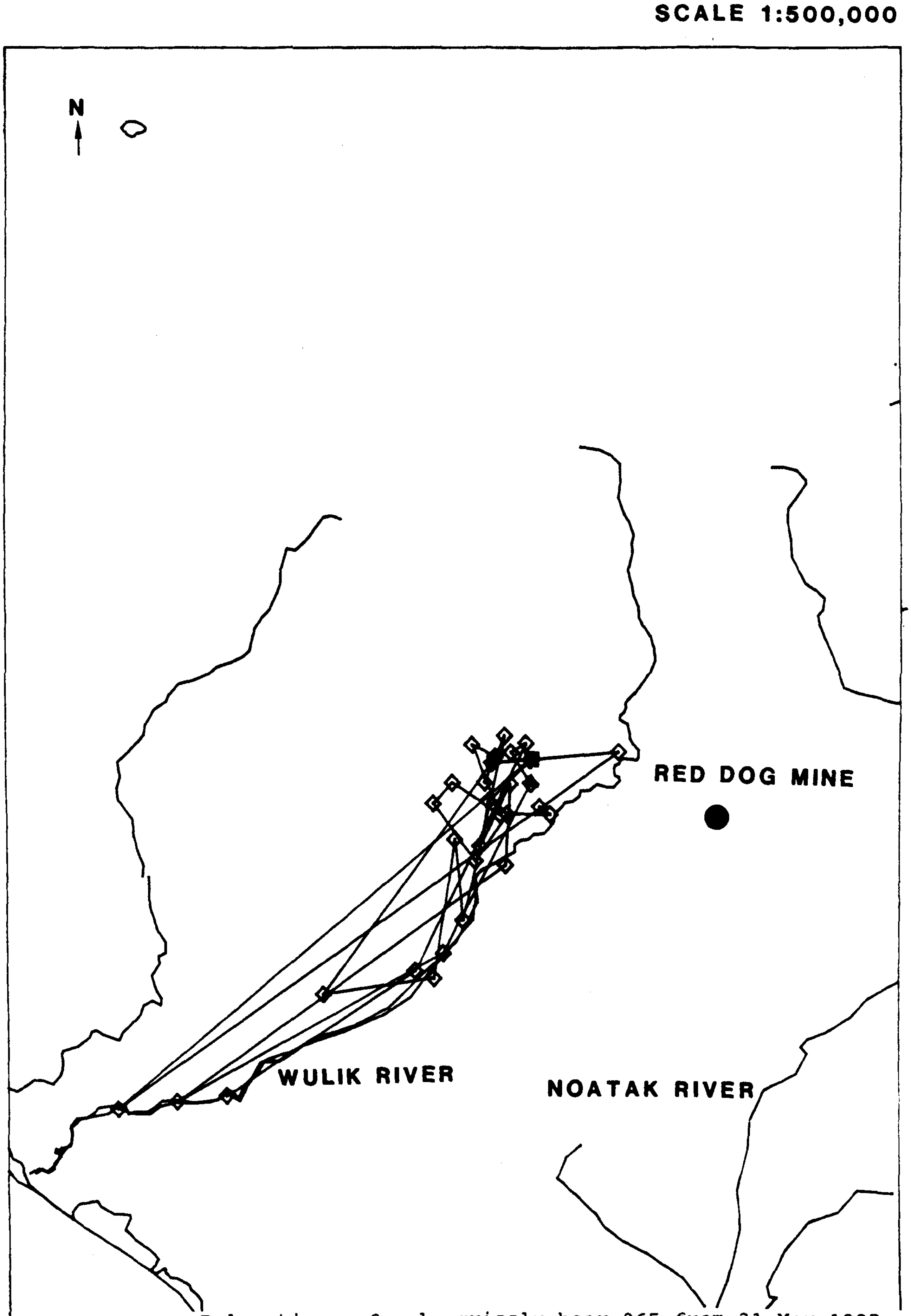

Figure 34. Relocations of male grizzly bear 065 from 31 May 1987 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

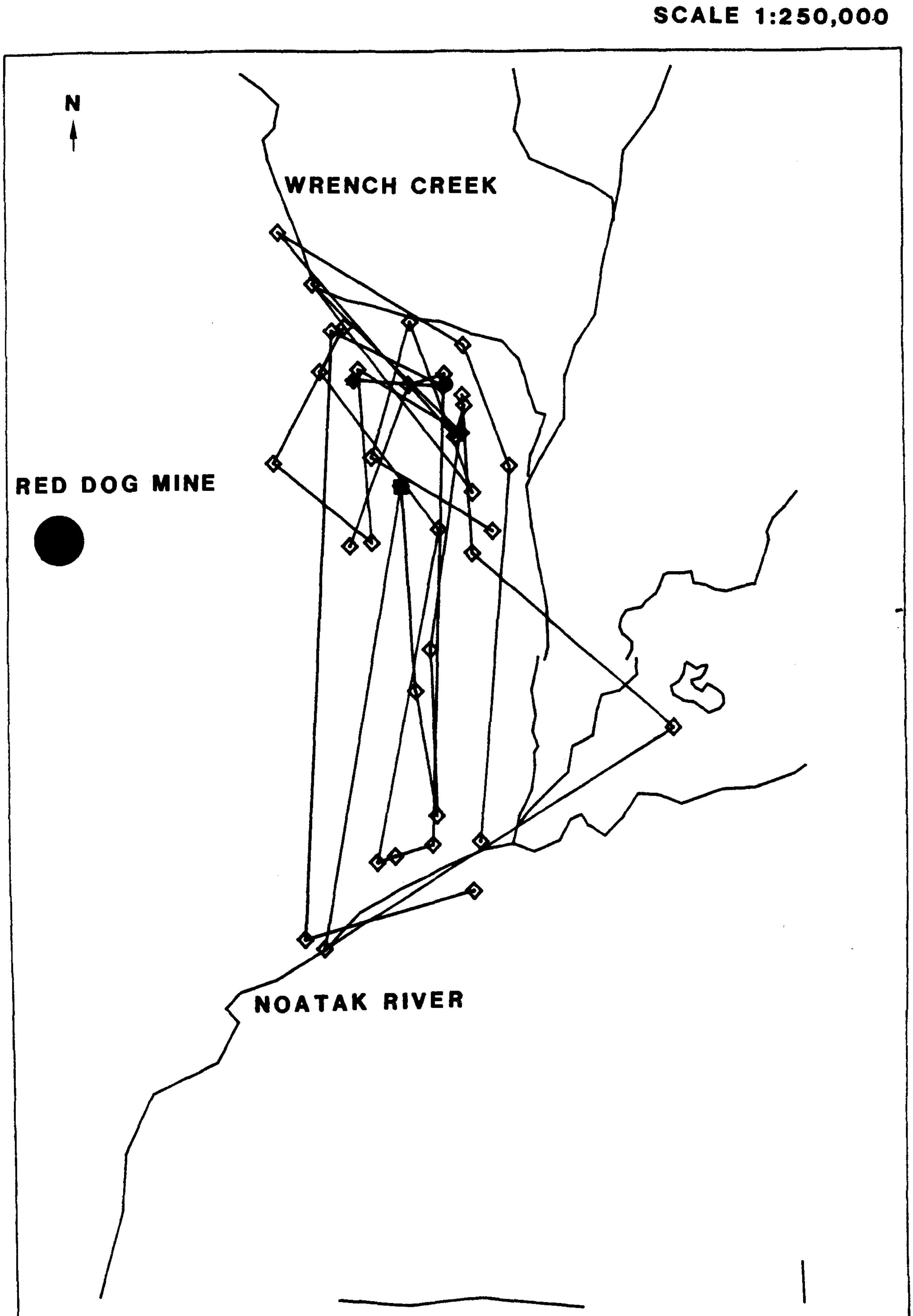

Figure 35. Relocations of female grizzly bear 067 from 31 May 1987 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

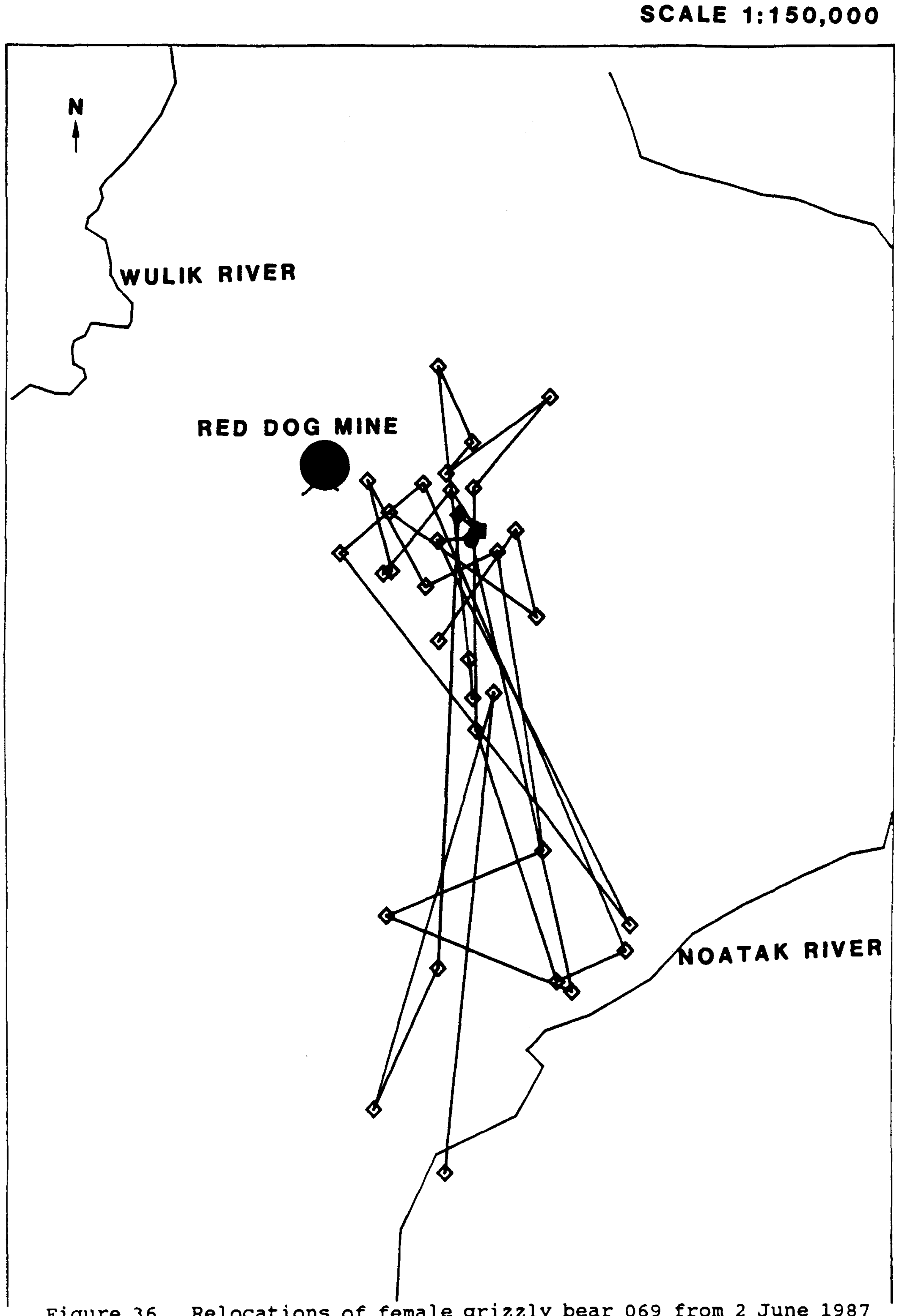

Figure 36. Relocations of female grizzly bear 069 from 2 June 1987 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1: 300,000

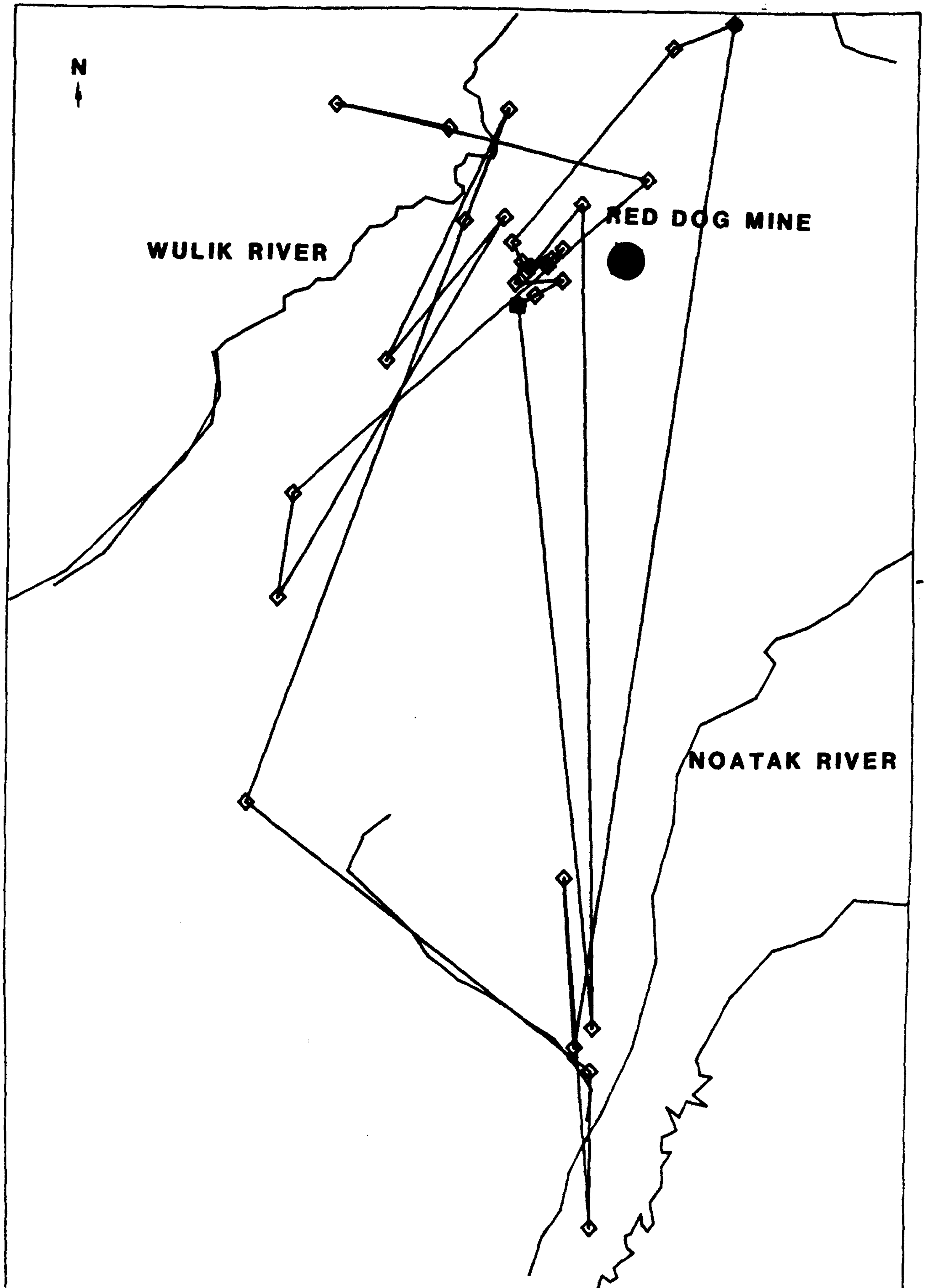

Figure 37. Relocations of female grizzly bear 070 from 2 June 1987 through 26 June 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:350,000

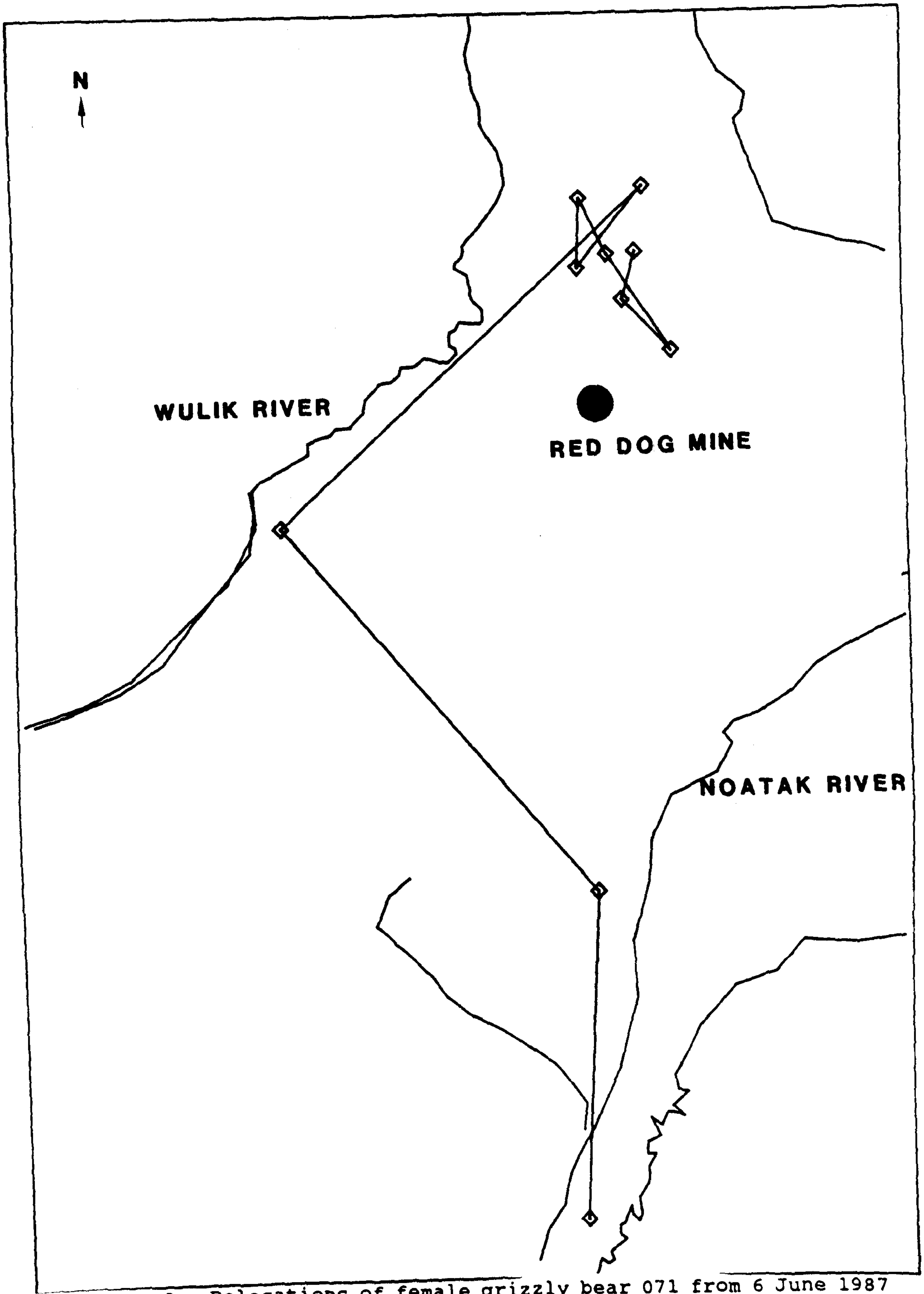

Figure 38. Relocations of female grizzly bear 071 from 6 June 1987 through 15 September 1987 in northwest Alaska using conventional radio telemetry.

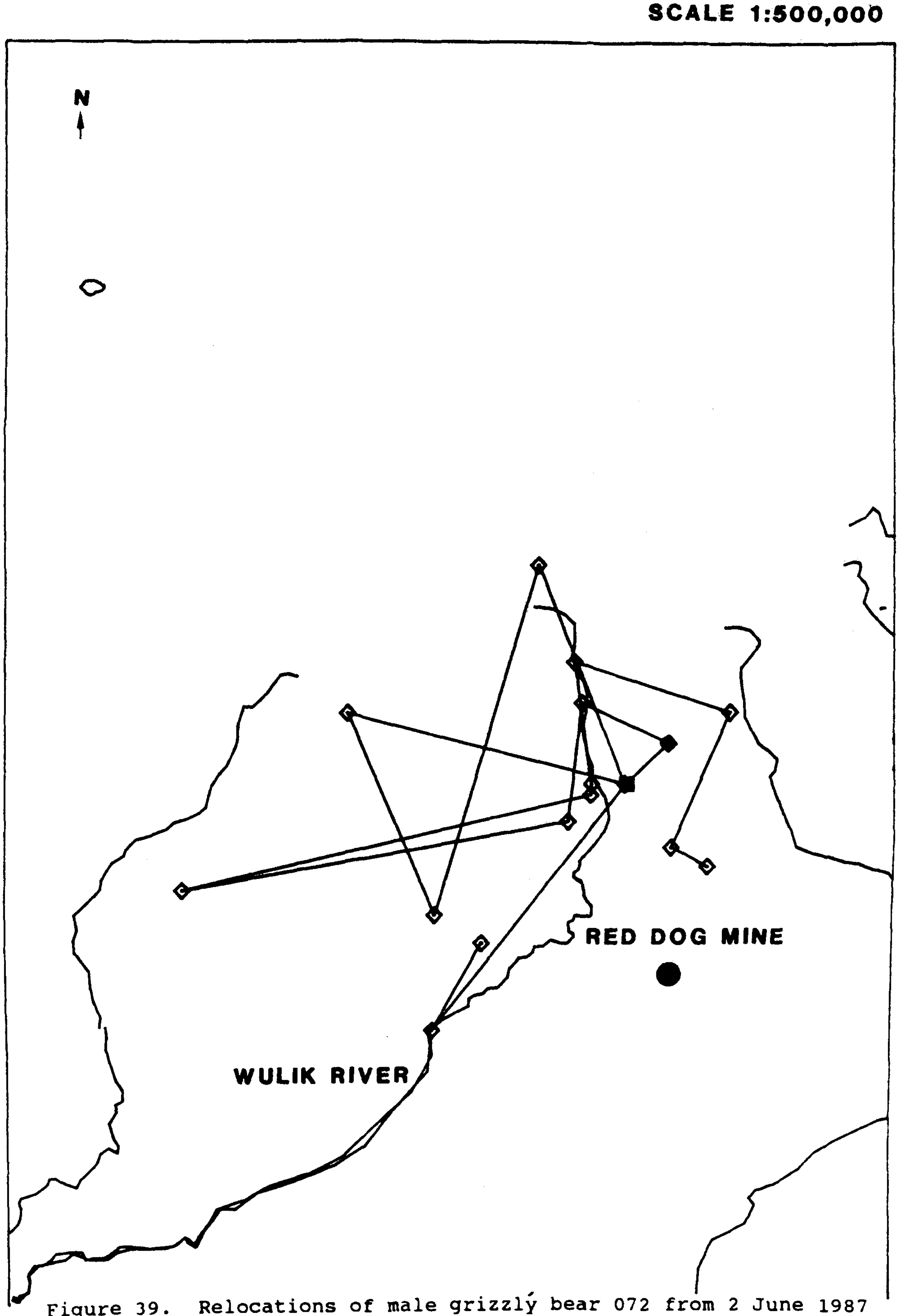

Figure 39. Relocations of male grizzly bear 072 from 2 June 1987 through 27 May 1989 in northwest Alaska using conventional radio telemetry.

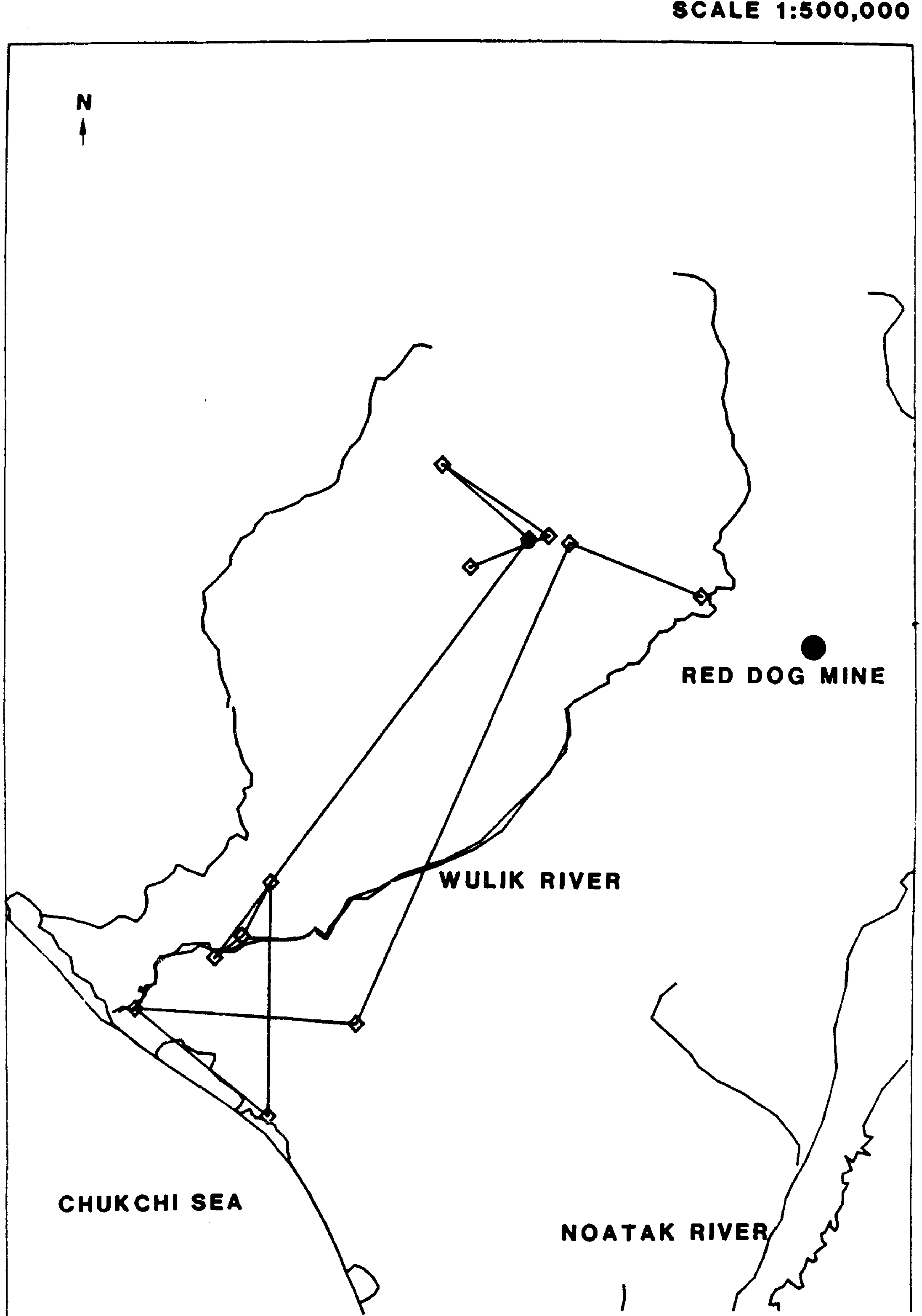

Figure 40. Relocations of male grizzly bear 073 from 4 June 1987 through 8 June 1988 in northwest Alaska using conventional radio telemetry.

SCALE 1:300,000

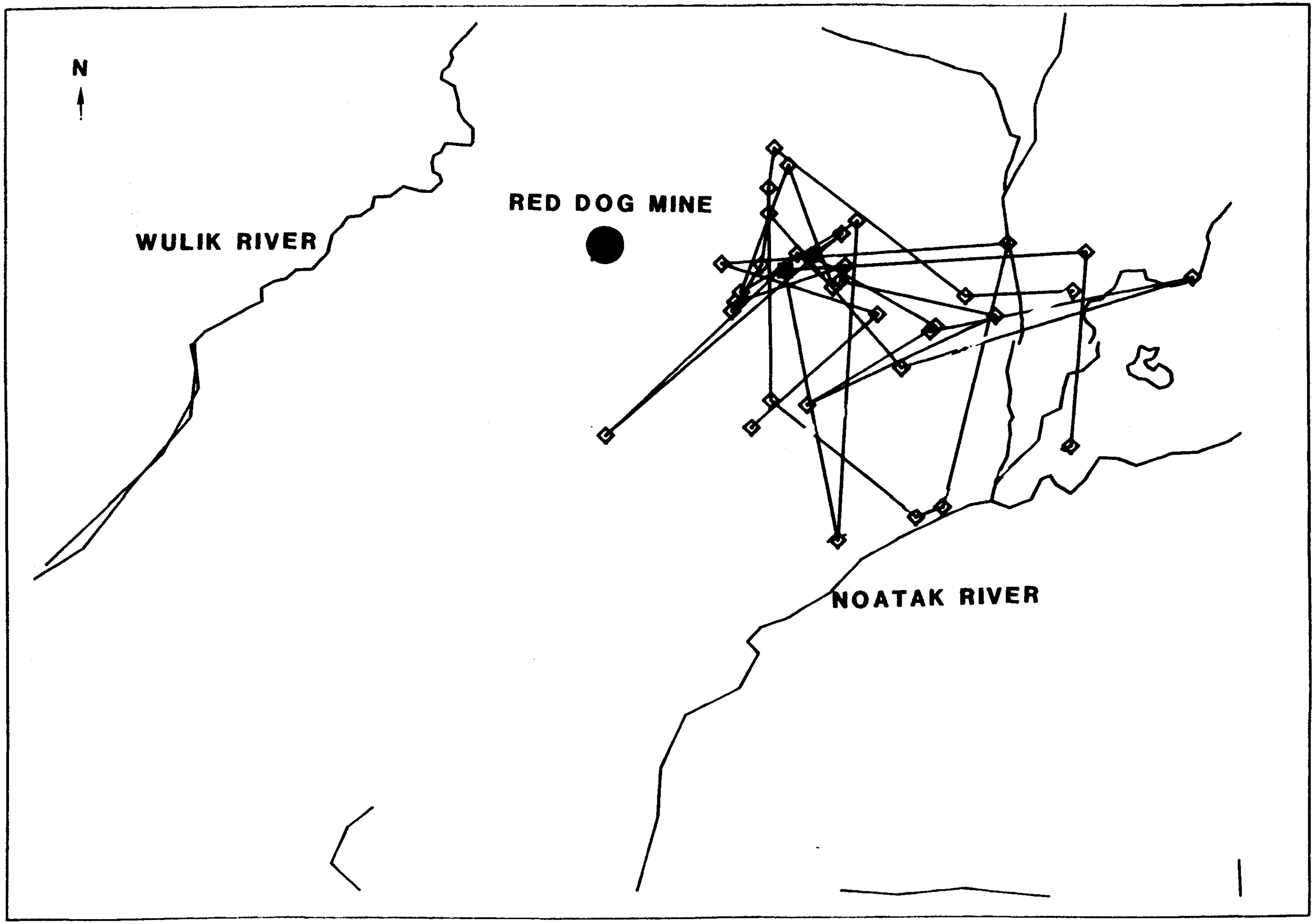

Figure 41. Relocations of female grizzly bear 074 from 4 June 1987 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

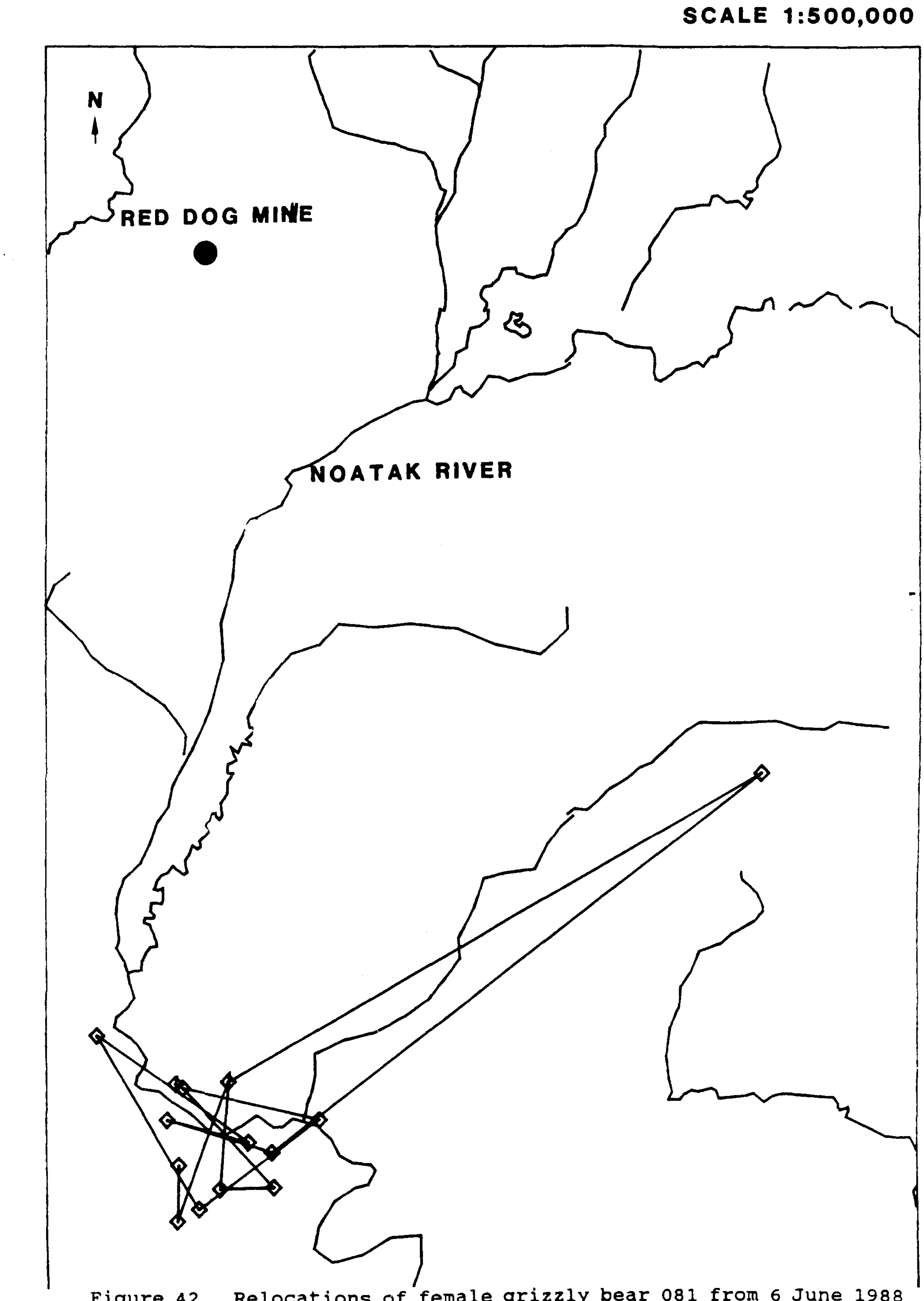

Figure 42. Relocations of female grizzly bear 081 from 6 June 1988 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

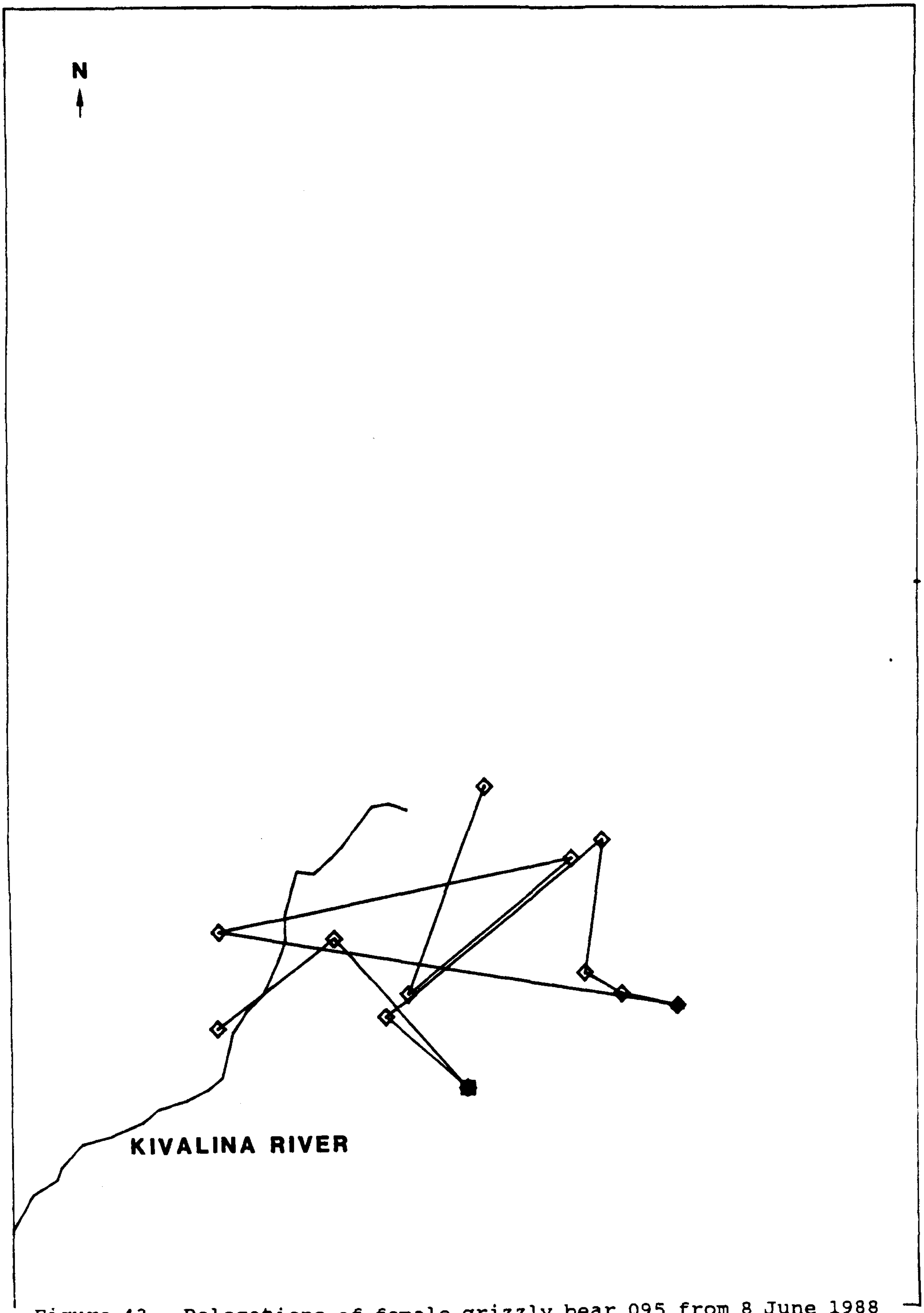

Figure 43. Relocations of female grizzly bear 095 from 8 June 1988 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

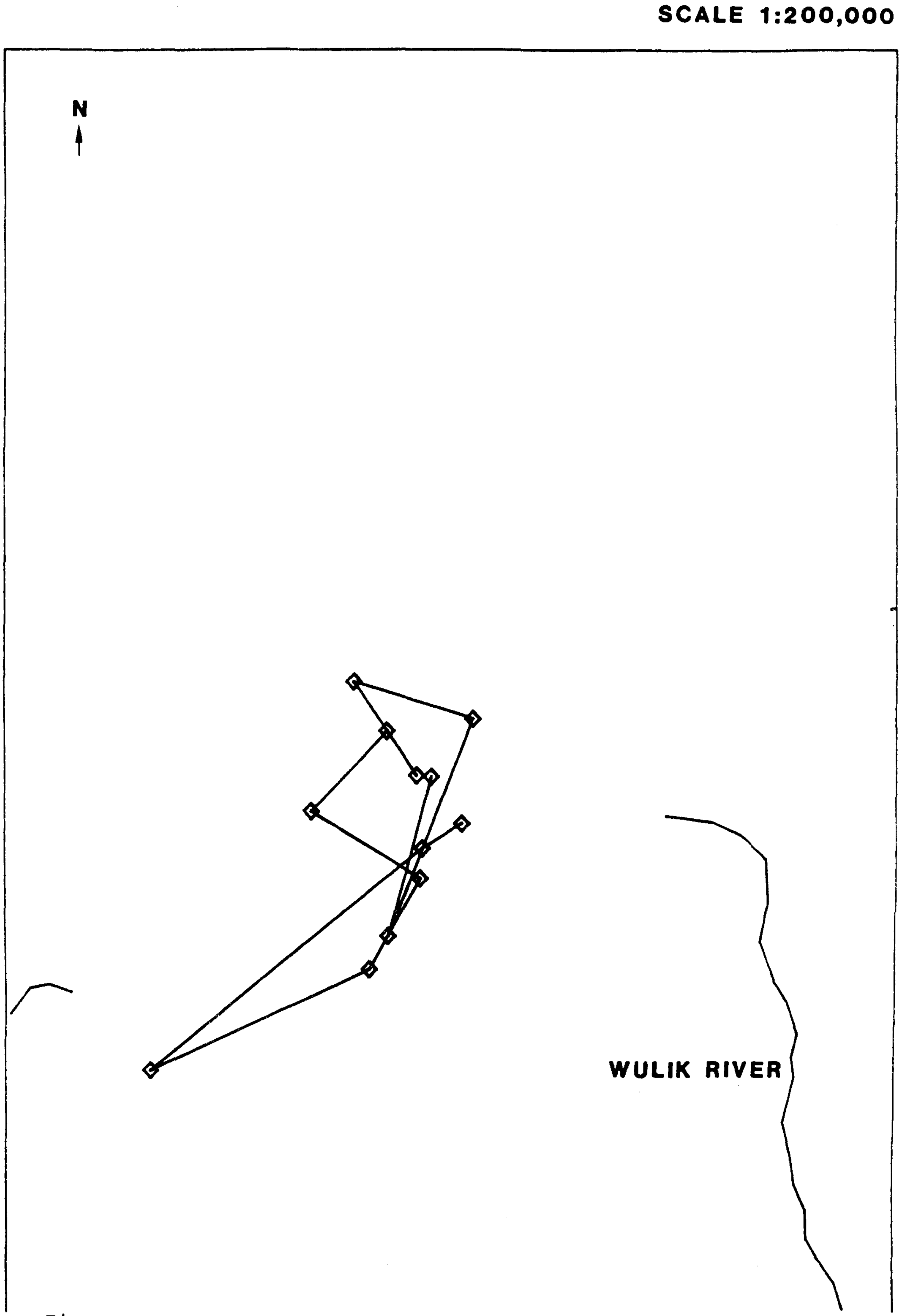

Figure 44. Relocations of female grizzly bear 096 from 9 June 1988 through 31 May 1990 in northwest Alaska using conventional radio telemetry.

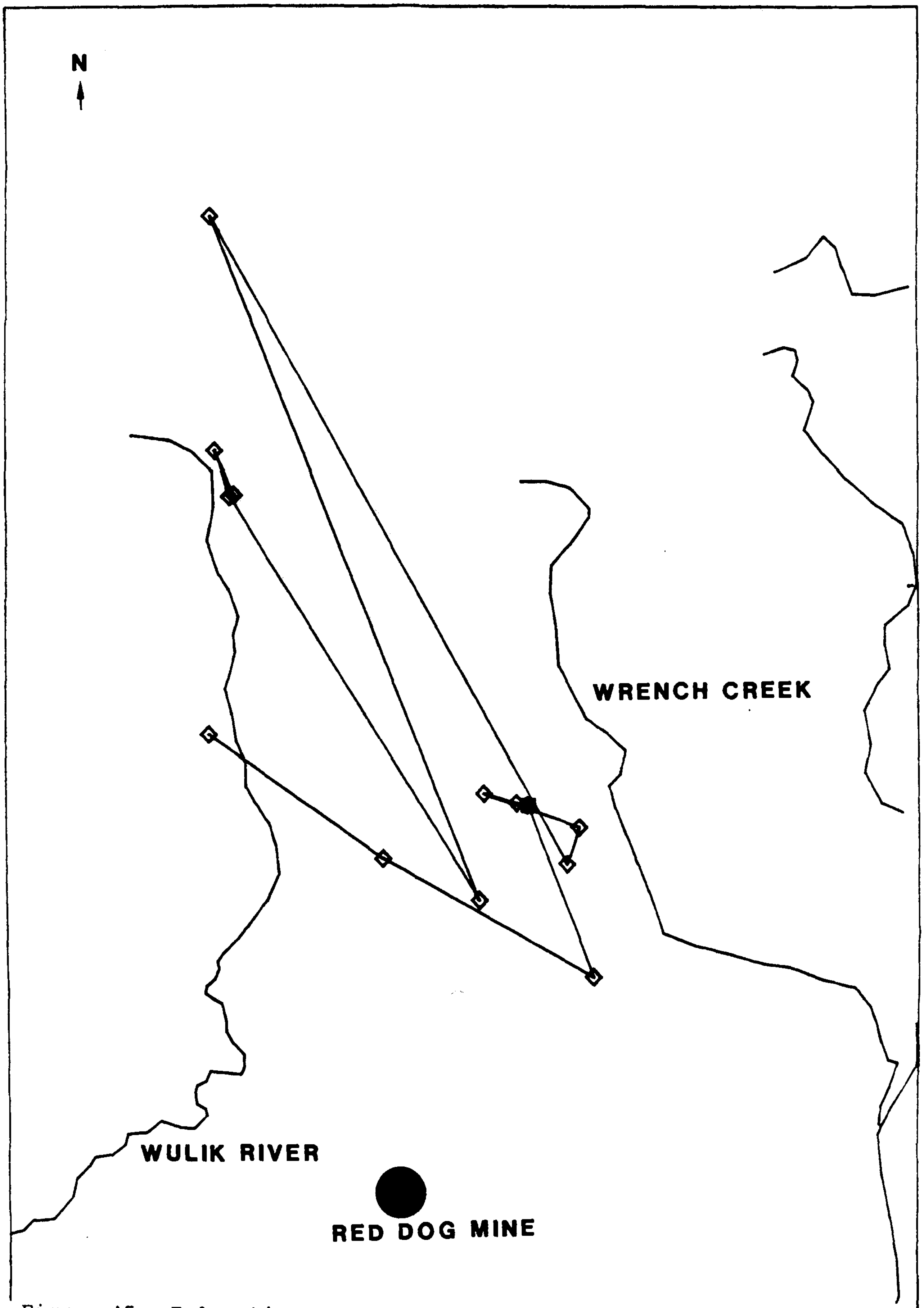

Figure 45. Relocations of female grizzly bear 097 from 9 June 1988 through 24 May 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:250,000

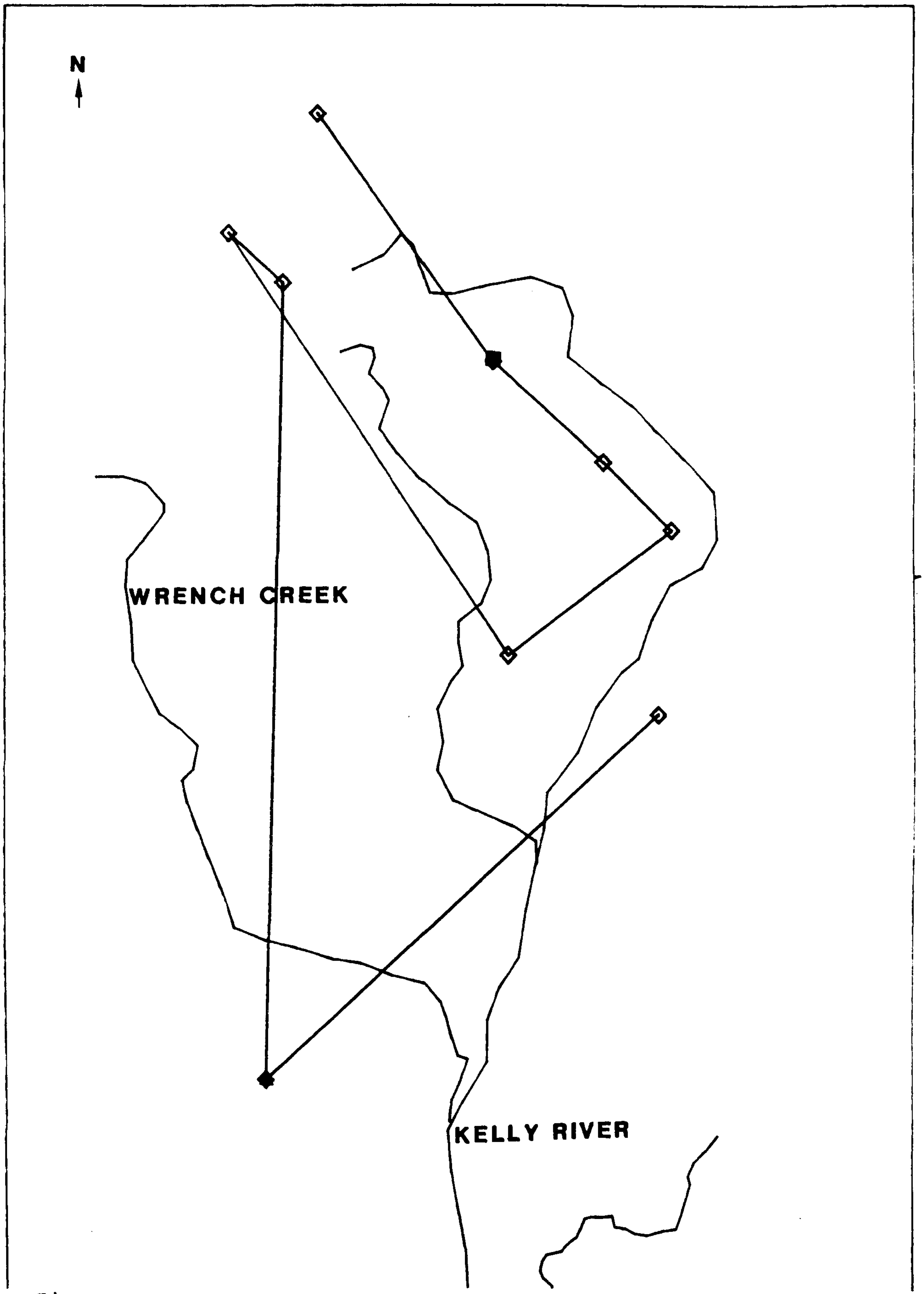

Figure 46. Relocations of female grizzly bear 098 from 9 June 1989 through 1 June 1990 in northwest Alaska using conventional radio telemetry.

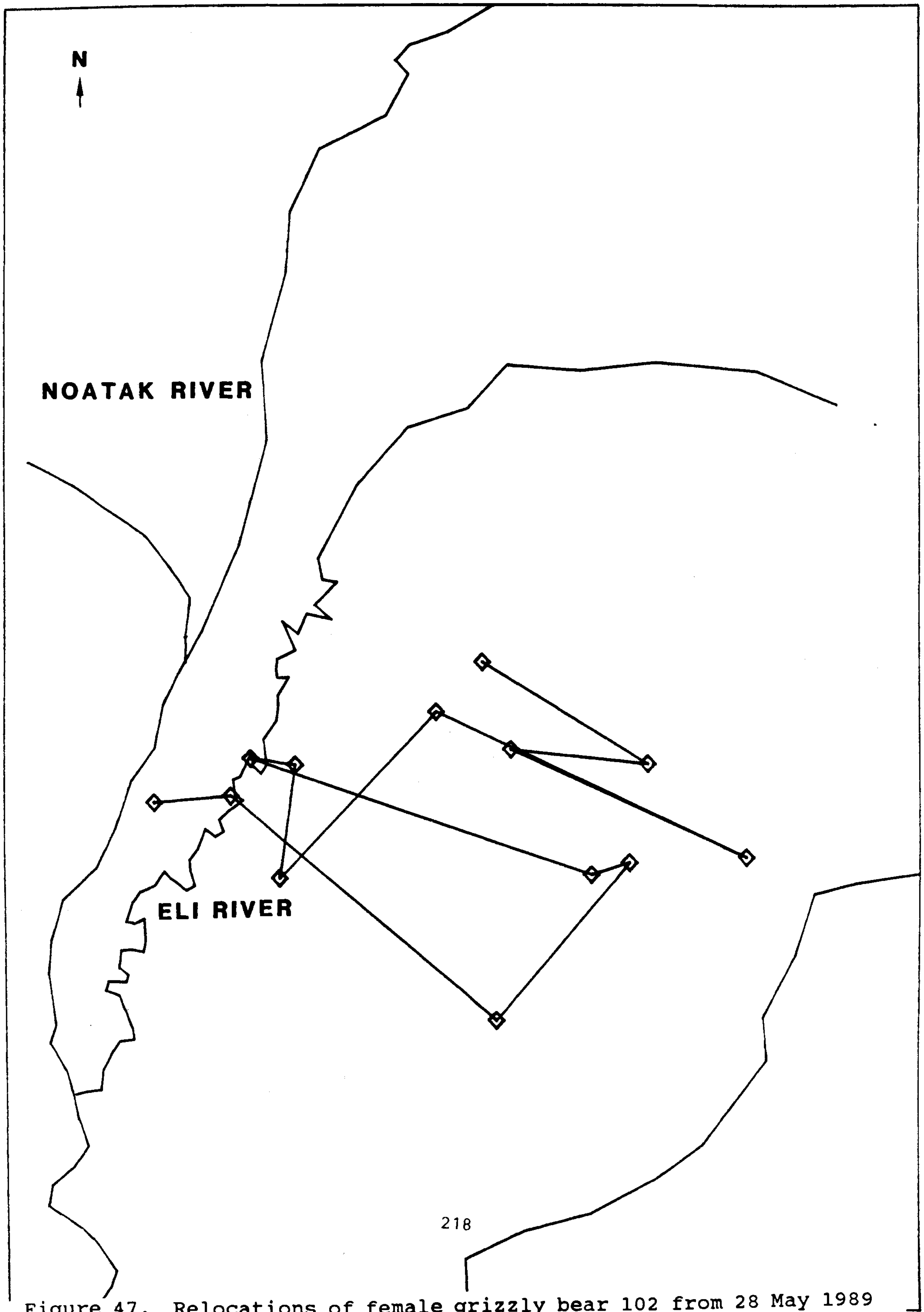

Figure 47. Relocations of female grizzly bear 102 from 28 May 1989 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:500,000

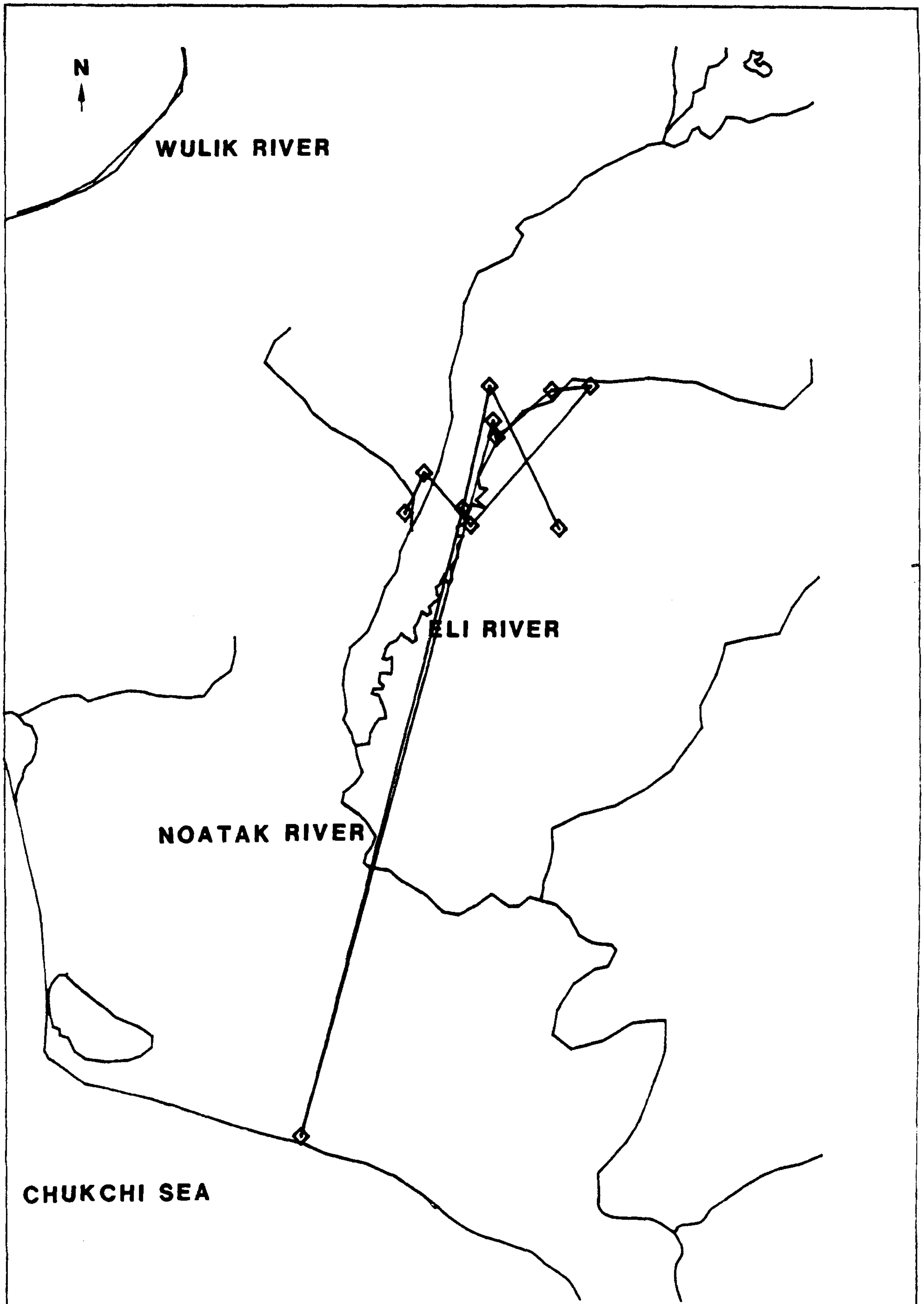

Figure 48. Relocations of female grizzly bear 103 from 28 May 1989 through 23 September 1990 in northwest Alaska using conventional radio telemetry.

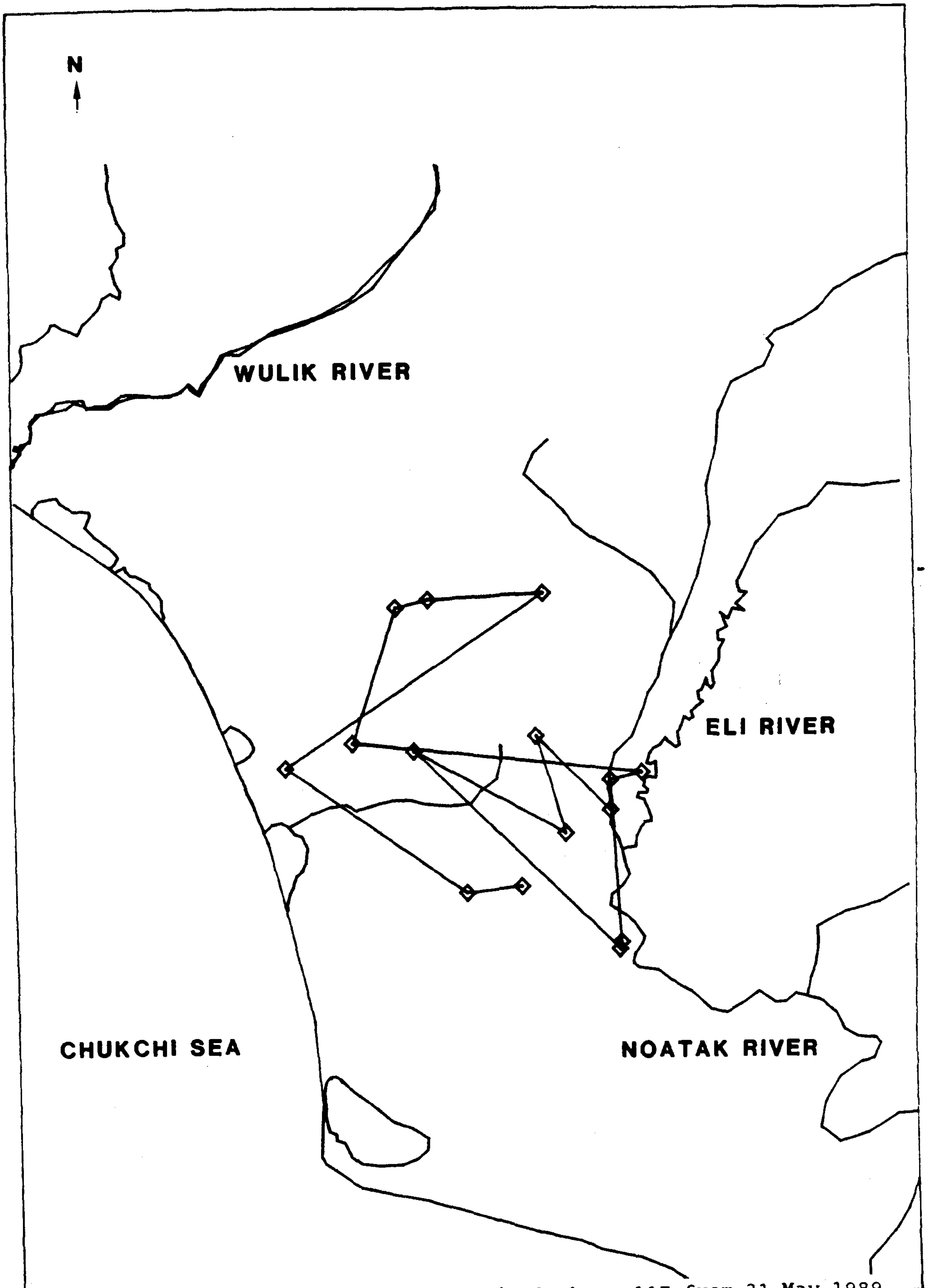

Figure 49. Relocations of female grizzly bear 117 from 31 May 1989 through 20 September 1990 in northwest Alaska using conventional radio telemetry.

SCALE 1:300,000

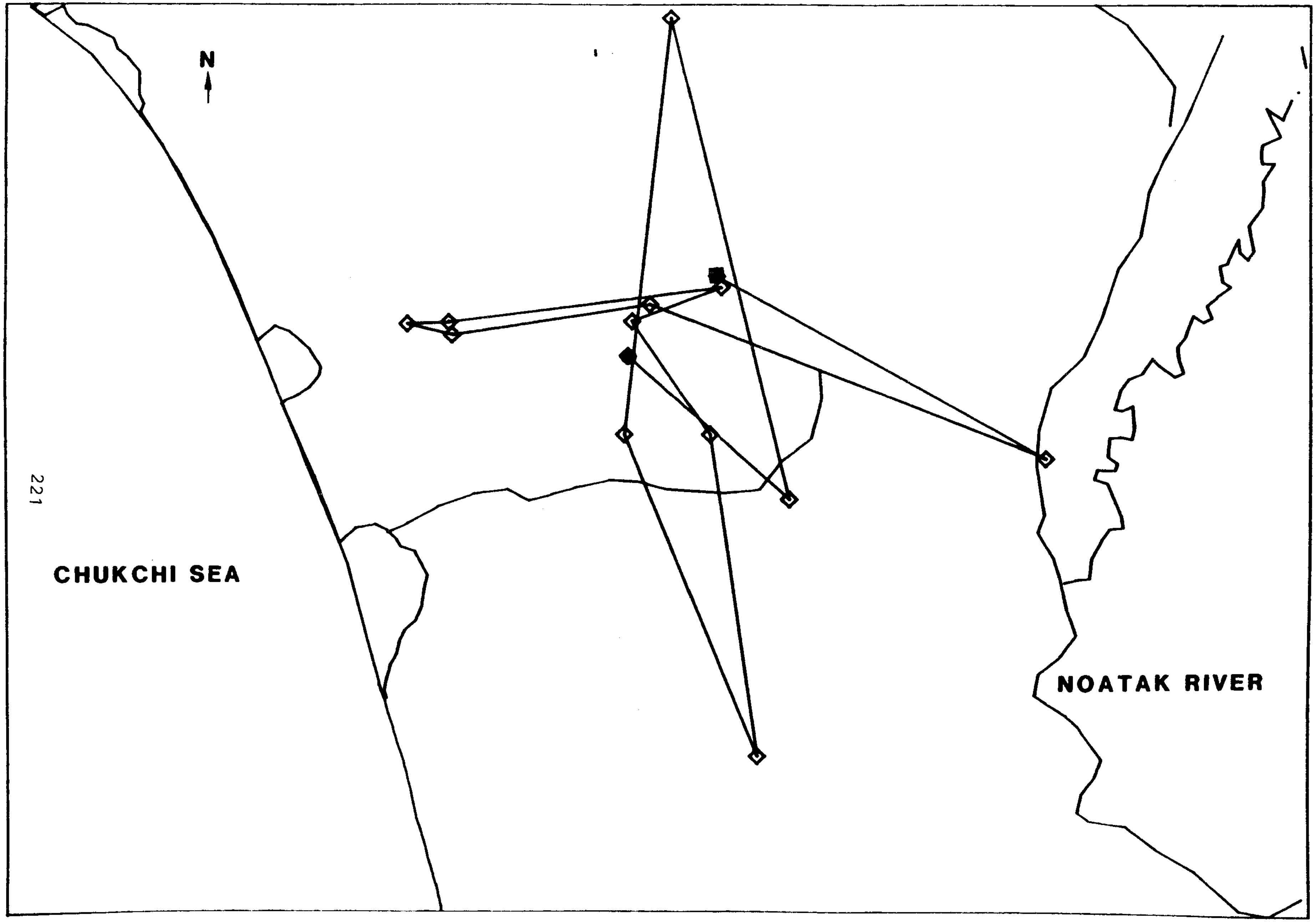

Figure 50. Relocations of female grizzly bear 014 from 17 April through 21 October 1988 in northwest Alaska using conventional radio telemetry.

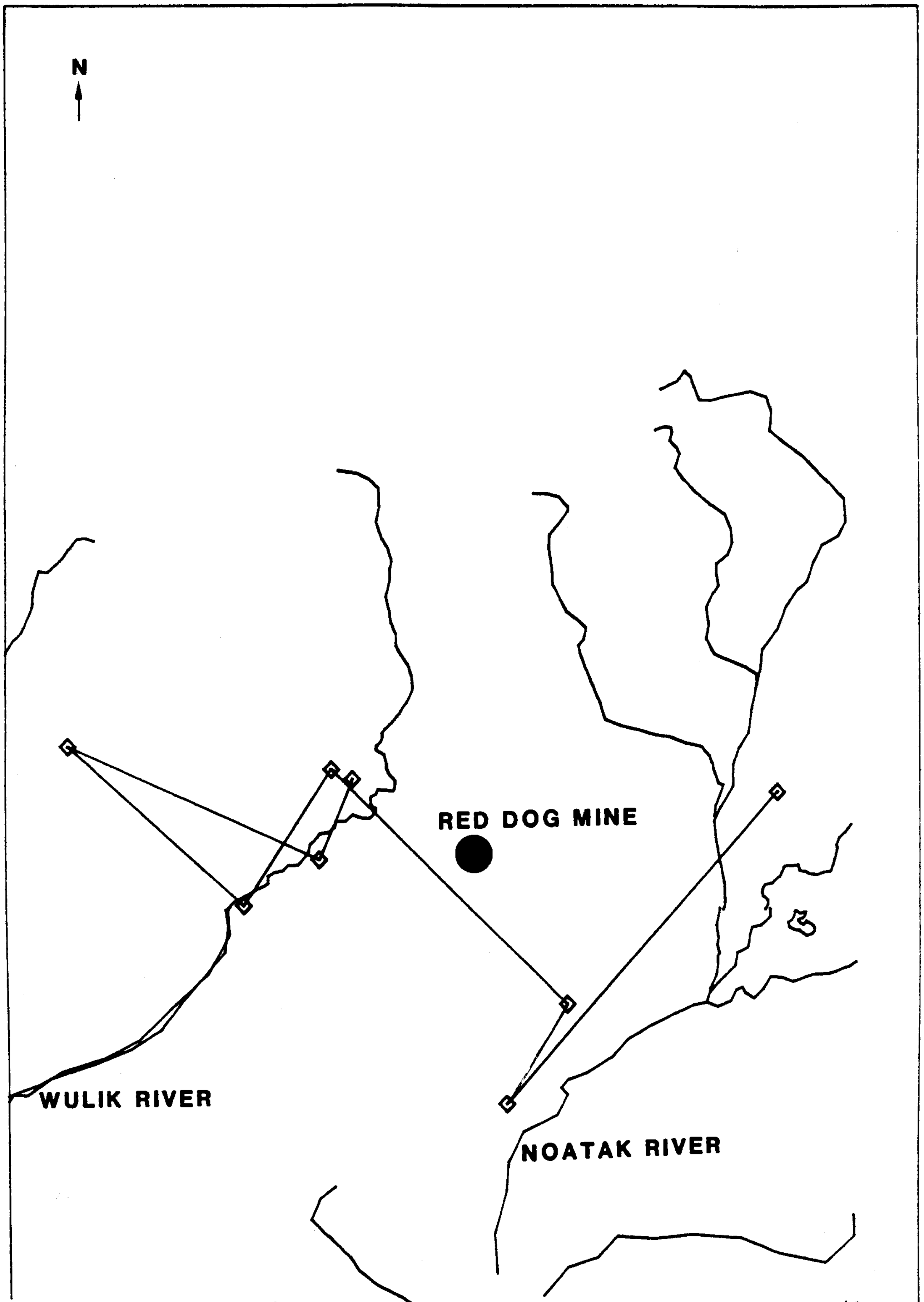

Figure 51. Relocations of female grizzly bear 028 from 30 April 1988 through 21 October 1988 in northwest Alaska using conventional radio telemetry.

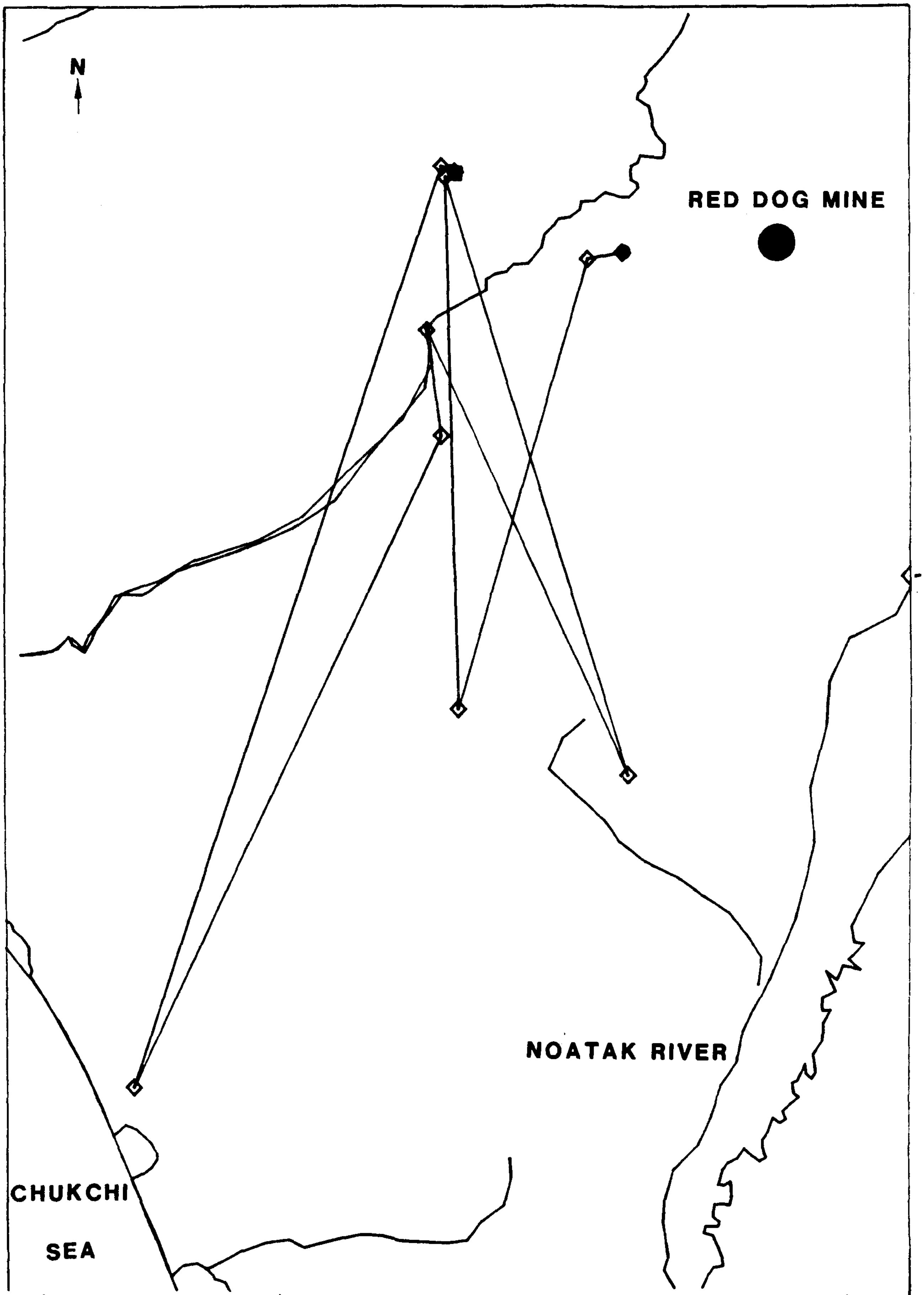

Figure 52. Relocations of female grizzly bear 043 from 18 April 1988 through 21 October 1988 in northwest Alaska using conventional radio telemetry.

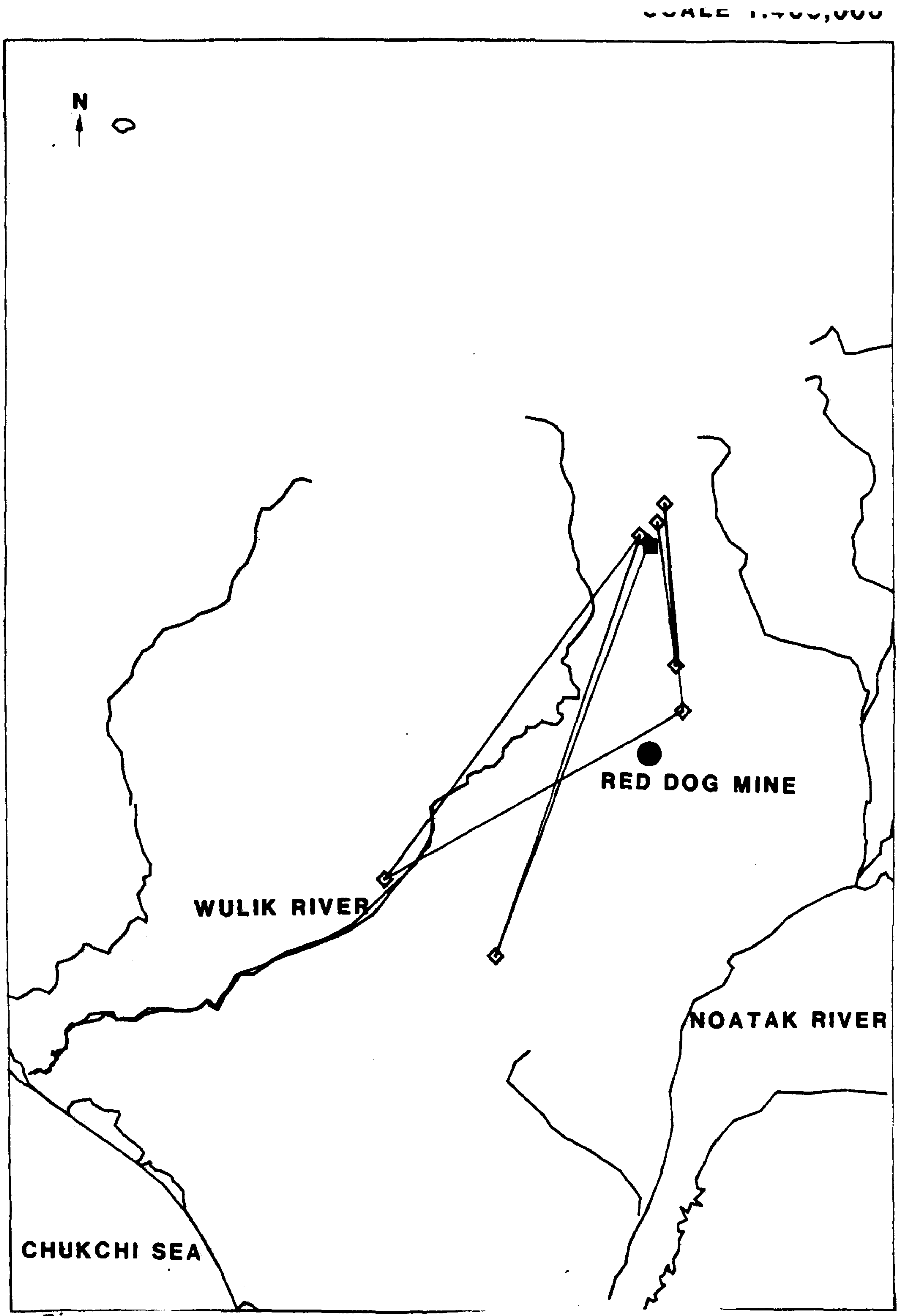

Figure 53. Relocations of female grizzly bear 058 from 18 April 1988 through 21 October 1988 in northwest Alaska.

SCALE 1:250,000

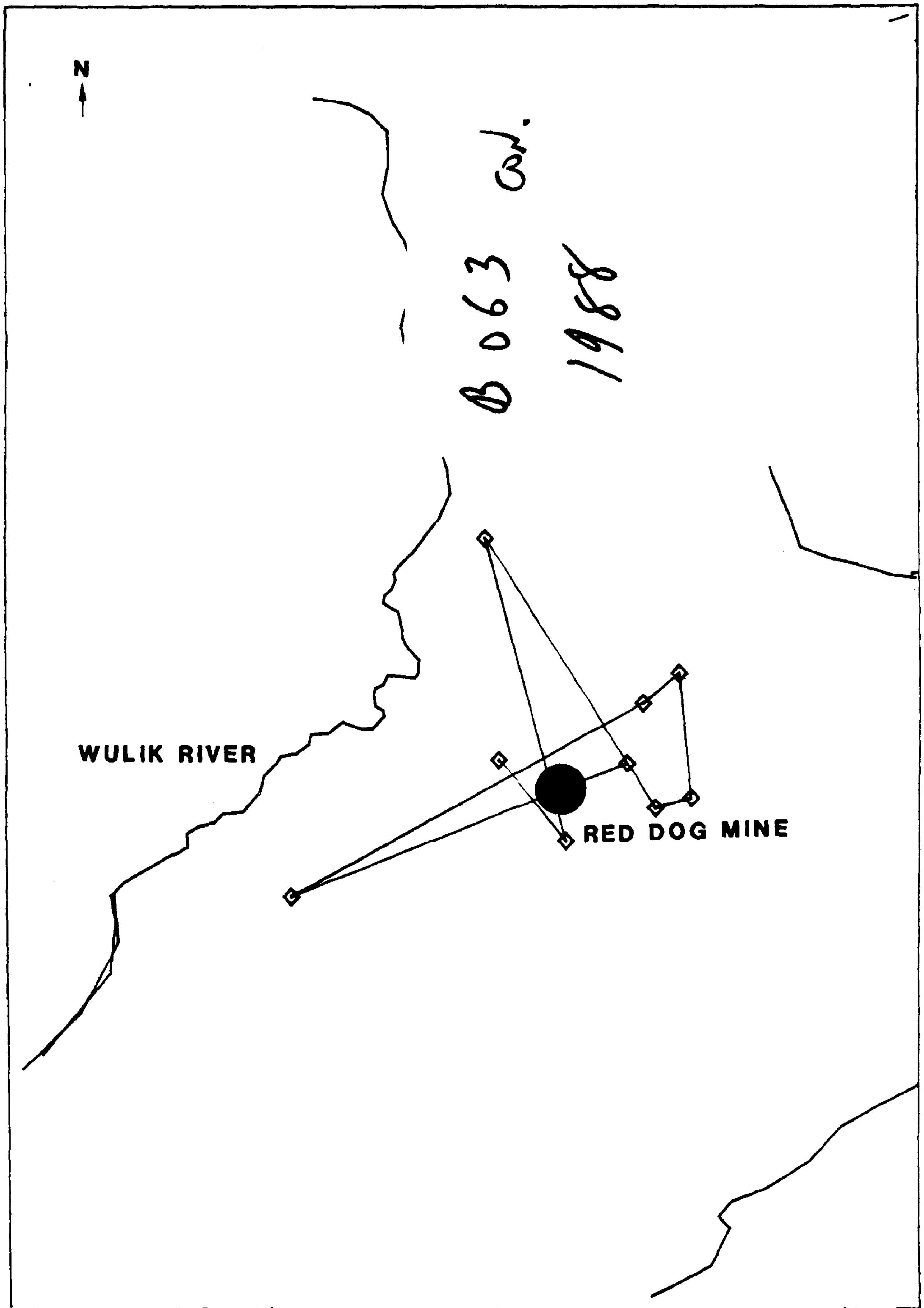

Figure 54. Relocations of female grizzly bear 063 from 17 April 1988 through 22 October 1988 in northwest Alaska using conventional radio telemetry.

SCALE 1:150,000

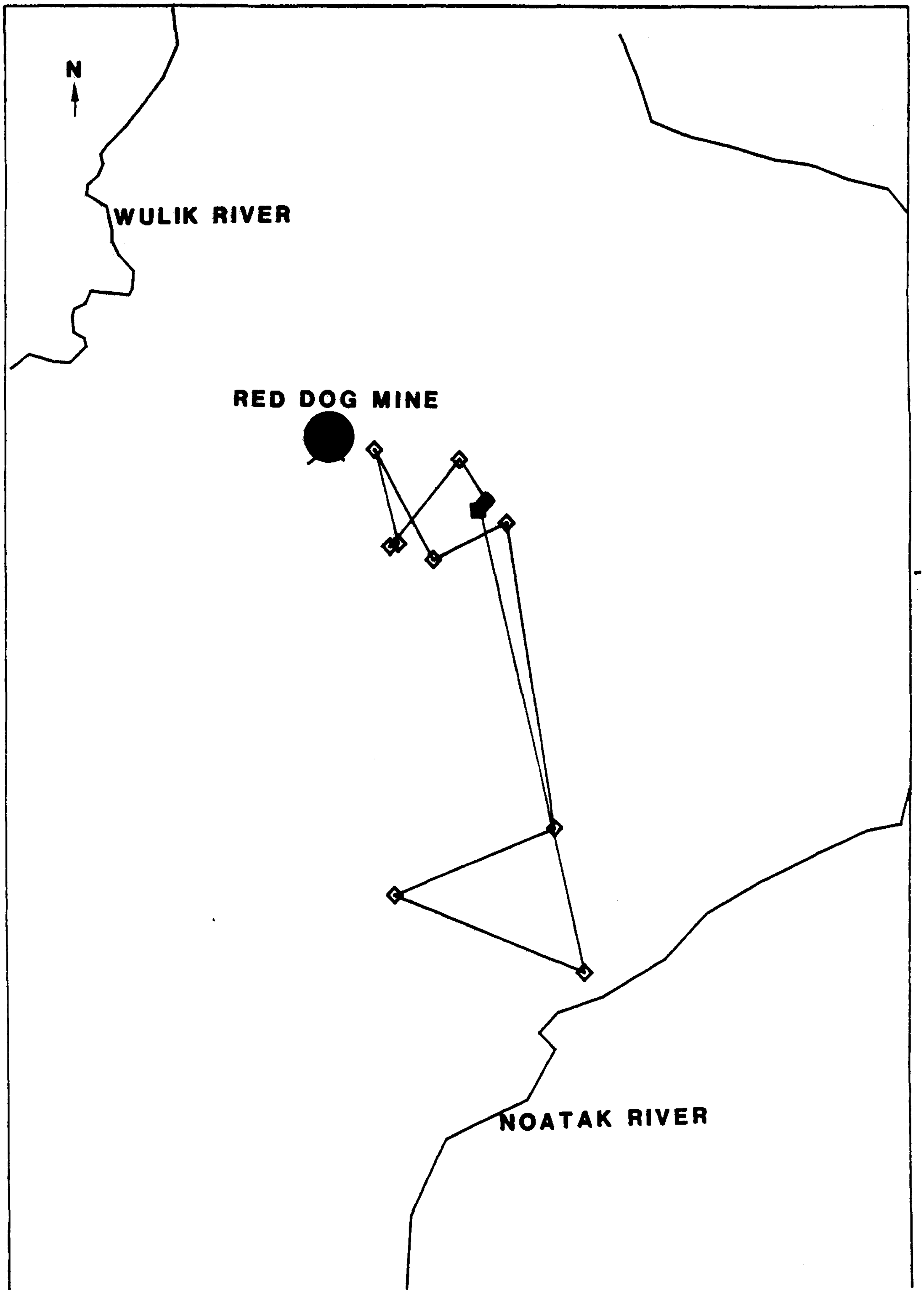

Figure 55. Relocations of female grizzly bear 069 from 17 April 1988 through 22 October 1988 in northwest Alaska using conventional radio telemetry.

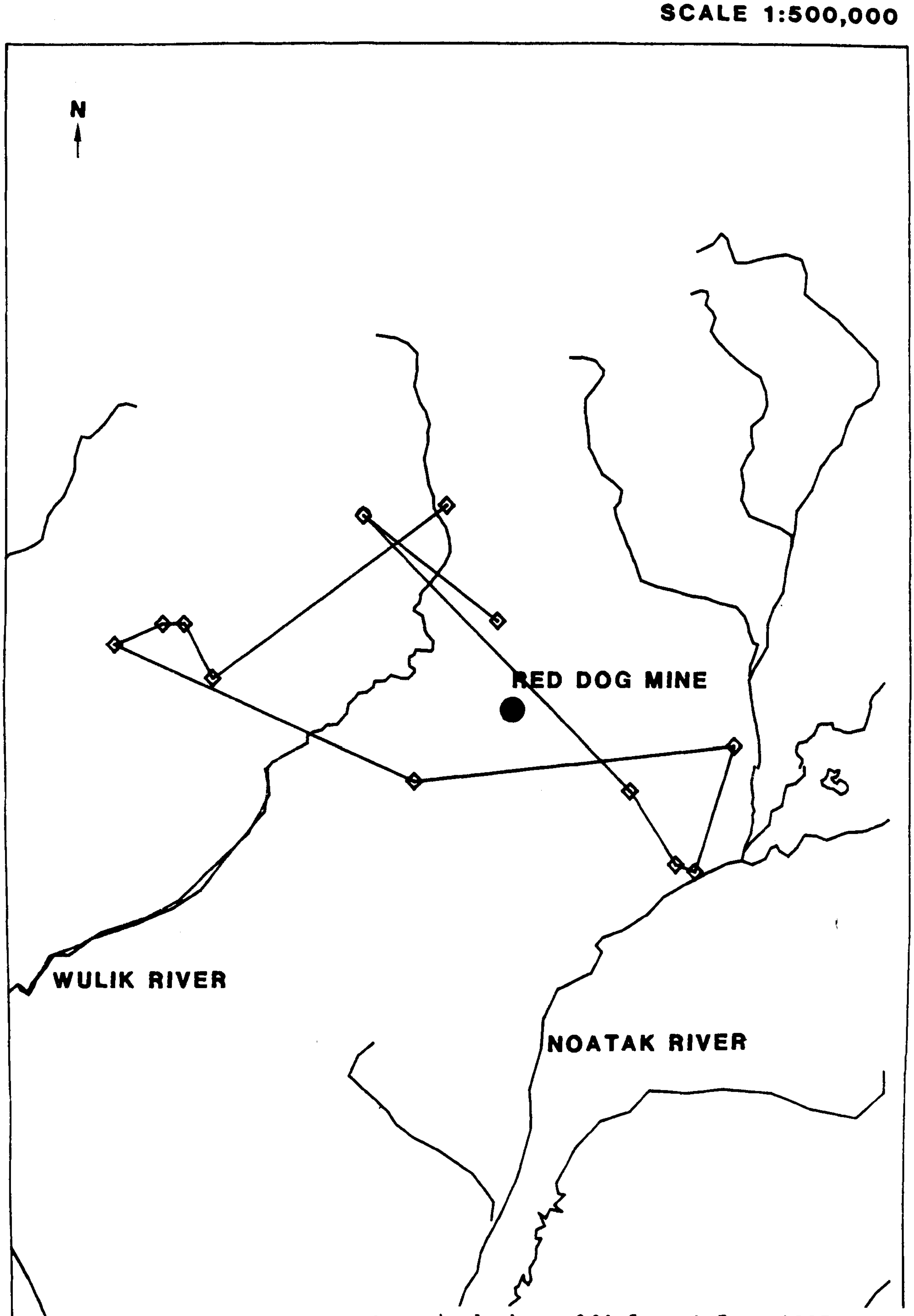

Figure 56. Relocations of male grizzly bear 031 from 4 June 1987 through 16 September 1989 in northwest Alaska using conventional radio telemetry.

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