ASSESSMENT OF THE EXXON VALDEZ OIL SPILL ON BROWN BEARS ON THE ALASKA PENINSULA

TERRESTRIAL MAMMAL STUDY NUMBER 4

FINAL REPORT

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EXECUTIVE SUMMARY

Brown bear populations on the coast of Katmai National Park are susceptible to damage from the Exxon Valdez Oil Spill (EVOS) through bears ingesting oil directly, eating contaminated prey, or scavenging oil contaminated carcasses. Brown bears are long lived animals that are at the top of the food chain. Effects of oil ingestion would be expected to manifest themselves in small increments over long periods of time.

To document the impacts of the EVOS on brown bear populations, this study investigated the survival of radio-collared females, the size and density of the brown bear population along a portion of the Katmai National Park coast, and the concentrations of aromatic and aliphatic hydrocarbons in brown bear fecal samples. Each of these parameters were then compared to similar parameters in a population of brown bears that was not exposed to crude oil.

To date, natural survival of radio-collared female brown bears in the Katmai study area has been approximately 95 percent. The radio-collared females in the Black Lake study area have had a natural survival rate of 93 percent. These survival rates are not statistically different.

Poor weather conditions and leaf emergence permitted only 4 replicates for the density estimate. The estimated density of all brown bears in the Katmai study area was 547 bears/1000 km^2 and in Black Lake the estimated density was 190 bears/1000 km^2. The higher density in the Katmai area can be explained mostly by differences in habitat and a closure on brown bear hunting there since 1931.

Fecal samples from 27 bears from the Katmai area and from 22 Black Lake bears were submitted for hydrocarbon analysis. None of the samples from Black Lake contained concentrations of hydrocarbons indicative of exposure to crude oil. Four of 27 fecal samples from Katmai National contained hydrocarbons that are indicative of exposure to crude oil. A one year old offspring of one of these bears was found dead. Laboratory analysis of bile from this yearling detected high concentrations of aromatic hydrocarbons.

OBJECTIVES

The objectives of this study are the same as those in the Natural Resources Damage Assessment Plan. The objectives are as follows:

1. Test the hypothesis that radio-collared brown bears in an oil contaminated area of the Alaska Peninsula (Katmai coast) ingested hydrocarbons (as evidenced by the level of hydrocarbons in fecal samples) at higher concentrations than radio-collared bears in an area on the Peninsula that was not contaminated (Black Lake).

2. Test the hypothesis that natural mortality rates of female brown bears near oiled areas of the Katmai coast occurred at a higher rate than females in other coastal brown bear populations inhabiting non-oiled areas during a period of three years after the EVOS.

3. Test the hypothesis that some of the natural mortality of brown bears near the Katmai coast can be attributed to the physiological effects of ingesting hydrocarbons.

4. Estimate the adult brown bear population density of the study area (approximately 150 square miles) through a cooperative project with the National Park Service using a modified capture-recapture technique (Miller et al. 1987) with the goal of obtaining a coefficient of variation of 0.10.

5. Identify potential alternative methods and strategies for restoration of lost use, populations, or habitat if injury is identified.

INTRODUCTION

Brown bears (Ursos arctos) are present in much of the coastal area that was impacted by the Exxon Valdez Oil Spill (EVOS). These bears are omnivorous feeders at the top of the food chain, and may have come in contact with oil by eating contaminated plants and animals, by scavenging oiled carcasses such as seabirds that have been washed ashore, by grooming oil from their fur, or perhaps by directly consuming tar balls.

Brown bears are long lived animals that reproduce only every two to six years; the longest reproduction interval of any large North American mammal. Oil ingestion and inhalation may cause physiological problems that lead to decreased reproduction and survivorship in the population over extended periods of time.

Because of the difficulty in measuring the physiological effects of oil ingestion in individual brown bears, this study primarily addresses differences in female survivorship and population density in a bear population from an oiled area (Katmai National Park) and an unoiled area (Black Lake, Miller and Sellers 1990). The exposure of individual bears to petroleum hydrocarbons was measured by collecting fecal samples from bears during capture activities and by collecting tissues from bears that were found dead.

Study Area

Brown bear density was estimated for a portion of the Shelikof Strait coast of Katmai National Park. The study area extended from Amalik Bay on the south to Hallo Bay on the north. It was bordered by Shelikof Strait on the east and the crest of the Aleutian Mountains on the west. This area was subdivided into 6 quadrats for the purposes of allocating search effort. Only quadrats 1-5 (901 km^2) were used in making the density estimate (Fig. 1)

Habitat in the study area included coastal sedge flats at Hallo Bay and Kukak Bay. Dense shrubs, primarily alder (*Alnus crispa sinuata*) dominated the slopes of the mountains; alder and willows (*Salix spp.*) dominated lower elevations. Grass/forb meadows, predominated by blue stem (*Calamagrostis canadensis*), were interspersed with shrub communities on most slopes. Trees were sparse but occasional stands of cottonwood (*Populus balsamifera*) were found at low elevations along the rivers. Snow and ice fields dominated above 3,000 feet elevation. Griggs (1936) and Cahalane (1959) gave early accounts of the vegetation along the coast of Katmai. The Smith and VanDaele (1988) Terror Lake study area had similar vegetation, physiography and climate.

While the Katmai study area had many physical and biological similarities to the Black Lake study area (Fig. 2), several notable differences contributed to the difference in bear densities reported below. The Black Lake area had proportionally much less marine coast line and had none of the heavily used salt marsh community. In addition, approximately 30% of the Black Lake area consisted of the Bering Sea coastal plain dominated by fresh water sedge marsh and ericaceous shrub tundra which did not attract much bear use until after the census period. The Black Lake area has received moderate to heavy bear harvests for the last 25 years while the Katmai study area has been closed to hunting since 1931.

STUDY METHODS

Bears were captured by darting from a helicopter (Hughes 500) and radio-marked during the spring of 1989 and 1990 (prior to density estimate). Permanent radio collars were attached to adult females. On subadults and males, where growth causes permanent collars to become too tight, non-permanent transmitters were attached. This was accomplished by inserting a canvas spacer, designed to rot through within 18 months, into a regular collar, or by gluing a small transmitter to the hair on the bears' back. A total of 28 bears were fitted with radio transmitters in 1989 and 42 in 1990, including 2 recaptures of bears whose transmitters failed in 1989.

Hydrocarbon Analyses

During tagging operations in 1989 at both Black Lake and Katmai National Park, fecal samples were collected from bears according to the U. S. Fish and Wildlife Service protocol for hydrocarbon analysis. Samples were stored in factory cleaned glass jars and frozen as soon as possible after collection. Samples were submitted to the U.S. Fish and Wildlife Service, Anchorage, for laboratory analysis. Stomach contents, brain and bile samples from a yearling bear found dead in Katmai National Park also were submitted.

Those samples were analyzed by Texas A&M University, Geochemical and Environmental Research Group, College Station Texas. Samples were extracted, purified, and analyzed by gas chromatography for aliphatic hydrocarbons and by mass spectrometer for aromatic hydrocarbons (Appendix 1).

Survival Rates

The radio transmitters fitted to females were equipped with a mortality indicating mode. When the animal was motionless for a predetermined period (usually 6 hours) the signal transmitted at a slower interval. When movement occurred (as when the animal was resting and not dead), the signal returned to normal from mortality mode. During monitoring flights, bears whose radios transmitted on mortality mode were visually located to determine if they were dead. If visual location from the air was not possible, a ground search was conducted.

Survival rates were calculated using the Kaplan-Meier technique (Pollock et al. 1989) for 23 radio-collared adult females monitored from June 1989 through May 1990, 38 adult females monitored from May-October 1990, and 32 females monitored from May through October 1991.

Density Estimate

Density was estimated using the general procedure described by Miller et al. 1987 and Miller and Sellers 1990. In brief, this procedure involved replicated searches of the entire study area in fixed-wing aircraft. When bears were seen, telemetry equipment was activated to determine whether the bear was marked (has a functioning radio-transmitter) or unmarked (without a transmitter). If a bear was marked, it's identity, association and location were recorded. Unmarked bears were not captured but estimated sex and age (adult/subadult) and location were recorded. The estimated age of offspring was also recorded. The number of radio-marked bears present in the area searched was independently determined using radio-tracking equipment. During the Katmai density estimate the presence of radio-marked bears was determined by the search planes. Radio-marked bears were not specifically located, but their presence in each quadrat was verified by telemetry signals before, after, or during the searches.

Results are reported for 3 different population components.

1. The number of independent bears refers to the number of bears excluding those offspring still accompanying their mothers (newborns, yearlings, most 2-year-olds, and some 3-year-olds). Females with young were included in this estimation, however, offspring were not. This estimation unit minimizes violation of the assumption that observations are independent of each other.

2. Total number of bears was estimated by assuming that offspring still with their mothers have the same status (marked or unmarked) as their mothers. This requires violating the assumption that observations of members of family groups were independent of each other, since all or none of family groups were usually seen. Simulation studies (Miller 1990) suggest this assumption violation tends to result in underestimation bias.

3. The number of bears >2.0 excludes newborn and yearling offspring still with their mothers but includes 2- and 3- year-olds still with their mothers as having the same status as their mothers. This is also a violation of the assumption that observations are independent; but because there are fewer 2-year-olds than newborns and yearlings, the impact is less than when there are more dependent observations. In making the estimates where families of bears were treated as independent sightings, misidentification of 2- or 3-year old offspring still with their mothers as yearlings or yearlings as older offspring will introduce error. Since unmarked bears were not captured, classification of young bears by age had to be done from the airplane, which

introduced an unknown level of error. This same potential for error existed at Black Lake.

An additional potential source of error is introduced in the estimation of all bears and bears >2.0 by uncertainties about the group size of marked bears that were not seen. The number of marked bears available to be seen is not precisely known if unseen marked females separate from their 2- or 3-year-old offspring during the search period. This is because these offspring are assumed to have the same marked status as their mother. Correspondingly, unnoticed separation would inflate the number of marks considered "present". Also, the separated bears, if seen, would be classified as unmarked bears. Either would result in an over-estimation bias. The magnitude of this potential source of bias was estimated by making independent estimates under the following set of assumptions:

1. Assume the family group was together in all cases where it is uncertain whether this was the case ("maximum" estimate);

2. Assume they were not together in these cases ("minimum" estimate); and

3. Make the most likely guess on whether they were together.

This problem does not exist in the estimate of number of "independent" bears.

Different investigators have proposed a number of different estimators for use with these type of data. Miller et al. (1987) presented a number of estimators and suggested a new estimator ("bear days") based on cumulating for all replicates the values for marked bears present (m_1), marked bears seen (m_2), and total bears seen (n_2) and using these cumulated values in the equations for a single Lincoln-Petersen experiment. Disadvantages with the bear-days estimator were noted by Eberhardt (1990) who recommended using the mean of the Lincoln-Petersen estimates for all replications and calculating the confidence interval based on the sampling variance of these values.

More recently G. White (pers. com. and in prep.) has developed a maximum likelihood estimator and confidence interval based on a binomial extension to the estimator presented by White and Garrott (1990). The extension is necessary when unmarked bears are captured and marked (sampling with replacement). When unmarked bears are not captured, the estimator collapses to that presented by White and Garrott (1990) and Neal (1990). A new parameter is necessary for this estimator (T_i) which was defined here as the total number of marked bears available to be seen based on their presence in the search area at least once during the search period. A marked bear that was never on the search area during the search period would not contribute to T_i but one that was present only once would. When unmarked bears are captured and marked, T_i increased during the study period. When, as in this estimate, unmarked bears are not captured, T_i is a constant over all replications.

STUDY RESULTS

Hydrocarbon Analysis of Tissues

Fecal samples were obtained from 27 bears from the Katmai area and from 22 Black Lake bears. None of the samples from Black Lake contained concentrations of hydrocarbons indicative of exposure to crude oil. Four of 27 fecal samples from Katmai National Park (numbers 27512, 27517, 27518, 27549) contained hydrocarbons that are indicative of exposure to crude oil (Appendix B). These differences in exposure to petroleum hydrocarbons are not statistically different (Chi-square = 1.85, 1 df, $.10 < p < .20$). A one year old offspring of one of these bears (bear 136) was found dead during a radiotelemetry flight. Subsequent analysis of bile from this yearling detected naphthalene and phenanthrene concentrations of 160,000 ppb 18,000 ppb respectively.

Twenty-five of the 27 fecal samples submitted came from bears that were captured on, or within one half mile of the beach. All four bears showing exposure to petroleum hydrocarbons came from this group. This represents an exposure rate to petroleum hydrocarbons of 14.8 percent (4/27) of all bears sampled and 16 percent (4/25) of bears that most likely were on the Katmai beaches during Spring 1989.

Survival Rates

None of the radio-collared adult females in Katmai died during oil year 1, two died during oil year 2, and two died during oil year 3. Evidence at the carcass remains in oil year 2 showed that one had been killed by another bear, and the other had been fed on by a bear but there was not enough of the carcass left to determine how it had died. In both cases, by the time the remains were examined, it was not possible to collect any tissue samples for analysis. In oil year 3 (1991) the specific cause of death was again not determined. In both cases only the skull and a few scattered bones remained. Again, itraspecific aggression was assumed in at least one case due to canine punctures in the remaining skull, a typical sign of fighting.

Thus for oil year 1, the Katmai survival rate was 1.00, for oil year 2 it was 0.95, and for oil year 3 it is 0.95. These natural survival rates are not statistically different than the Black Lake study (Miller and Sellers, 1990) and higher than the Terror Lake study (Smith and VanDaele, 1988) on Kodiak Island. Statistical testing (log-rank test) shows no significant difference (Chi-square = 0.98, 1 df, $.30 < p < .50$) with the adult female survival rate (excluding hunting mortality) of .90 at Black Lake between 1989 and 1990 (Miller and Sellers, 1990). Survival rates in the two study areas between 1989 and 1991 also are not statistically different (Chi-square = .09, 1df, $.75 < p < .80$).

Survival rates for other sex and age cohorts have not been analyzed and are not included under Objective 2. Several other cases of natural mortality have been investigated, but in only one case were we able to collect fresh samples for further chemical and histological analysis. Female #136 had 2 yearlings when she was captured on 13 June 1989. By 27 June 1989 she had lost one of them, and on 30 June she was seen standing by the body of the second yearling. We necropsied the yearling that evening and estimated that it had been dead less than 24 hours. No evidence of any trauma was found, and tissue samples were collected for hydrocarbon analysis. Naphthalene and Phenanthrene concentrations in the bile of this yearling may have been sufficiently high to cause, or at least contribute to the death of this bear. The circumstances in this case rule out any type of accidental or violent death.

Density Estimate

Forty-four bears had functioning transmitters at the time the density estimation phase began. Following the period of marking, 4 fixed-wing aircraft each with a biologist and pilot were available to conduct the searches. Bad weather prevented any searches during the period 23-31 May. It was considered important to accomplish these searches before leaf emergence restricted sightability of bears. By May 31, leaves were well developed, especially on lower, south facing slopes so the census was canceled. The weather improved on June 3 and a single replicate was accomplished using a single airplane. Based on this flight it appeared possible that acceptable results might be obtained even with the high level of leaf emergence and lower than ideal sightability. Correspondingly, 3 more replicates were flown on 5-7 June, each with 2 aircraft. Density was estimated based on these 4 replicate searches. Total time spent looking for bears during these 4 searches was 459, 547, 665, and 593 minutes, respectively.

During these searches it was very difficult to see bears in the shrubby habitats that composed >50% of the study area. Bears were readily visible on the intertidal sedge flats and beaches and this is where most bears were seen. Some bears, especially females with newborn cubs, were seen at higher elevations where leaf emergence occurred later. Occasionally bears were seen in openings in the shrubby overstory.

At the time the density estimation began there were 44 radio-marked bears in the study area, 33 females and 11 males (Table 2). Eighteen of these females were accompanied by a total of 28 offspring (age 0-3) (Table 2). Four bears were radio-marked in 1989 but did not enter the study area during the density estimate in 1990. During the density estimate, the population of marked bears appeared naturally closed. All of the radio-marked bears present at least once were present during all 4 replicate searches and no radio-marked bears moved onto the search area during the search period (Table 2). This means that the value for T_t, total number of individual marked bears present at some time during the density estimation phase, was 62, 44, and 52, respectively, for the estimates of all bears, independent bears, and bears > 2.0. One glue-on radio was shed between replicate 2 and 3, reducing the number of radio-marked bears from 44 to 43.

For each replication, information on the association, presence in the search area, and whether or not a bear was seen, is provided in Table 2. For each replication, summary information on presence and sightings of both marked and unmarked bears is presented in Table 3. The group size of marked females with 2- or 3-year-old offspring that were not seen during the search period is not precisely known because these offspring may have separated from their mothers. To bracket the feasible ranges caused by this uncertainty, the maximum and minimum number of marks present were calculated. This uncertainty does not affect estimates of number of "independent" bears (excluding offspring still with their mothers) but does affect estimates of all bears and bears >2.0 years-old (Table 6).

Minimum Population and Density Estimate

A minimum number of bears known to be present was calculated as the sum of marked bears present and unmarked bears seen. For bears of all ages this minimum number was 142, 162, 182, and 159 for replications 1-4, respectively (Table 3). Based on at least 182 bears present in the study area the minimum density would be 202 bears/1,000 km^2 (523/1,000 mi^2, 1.9 mi^2/bear). The minimum number of independent bears was largest during replication 3: 131 bears seen or known present.

In both cases, the minimum number of bears estimated in this way was significantly less than the lower limit of the 95% CI calculated below. This means that it would not be helpful to truncate the confidence interval at this minimum value.

Capture-Recapture Estimates

Capture-recaptures estimates were calculated in 3 ways. The first way utilized the bear-days estimator described by Miller et al. (1987). The second method utilized the mean of the Lincoln-Petersen estimates calculated for each of the 4 replications. The third method utilized the maximum likelihood estimator described by White and Garrott (1990). Results from all 3 of these estimators are presented here.

In comparison with the Katmai estimate, the density estimate obtained at Black Lake in 1989 was more precise because of more replications (7 instead of 4), higher visibility of bears (43% of independent bears instead of 21%), more intensive search effort (0.9 min/km^2 instead of 0.6), and higher percentage of marked bears in the population (28% of independent bears instead of 12%). Problems with the Katmai estimate would not have existed if weather had permitted the estimate to be conducted as originally planned, before leaves emerged and before temporary transmitters were shed (N=12).

Bear-days Estimates at Katmai and Black Lake.

Using the bear-days estimator, the number of bears (all ages) present on the study area during the search period was 493. The calculated 95% CI around this estimate based on the binomial approximation to the hypergeometric distribution was 394-651. The corresponding density estimate was 547 bears/1,000 km^2 (95% CI = 437-722 bears/1,000 km^2) (Table 5). For independent bears, the estimated density was 407 bears/1,000 km^2 (95% CI = 311-571 independent bears/1,000 km^2) (Table 5). For bears >2.0 the estimated density was 474 bears/1,000 km^2 (95% CI = 368-647 bears >2.0/1,000 km^2).

Comparison data for the Black Lake study area are presented in Table 7. Corresponding density estimates were lower for the Black Lake study during which search conditions were better and a more precise estimate was obtained (Miller and Sellers 1990). At Black Lake, the estimate for bears of all ages was 190 bears/1,000 km^2 (95% CI = 168-219), about 35% of that estimated in Katmai. As a percentage of the 95% CI for the Katmai density estimate, the Black Lake density was 26-43% of that estimated for the Katmai coast. For independent bears, the Black Lake density was estimated at 121 bears/1,000 km^2 ((95% CI = 103-104 bears/1,000 km^2). This density is 30% of that estimated for independent bears on the Katmai coast (21-39% based on the Katmai CI). For bears >2.0, the Black Lake density was estimated at 142 bears/1,000 km^2 ((95% CI = 123-166 bears >2.0/1,000 km^2). This density is 30% of that estimated for bears >2.0 on the Katmai coast (22-39% based on the Katmai CI).

Mean Lincoln-Petersen Estimates at Katmai.

Estimates and confidence intervals based on the mean Lincoln-Petersen estimator (Eberhardt 1990) are presented in Table 8. The mean Lincoln-Petersen density estimate for all bears was 537 bears/1,000 km^2 ((95% CI = 454-621 bears/1,000 km^2), just 2% less than the bear-days estimate of density. For independent bears the mean Lincoln-Petersen estimate was 396 bears/1,000 km^2 ((95% CI = 314-479 bears/1,000 km^2), just 3% less than the bear-days estimate.

The entire range of the 95% CI can be expressed as a percentage of the estimate to compare the relative size of the CIs associated with different estimators. For the estimate of all bears, the CI of the mean Lincoln-Petersen was 31% of the estimate compared to 52% for the bear-days estimator. For the estimate of independent bears the CI of the mean Lincoln-Petersen was 42% of the estimate compared to 50% with the bear-days estimator. Even though the bear-days CI was asymmetric (larger above than below the estimate) and the mean Lincoln-Petersen estimate was symmetric, the entire range of the mean Lincoln-Petersen CI was contained within the bear-days CI. These results suggest that for the Katmai data, the bear-days CI was more conservative than that calculated using the mean Lincoln-Petersen.

Maximum Likelihood Estimates at Katmai.

Estimates using the maximum likelihood estimator and CI described by White and Garrott (1990) are presented in Table 9. The density estimates were similar to the other estimators used but the CI was smaller.

Potential Errors Based on Time of Weaning.

Because leaves were out during the census period it was difficult to verify whether 2- and 3-year old offspring were still with their radio-marked mothers. This influenced the number of "marked" bears available to be resighted in the estimates for bears of all ages and bears >2.0. An attempt was made to verify the family status of radio-marked females immediately following the density estimate but not all bears were seen at this time. Some bears were not seen until mid-summer. The range of likely error introduced by this uncertainty was calculated by assuming that where family status was uncertain, that all families were still together (the "maximum" estimate) and that they were separated in all cases (the "minimum" estimate). A subjective estimate or "best" estimate was also made of whether they were together. The "best" estimate was based both on the estimated age of the young (large or probable 3-year old offspring were assumed more likely to have separated and smaller or 2-year old offspring less likely to have separated at the time the census was conducted) and on the elapsed time between the last observation of the intact family and the census period. The range of results is reported in Table 10. For the bear-days estimator, the minimum estimate was <4% smaller than the best estimate for both all bears and bears > 2.0; the maximum estimate was about 15% higher. Similar results were found for the mean Lincoln-Petersen estimate except the maximum estimate was 38% higher than the best estimate for bears >2.0 (Table 10).

DISCUSSION

Hydrocarbon Analysis

Approximately 15 percent (4/27) of bears captured in Katmai National Park were exposed to crude oil. None of the bears (0/22) in the Black Lake sample was exposed. High concentrations of aromatic hydrocarbons were found in the bile of a yearling bear that was found dead in Katmai National Park. Laboratory analysis of fecal samples showed that the mother of this bear had been exposed to crude oil.

Razor clams from the Alaska Peninsula coast, upon which bears are known to feed, have been collected for hydrocarbon analysis under Fish/Shellfish study #13. The duration or extent of exposure to oil through razor clams is still undetermined as hydrocarbon results from Fish/Shellfish study #13 are not yet available (Charles Trowbridge, ADF&G Cordova, pers. com.).

The physiological implications of oiling at the concentrations detected in fecal samples of Katmai brown bears remains unanswered. Oil has been detected other tissues of other species, however, sampling of most of those tissues required killing the animal. Studies of other mammals are critical for extrapolation of oil concentrations detected in feces to associated physiological problems. To date, those studies have not been conducted. Terrestrial Mammal Study #6 - Influence of Hydrocarbons on Reproduction of Mink - was the type of study that would provide the types of information necessary for extrapolation from feces concentrations to physiological effect. Fecal samples from mink that were fed known dosages of crude oil remain unanalyzed. Without that information, extrapolation from other tissues to physiological effect is necessary.

Concentrations of naphthalenes and phenanthrenes in the bile of harbor seals in which histological abnormalities were detected ranged from 2,200 ppb to 360,000 ppb. This is significantly higher than the 12 to 99 ppb found in brown bear fecal samples. The bile of the yearling of bear 136 contained concentrations of naphthalenes and phenanthrenes commensurate with oil induced damage in harbor seals.

Histologically detected abnormalities in harbor seals include mild rhabdomyolosis (degeneration of muscle cells) of the nostrils, acanthosis and hyperkeratosis of the skin (dry, scaly, thickened skin) and intramyelinic edema. Intramyelinic edema occurs when there is swelling within the myelin sheaths of the nerve axons. The myelin is rich in lipids, and this may attract toxic, fat-soluble hydrocarbons.

Survival Rates

Mortality within the Katmai study area is occurring at a rate that is not different from mortality at Black Lake. Because bears are long lived, it is possible that the effects of oil ingestion would be of a chronic, low-level nature. Continued monitoring of radio-collared females may detect small differences in survival as they accumulate over time. Currently, 17 female bears carry active radio transmitters. All other radios have been shed or removed. A proposal to collar additional bears in Katmai National Park and monitor the remaining 17 bears has been submitted to an alternative funding source.

Density Estimate

The density of bears in the study area of Katmai National Park is greater than both the Black Lake and the Terror Lake study areas. Because of the rich coastal habitat and the closure of Katmai National Park to hunting, this higher density of brown bears is not unexpected. It is possible that the density of brown bears in Katmai National Park was even greater before the EVOS, however, since observed bear mortality appears to be normal, and bears did not appear to be physiologically stressed, no immediate effects were detected.

CONCLUSIONS

Brown bears were observed with oil in their fur, consuming oiled carcasses, and presumably feeding on razor clams in the intertidal area.

Hydrocarbon exposure was documented, and the death of a yearling bear whose mother had been exposed to oil was likely attributable to hydrocarbon exposure.

Survival of radio-collared females in Katmai National Park was 95 percent versus 93 percent at Black Lake. These percentages are not statistically different.

Brown bear density in Katmai Natinal Park is substantially higher than in most places in Alaska. The density estimate conducted in this study had confidence intervals that made documenting a change in density as a result of the oil spill unrealistic unless massive mortality ocurred.

Methods used to document damage to the brown bears were certainly suboptimal. Fecal samples are a very poor tissue from which to measure hydrocarbon exposure, however, other tissues usually require killing the animal. Laboratory analysis using tissues that can be obtained without killing the animal (blood cell or blood serum effects, Vanadium in hair samples, muscle cores) should be investigated.

One opportunity for measuring the impact of the EVOS on the Katmai bears probably rests with continued monitoring of the population. Small incremental changes that have not yet been detectable during the study, may be detectable as these changes accumulate.

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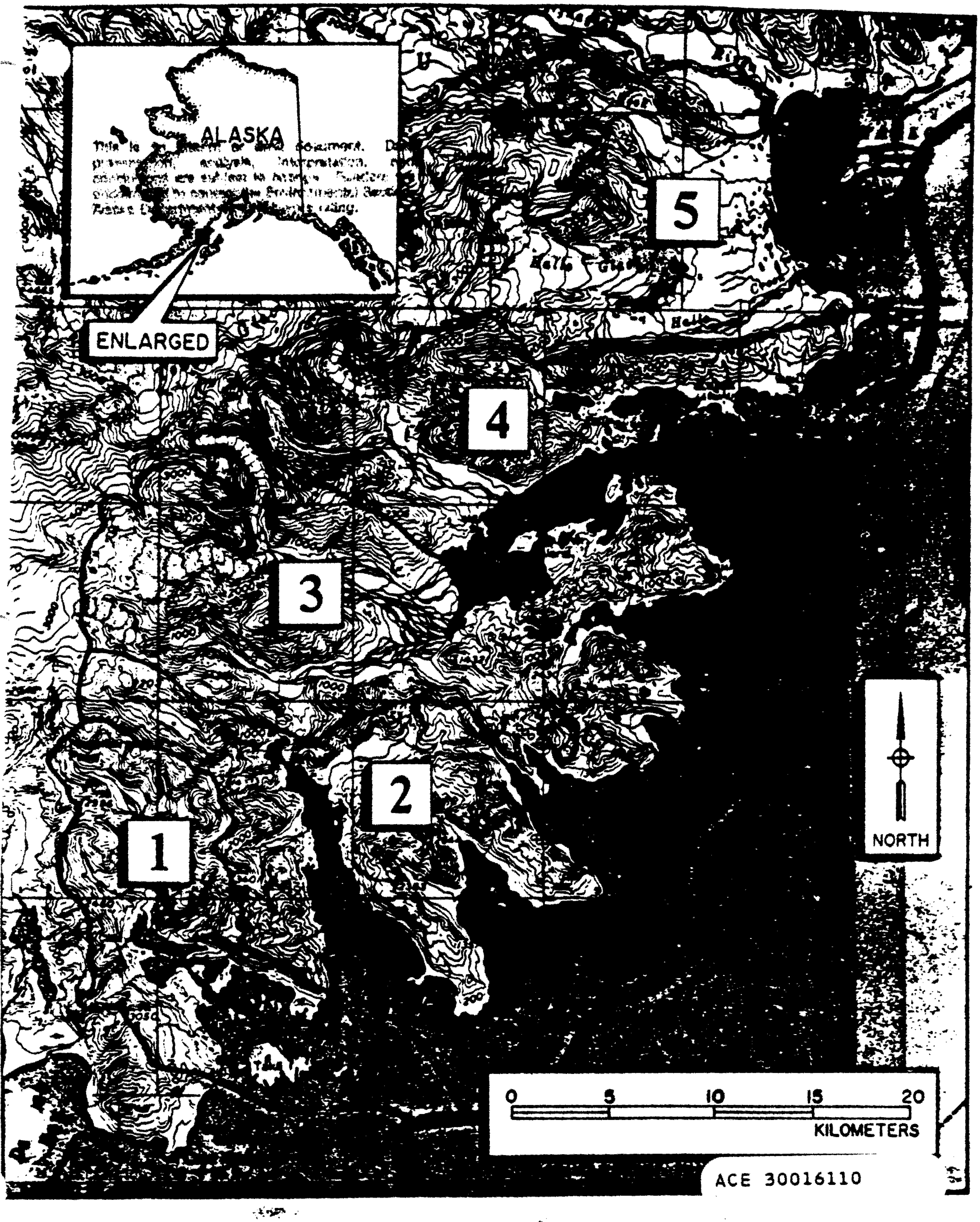

Figure I. Katmai National Park study area and location of quadrats used to estimate brown bear density during Spring 1990

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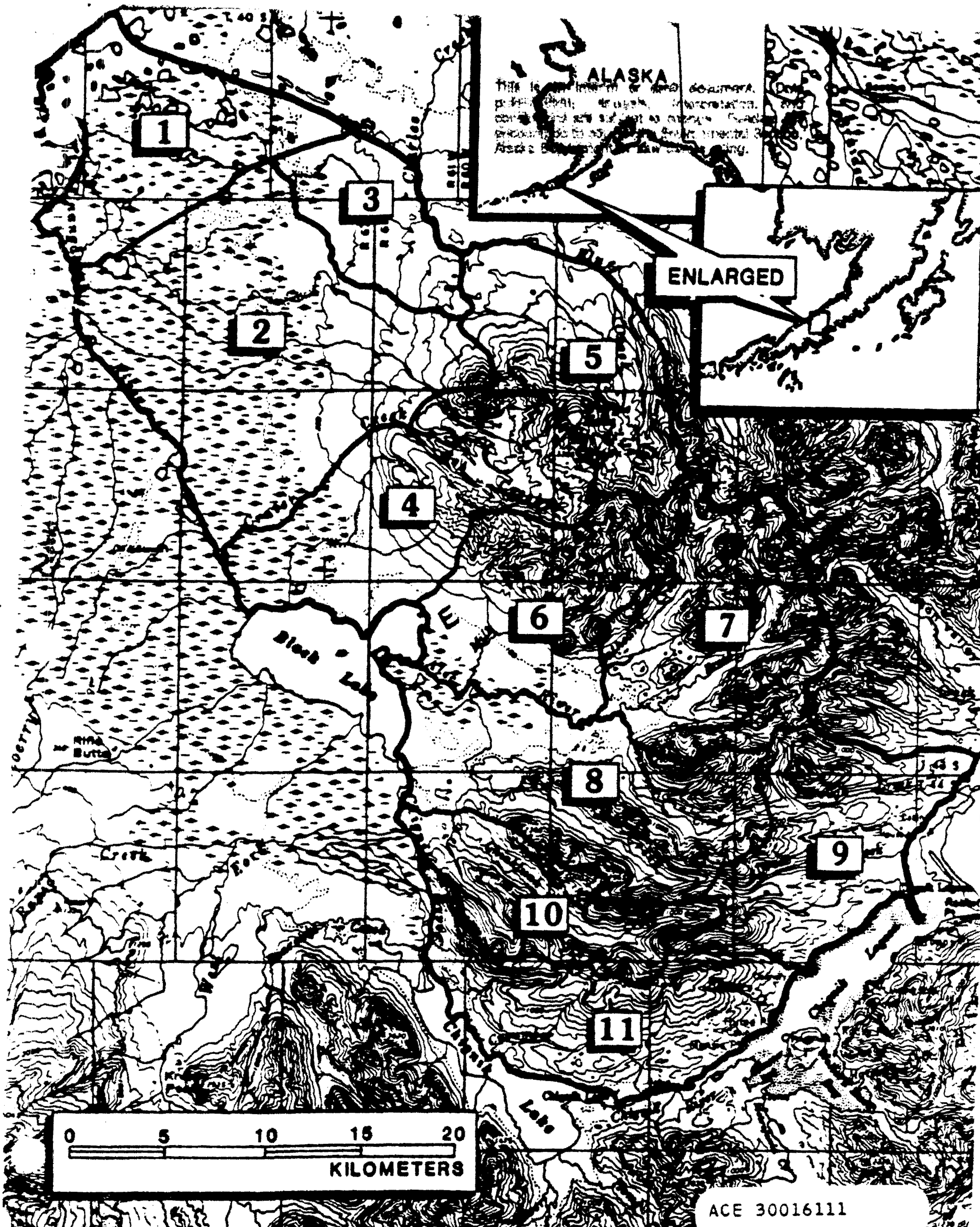

gure 2. Black Lake study area and location of quadrats used to estimate brown bear density during

Table 1. Brown bear capture data, Katmai Coast, 1989.

ID	Sex	Age	Capture Location	Weight	Capture Date	Ear Tags Left	Ear Tags Right	C*	Radio Collar Type	Collar Flag Color	Per Cent HB	Per Cent PCV	Samples Hair	Samples Feces	Comments
101	M	4	SWIKSHAK	400	5/31/89	42	41	R	CANVAS	RED	14.2	41.0	Y	Y	ALONE
102	M	7	SWIKSHAK	800	5/31/89	2509	2651	R	NONE	NONE	16.5	45.0	Y	Y	WITH UNCAP. FEMALE
103	M	3	SWIKSHAK	275	5/31/89	51	55	R	CANVAS	RED	13.9	41.0	Y	Y	ALONE
104	F	13	HALLO	430	5/31/89	53	54	W	REG	WHITE	15.0	43.0	Y	Y	WITH 105
105	M	14	HALLO	750	5/31/89	2641	95	R	NONE	NONE	17.0	45.0	Y	N	WITH 104
106	F	5	KINAK	400	6/4/89	99	95	Y	REG	YELLOW	16.2	48.0	Y	Y	WITH 107
107	M	12	KINAK	800	6/4/89	39	40	R	NONE	NONE	16.5	48.5	Y	N	WITH 106 FEMALE
108	F	4	KUKAK RIVER	250	6/4/89	3088	3086	Y	REG	YELLOW	16.7	48.5	Y	N	WITH LARGE MALE
109	M	6	KUKAK	430	6/4/89	2634	2628	R	CANVAS	RED	16.0	46.5	Y	Y	ALONE
110	M	6	KUKAK	375	6/4/89	47	48	R	CANVAS	RED	14.6	42.0	Y	Y	ALONE
111	F	9	AMALIK	300	6/5/89	3066	3208	Y	REG	YELLOW	15.9	46.5	Y	Y	W/2a2
112	F	12	AMALIK	400	6/5/89	3098	86	Y	REG	YELLOW	14.3	41.0	Y	Y	W/2a1
113	F	19	AMALIK	350	6/5/89	NONE	300	Y	REG	YELLOW	NA	NA	N	N	W/2a2 RECAP
114	F	9	AMALIK	375	6/5/89	262	253	Y	REG	YELLOW	13.8	37.5	Y	N	W/2a0
115	F	3	AMALIK	325	6/5/89	3001	3097	Y	REG	WHITE	15.0	42.0	Y	Y	WITH MALE
116	M	3	KUKAK	350	6/5/89	83	72	R	CANVAS	RED	16.2	48.0	Y	Y	ALONE
117	F	6	KUKAK	325	6/5/89	3298	3031	Y	REG	YELLOW	13.8	41.0	Y	Y	ALONE
118	F	9	KUKAK	300	6/5/89	265	266	Y	REG	YELLOW	17.6	48.5	Y	Y	WITH 119
119	M	12	KUKAK	800	6/5/89	46	93	R	NONE	NONE	17.7	50.0	Y	Y	WITH 118
120	F	7	HALLO	400	6/5/89	256	260	Y	REG	YELLOW	14.5	41.5	Y	Y	W/1a2
121	M	3*	HALLO	350	6/5/89	2638	2685	R	CANVAS	RED	13.6	39.0	Y	Y	ALONE
122	M	3	HALLO	200	6/5/89	61	2640	R	CANVAS	RED	15.5	43.0	Y	Y	ALONE
123	F	11	HALLO	350	6/5/89	3039	3050	Y	REG	YELLOW	15.0	40.0	Y	N	W/1a0
124	F	8*	KUKAK	400	6/5/89	3051	3029	Y	REMOVED	N/A	NA	NA	N	N	W/MALE
125	M	8	KINAK	500	6/6/89	2644	2669	R	NONE	NONE	16.5	49.0	Y	Y	ALONE
126	F	5	MISSAK	300	6/6/89	257	259	Y	REG	WHITE	15.6	44.5	Y	Y	W/MALE
127	F	3*	MISSAK	225	6/6/89	3003	3030	Y	CANVAS	YELLOW	18.7	49.5	Y	Y	ALONE
128	F	15	MISSAK	350	6/6/89	3285	3028	Y	REG	YELLOW	14.5	39.5	Y	N	W/1a1
129	F	16	MISSAK	440	6/6/89	267	272	Y	REG	UNK	12.5	35.5	Y	Y	W/2a2
130	F	10	MISSAK	300	6/6/89	3210	3041	Y	REG	UNK	16.5	47.5	Y	N	W/1a1

Table 1. (cont.)

ID	Sex	Age	Capture Location	Weight	Capture Date	Ear Tags Left	Ear Tags Right	C*	Radio Collar Type	Collar Flag Color	Per Cent HB	Per Cent PCV	Samples Hair	Samples Feces	Comments
131	F	9	CAPE GULL	350	6/6/89	3057	3096	Y	CANVAS	NONE	10.2	29.0	Y	Y	ALONE
132	F	11	KAFLIA	375	6/6/89	3038	3021	Y	REG	NONE	15.9	44.0	Y	N	W/MALE
133	F	7	KULIAK	430	6/6/89	271	251	Y	BLACK	YELLOW	16.7	45.5	Y	Y	ALONE
134	F	4	KUKAK	200	6/6/89	3280	3069	Y	CANVAS	NONE	13.9	39.0	Y	Y	ALONE
135	F	6	CAPE GULL	325	6/6/89	100	3014	Y	CANVAS	YELLOW	16.3	47.0	Y	N	W/2@1
136	F	8	SWIKSHAK	400	6/13/89	3073	3035	Y	NONE	YELLOW	14.6	45.0	Y	Y	W/2@1
127	F		NISSAK	375	5/21/90	RECAPTURE			REG	NONE	17	50	Y	N	ALONE
135	F		CAPE GULL	325	5/19/90	RECAPTURE			REG	NONE ?	13.8	36.4	Y	N	ALONE
137	M	15	KUKAK	950	5/19/90	345	346	R	GLUE		NA	NA	Y	N	ALONE
138	M	13	KUKAK	550	5/19/90	303	205	R	GLUE		15.5	45.7	Y	N	ALONE
139	M	4	KUKAK	250	5/19/90	211	306	R	GLUE		15	44.2	Y	N	ALONE
140	M	8	KUKAK		5/19/90	207	222	R	CANVAS	ORANGE	15.3	42	Y	N	ALONE
141	M	25	KUKAK	850	5/19/90	327???		R	GLUE		16	47.5	Y	N	ALONE
142	M	15			5/19/90	181	197	Y	GLUE		15	41.5	Y	N	ALONE
143	F	26		300	5/19/90	185	177	Y	REG	WHITE	14.8	44.1	Y	N	W/2@2
144	M	3			5/19/90	307	309	R	CANVAS	RED	15	43.6	Y	N	ALONE
145	F	11		325	5/19/90	183	396	Y	REG	WHITE	16.7	48.3	?	N	W/#146
146	M	17		950	5/19/90	201	202	R	GLUE		11	29.1	Y	N	W/#145
147	M	11	AMALIK	750	5/20/90	394	388	R	CANVAS	ORANGE	13.3	????	Y	N	ALONE
148	F	6	AMALIK	275	5/20/90	156	151	Y	HEAVCAN	WHITE	13	36	Y	N	ALONE
149	M	15	KAFLIA	750	5/20/90	341	333	R	GLUE		10.5	26	Y	N	ALONE
150	M	14	CAPE GULL	950	5/20/90	304	311??		GLUE		18	45	Y	N	ALONE
151	F	3	KAFLIA	250	5/20/90	393	383	Y	CANVAS	WHITE	14.5	45.8	Y	N	ALONE
152	M	18		1000	5/20/90	221	301	R	GLUE		NA	NA	Y	N	ALONE
153	M	8	CAPE GULL	550	5/20/90	219	220	R	GLUE	????	14	41.7	Y	N	ALONE
154	F	18		325	5/20/90	400	176	Y	REG	WHITE	NA	NA	Y	N	W/1@ 2 OR 3
155	M	2	N OF KULIAK	225	5/20/90	334	332	R	CANVAS	RED	13.3	37.4	Y	N	ALONE
156	M	19	KAFLIA	850	5/20/90	225	215	R	GLUE		14.5	35.3	Y	N	UNCAP. FEMALE
157	M	8	KINAL	450	5/20/90	314	313	R	CANVAS	RED	14	47.8	Y	N	UNCAP. SMALL FEMALE
158	M	4		250	5/20/90	316	319	R	CANVAS	RED	13.5	????	Y	N	ALONE
159	F	11	KULIAK	275	5/20/90	397	180	Y	REG	WHITE	14.8	45.1	Y	N	W/1@1

Table 1. (cont.)

ID	Sex	Age	Capture Location	Weight	Capture Date	Ear Tags Left	Ear Tags Right	C*	Radio Collar Type	Collar Flag Color	Per Cent HB	Per Cent PCV	Samples Hair	Samples Feces	Comments
160	F	18			5/20/90	31	29	Y	REG	WHITE	14.3	28.4	?	N	W/1@2
161	F	9		300	5/21/90	46	36	Y	REG	WHITE	15.5	50	Y	N	W/2@2 OR 3
162	M	4	KINAK	400	5/21/90	370	365	R	CANVAS	RED	17	51.7	Y	N	W #163
163	F	4	KINAK		5/21/90	420	409	Y	HEAV CAN	WHITE	15	41.4	Y	N	W #162
164	F	4		*300	5/21/90	392	394	W	HEAV CAN	WHITE	16.5	50.9	Y	N	W/1 SUB AD
165	M	11			5/21/90	213	214	R	GLUE		14.5	43.1	Y	N	ALONE
167	M	2		175	5/21/90	340	343	R	GLUE		14	46.6	Y	N	KILLED BY ANOTHER BEAR
168	F	3	KINAK		5/21/90	26	27	Y	CANVAS	????	12.5	34.5	Y	N	W/1 SUB ADULT
169	F	12		375	5/21/90	176	416	Y	WHITEREG	WHITE	17.3	51.7	Y	N	W/1@2
170	M	8			5/21/90	355	351	R	GLUE		15.5	44.8	Y	N	MALE NEARBY
171	F	20		500	5/21/90	041	033	Y	REG	WHITE	16.4	49.1	Y	N	ALONE
172	F	9			5/21/90	049	045	Y	REG	WHITE	15	44.8	Y	N	W/2@1
173	F	12		400	5/21/90	158	174	Y	REG	WHITE	14.5	44	Y	N	W/2@2
174	F	15	HIDDEN HARBOR		5/21/90	408	407	Y	REG	WHITE	16	49.1	Y	N	W/#175 BECHAROF 09-84
175	M	9		750	5/21/90	391	376	R	GLUE		NA	NA	Y	N	W/#174
176	M	12		575	5/22/90	352	359	R	HEAV CAN	ORANGE	18.5	47	Y	N	ALONE
177	F	6		325*	5/22/90	187	190	Y	GLUE/CAN	NA	15.8	44.8	Y	N	ALONE
178	F	20	KUKAK	450	6/12/90	270	268	Y	REG	NONE	NA	SERA ONLY	Y	N	W/2@1

* ear tag color: y=yellow, r=red

This is an interim or draft document. Data presentation, analysis, interpretation, and conclusions are subject to change. Readers are encouraged to contact the Environmental Section, Alaska Department of Law before citing.

Table 2. Status of marked brown bears during density estimation on Katmai coast, 1990. Data on group size referes to females with dependent young; other types of groups are indicated as (p) for breeding pair or (s) for apparent siblings.

ID	SEX	AGE	YOUNG INT. NO.	YOUNG EST. AGE	REP.1 (6/3) STAT.	REP.1 GROUP SIZE	REP.1 SEEN?	REP.2 (6/5) STAT.	REP.2 GROUP SIZE	REP.2 SEEN?	REP.3 (6/6) STAT.	REP.3 GROUP SIZE	REP.3 SEEN?	REP.4 (6/7) STAT.	REP.4 GROUP SIZE	REP.4 SEEN?	# OUT	# IN	# SEEN	% IN	% SEEN	FINAL FAMILY STATUS
104	F				IN			IN			IN			IN			0	4		100	0	
106	F		1	0	IN	1?		IN	1?		IN	1?		IN	1?		0	4		100	0	W/AD MALE ON 6/8
108	F				IN	(P)	YES	IN			IN			IN			0	4	1	100	25	
111	F		2	3	IN	1?		IN	1?		IN	1?		IN	1?		0	4		100	0	W/AD MALE ON 6/8
113	F		3	0	IN	4		IN	4		IN	4		IN	4		0	4		100	0	W/3 COY ON 6/8
114	F		2	1	IN	3	YES	IN	3		IN	3		IN	3		0	4	1	100	25	W/2 @ 1 ON 6/8
117	F		1	0	IN	2		IN	2		IN	2	YES	IN	2	YES	0	4	2	100	50	W/1 COY ON 6/7
118	F				IN			IN			IN			IN			0	4		100	0	
120	F		1	3	IN	2		IN	2	YES	IN	2	YES	IN	(P)	YES	0	4	3	100	75	W/AD MALE ON 6/7
121	M				OUT			OUT			OUT			OUT			4	0		0	ERR	
123	F		3	0	OUT			OUT			OUT			OUT			4	0		0	ERR	
126	F				IN			IN	(P)	YES	IN			IN			0	4	1	100	25	
127	F				IN			IN			IN			IN			0	4		100	0	
128	F				IN	(P)	YES	IN			IN			IN			0	4	1	100	25	
129	F		2	3	IN	1?		IN	1?		IN	1?		IN	1?		0	4		100	0	ALONE ON 7/11
130	F		1	2	IN	2		IN	2		IN	2		IN	2		0	4		100	0	W/1 @ 1 ON 6/8
132	F		1	0	IN	2		IN	2		IN	2		IN	2		0	4		100	0	W/1 COY ON 6/12
133	F		LOST COY		IN	1	YES	IN	(P)	YES	IN			IN			0	4	2	100	50	ALONE BY 6/3
134	F				IN			IN			IN			IN			0	4		100	0	
135	F		2	2	IN	1?		IN	(P)	YES	IN	(P)	YES	IN			0	4	2	100	50	W/AD MALE ON 6/5
136	F				OUT			OUT			OUT			OUT			4	0		0	ERR	
139	M				IN			IN		YES	IN		YES	IN		YES	0	4	3	100	75	
140	M				IN			IN			IN			IN		YES	0	4	1	100	25	
143	F		2	2	IN	1?		IN	(P)	YES	IN			IN			0	4	1	100	25	W/AD MALE ON 6/5
144	M				IN			IN			IN			IN			0	4		100	0	
145	F				IN			IN			IN			IN			0	4		100	0	
146	M				IN			IN	(P)	YES	IN	(P)	YES	IN	(P)	YES	0	4	3	100	75	
147	M				OUT			OUT			OUT			OUT			4	0		0	ERR	
148	F				IN			IN			IN			IN			0	4		100	0	

Table 2. Cont.

			YOUNG		REP.1 (6/3)			REP.2 (6/5)			REP.3 (6/6)			REP.4 (6/7)								FINAL
			INT.	EST.	GROUP			GROUP			GROUP			GROUP			#	#	#	%	%	FAMILY
ID	SEX	AGE	NO.	AGE	STAT.	SIZE	SEEN?	STAT.	SIZE	SEEN?	STAT.	SIZE	SEEN?	STAT.	SIZE	SEEN?	OUT	IN	SEEN	IN	SEEN	STATUS
151	F				IN			IN			IN			IN			0	4		100	0	
153	M				IN			IN			DROPPED			DROPPED			0	2		103	0	
154	F		1	2	IN	2		IN	2		IN	2	YES	IN	2		0	4	1	100	25	TOGETHER 6/6
155	M				IN			IN			IN			IN			0	4		100	0	
157	M				IN			IN	(P)	YES	IN			IN			0	4	1	100	25	
158	M				IN			IN			IN	(P)	YES	IN			0	4	1	100	25	
159	F		1	1	IN	2	YES	IN	2	YES	IN	2		IN	2		0	4	2	100	50	
161	F		2	2	IN	1?		IN	1?		IN	1?		IN	1?		0	4		100	0	SHED BY 6/27
162	M				IN			IN		YES	IN			IN			0	4	1	100	25	
163	F				IN			IN			IN			IN			0	4		100	0	
164	F		1	3	IN	1?		IN	1?		IN	1	YES	IN			0	4	1	100	25	ALONE ON 6/6
165	M				IN			IN			IN			IN	(P)	YES	0	4	1	100	25	
168	F				IN	(S)	YES	IN	(P)	YES	IN	(P)	YES	IN	(P)	YES	0	4	4	100	100	
169	F		1	2	IN	2	YES	IN	2?		IN	2?		IN	2?		0	4	1	100	25	UNKNOWN
171	F				IN			IN			IN			IN	(P)	YES	0	4	1	100	25	
172	F		2	1	IN	3		IN	3		IN	3	YES	IN	3	YES	0	4	2	100	50	W/2 @1 ON 6/27
173	F		2	2	IN	3		IN	3		IN	3	YES	IN	3		0	4	1	100	25	W/2 @ 2 ON 6/27
174	F				IN			IN			IN	(P)	YES	IN			0	4	1	100	25	
177	M				IN			IN			IN		YES	IN			0	4	1	100	25	
																TOTALS	16	174	40	91.6	23.0	

Table 3. Summary of observations of brown bears during brown bear density estimate on Katmai Coast, June 1990. "Independant bears" excludes offspring, of what ever age, still with thier mothers.

REPLICATION	1	2	3	4	MEAN	MIN.	MAX.
Marked bears present, all ages							
(most likely number)	62	62	61	60	61.3	60	62
Independent marked bears present							
Marked bears seen	44	44	43	43	43.5	43	44
All ages	11	13	20	12	14.0		
Independent	7	11	13	9	10.0	7	13
Unmarked bears seen, all ages	80	100	121	99	100.0	80	121
No. cubs-of-year	0	4	4	7	3.8	0	7
No. "yearlings	12	19	10	1	10.5	1	19
No. older than "ylgs."	68	77	107	91	85.8	107	68
No. independent	64	72	88	79	75.8	64	88
Total marked and unmarked bears seen							
No. all ages	91	113	138	111	113.3	91	138
No. independent	71	83	101	88	85.8	71	101
Sightability, independent marked bears							
No. inside area	44	44	43	43	43.5	43	44
No. seen	7	11	13	9	10.0	7	13
% seen	15.9	25.0	30.2	20.9	23.0	16.3	29.5

Table. 4 Log-rank test calculations comparing survival (excluding hunting mortality) of radio-collared adult female (>2 yr. old) brown bears at Katmai coast (1989-91) and Black Lake (1988-91), Alaska.

Dates	Katmai: No. at risk (r0j)	Katmai: No. deaths (d0j)	Katmai: Survival	Black Lake: No. at risk (r1j)	Black Lake: No. deaths (d1j)	Black Lake: Survival	Total: No. at risk (rj)	Total: No. deaths (dj)	Total: Expected value E(d1j)a	var(d1j)b	var(d1j)c
1 May-15 May	45	0	1.0000	77	0	1.0000	122	0	0.000	0.000	0.000
16 May-23 May	64	0	1.0000	77	0	1.0000	141	0	0.000	0.000	0.000
24 May-31 May	64	1	0.9844	88	1	0.9886	152	2	1.158	0.488	0.481
1 Jun-7 Jun	84	0	0.9844	115	1	0.9800	199	1	0.578	0.244	0.243
8 Jun-15 Jun	84	0	0.9844	127	1	0.9723	211	1	0.602	0.240	0.238
16 Jun-23 Jun	85	0	0.9844	131	0	0.9723	216	0	0.000	0.000	0.000
24 Jun-30 Jun	84	0	0.98440	130	0	0.9723	214	0	0.000	0.000	0.000
1 Jul-31 Jul	82	2	0.9604	130	3	0.9499	212	5	3.066	1.186	1.158
1 Aug-31 Aug	76	1	0.9477	127	0	0.9499	203	1	0.626	0.234	0.233
1 Sep-30 Sep	72	0	0.9477	127	0	0.9499	199	0	0.000	0.000	0.000
1 Oct-31 Oct	46	0	0.9477	125	1	0.9423	171	1	0.731	0.197	0.195
1 Nov-30 Apr	44	0	0.9477	119	1	0.9344	163	1	0.730	0.197	0.196
Total		4			8			12	7.490	2.785	2.745

[a] E(d1j)=djr1j/rj

[b] Var(d1j)=djr1jr0j/rj2

[c] Var(d1j)=djr1jr0j(rj-dj)/rj2(rj-1)

Year	Katmai: No. at Risk	Katmai: No. of Deaths	Katmai: Survival Estimate	Katmai: 95% CI	Black Lake: No. at Risk	Black Lake: No. of Deaths	Black Lake: Survival Estimate	Black Lake: 95 % CI
1988					28	2	0.93	0.83-1.00
1989	23	0	1.00	1.00-1.00	38	3	0.92	0.79-1.00
1990	38	2	0.95	0.86-1.00	32	2	0.93	0.83-1.00
1991	27	2	0.92	0.79-1.00	40	1	0.98	0.92-1.00

Table 5. Population and density estimates for brown bears in Katmai Natl. Park coastal study area using the bear-days estimator.

Estimate for bears of all ages

day	DATE	n1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km²	1000mi²	Binomal Approx. CI Est. no. bears LOWER	UPPER	range as % of est.	DENSITY (PER 1000km²) LOWER	UPPER	DENSITY (PER 1000mi²) LOWER	UPPER
1	6/3/90	62	11	91	482.0	0.177	482.0	220.3	534.8	1385.3	301.0	1001.6	145.4	334.0	1111.4	128.9	429.1
2	6/5/90	62	13	113	512.0	0.210	512.0	165.1	568.1	1471.5	364.7	806.2	86.2	404.7	894.6	156.3	345.4
3	6/6/90	61	20	141	418.2	0.328	476.4	111.9	528.6	1369.1	368.4	654.6	60.1	408.8	726.4	157.8	280.5
4	6/7/90	60	12	111	524.5	0.200	492.8	104.1	546.9	1416.4	394.1	650.9	52.1	437.4	722.3	168.9	278.9
			cumulative % =			22.857											
			mean daily L-P=		484.19				537.3	1391.6							
				SE=	20.55												

Estimate for independent bears only (excluded offspring with their mothers)

day	DATE	n1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km²	1000mi²	Binomal Approx. CI Est. no. bears LOWER	UPPER	range as % of est.	DENSITY (PER 1000km²) LOWER	UPPER	DENSITY (PER 1000mi²) LOWER	UPPER
1	6/3/90	44	7	71	404.0	0.159	404.0	226.2	448.3	1161.1	220.5	1083.7	211.7	253.5	1202.6	97.9	464.3
2	6/5/90	44	11	83	314.8	0.250	362.5	132.2	402.3	1041.9	246.6	621.5	103.4	273.7	689.6	105.7	266.3
3	6/6/90	43	13	101	319.6	0.302	351.7	97.8	390.2	1010.7	259.8	519.2	73.8	288.2	576.2	111.3	222.5
4	6/7/90	43	9	88	390.6	0.209	366.8	91.2	407.8	1054.2	279.9	514.2	63.9	310.6	570.6	119.9	220.3
			cumulative %=			22.989											
			mean daily L-P=		357.04				396.2	1026.1							
				SE=	28.29												

Estimate for bears) 2.0 only

day	DATE	n1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km²	1000mi²	Binomal Approx. CI Est. no. bears LOWER	UPPER	range as % of est.	DENSITY (PER 1000km²) LOWER	UPPER	DENSITY (PER 1000mi²) LOWER	UPPER
1	6/3/90	52	8	76	452.4	0.154	452.4	240.6	502.1	1300.3	264.1	1115.9	188.3	293.0	1238.2	113.1	478.1
2	6/5/90	52	12	89	365.9	0.231	414.5	145.0	459.9	1191.3	287.3	687.8	96.6	318.8	763.2	123.1	294.7
3	6/6/90	51	17	126	365.9	0.333	399.2	101.7	443.0	1147.4	302.1	567.1	66.4	335.3	629.3	129.4	243.0
4	6/7/90	50	9	98	583.9	0.180	427.1	99.6	473.9	1227.4	331.5	583.0	58.9	367.8	647.0	142.0	249.8
			cumulative %=			22.439											
			mean daily L-P=		422.04				468.3	1212.9							
				SE=	29.50												

Table 6. Estimate of brown bear density using the bear-days estimator and maximum and minimum numbers of offspring still with their mothers.

Estimate for all bears with maximum number of offspring still with their mothers

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km^2	1000mi^2	Binomal Approx. Est. no. bears LOWER	UPPER	CI range as % of est.	DENSITY (PER 1000km^2) LOWER	UPPER	DENSITY (PER 1000mi^2) LOWER	UPPER
1	6/3/90	73	11	91	566.3	0.151	566.3	263.2	628.4	1627.6	354.4	1179.3	145.7	393.2	1308.6	151.8	505.3
2	6/5/90	71	13	113	585.3	0.183	594.0	194.8	659.1	1707.1	423.5	936.3	86.3	470.0	1038.9	181.5	401.1
3	6/6/90	69	20	141	472.3	0.298	540.1	131.4	608.2	1575.3	424.1	753.7	60.1	470.6	836.4	181.7	322.9
4	6/7/90	68	12	111	593.5	0.176	565.0	121.6	626.9	1623.8	452.1	746.5	52.1	501.6	828.4	193.7	319.8
		cumulative % =				19.929											
		mean daily L-P=			554.35				615.1	1593.2							
			SE=		24.10												

Estimate for all bears with minimum number of offspring still with their mothers

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km^2	1000mi^2	Binomal Approx. Est. no. bears LOWER	UPPER	CI range as % of est.	DENSITY (PER 1000km^2) LOWER	UPPER	DENSITY (PER 1000mi^2) LOWER	UPPER
1	6/3/90	60	11	91	466.7	0.183	466.7	212.5	517.8	1341.2	291.3	969.3	145.3	323.2	1075.6	124.8	415.3
2	6/5/90	60	13	113	495.7	0.217	495.6	159.2	549.9	1424.3	352.9	780.2	86.2	391.6	865.8	151.2	334.3
3	6/6/90	59	20	141	404.7	0.339	461.0	107.7	511.5	1324.9	356.4	633.4	60.1	395.5	702.9	152.7	271.4
4	6/7/90	58	12	111	507.3	0.207	476.8	100.2	529.1	1370.3	381.3	629.6	52.1	423.1	698.7	163.4	269.8
		cumulative %.=				23.629											
		mean daily L-P=			468.60				520.0	1346.7							
			SE=		19.87												

Table 6. (cont.)

Estimate for bears >2.0 with maximum number of offspring still with their mothers

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km^2	DENSITY (PER 1000mi^2	Binomal Approx. Est. no. bears LOWER	Binomal Approx. Est. no. bears UPPER	CI range as % of est.	DENSITY (PER 1000km^2) LOWER	DENSITY (PER 1000km^2) UPPER	DENSITY (PER 1000mi^2) LOWER	DENSITY (PER 1000mi^2) UPPER
1	6/3/90	62	8	76	530.0	0.129	538.0	290.7	597.0	1546.2	314.9	1330.5	188.8	349.4	1476.3	134.9	570.0
2	6/5/90	60	12	89	421.3	0.200	485.6	172.9	538.9	1395.7	337.0	806.9	96.8	374.0	895.3	144.4	345.7
3	6/6/90	58	17	126	415.3	0.293	463.3	120.6	514.1	1331.5	350.9	658.6	66.4	389.3	730.8	150.3	282.2
4	6/7/90	57	9	98	573.2	0.158	493.5	117.3	547.6	1418.2	383.2	674.1	58.9	425.3	748.0	164.2	288.8
		cumulative X =				19.489											
		mean daily L-P=			486.95				540.3	1399.5							
				SE=	34.90												

Estimate for bears >2.0 with minimum number of offspring still with their mothers

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*=+/-	DENSITY (PER 1000km^2	DENSITY (PER 1000mi^2	Binomal Approx. Est. no. bears LOWER	Binomal Approx. Est. no. bears UPPER	CI range as % of est.	DENSITY (PER 1000km^2) LOWER	DENSITY (PER 1000km^2) UPPER	DENSITY (PER 1000mi^2) LOWER	DENSITY (PER 1000mi^2) UPPER
1	6/3/90	50	8	76	435.3	0.160	435.3	230.6	483.1	1251.1	253.9	1073.0	188.1	281.8	1190.6	108.8	459.7
2	6/5/90	50	12	89	352.1	0.240	398.7	130.8	442.4	1145.8	276.2	661.4	96.6	306.5	733.9	118.4	283.4
3	6/6/90	49	17	126	351.8	0.347	383.9	97.2	426.0	1103.3	290.4	545.2	66.4	322.3	605.0	124.4	233.6
4	6/7/90	48	9	98	484.1	0.188	410.5	95.2	455.5	1179.7	318.6	560.3	58.9	353.5	621.7	136.5	240.0
		cumulative X =				23.350											
		mean daily		L-P=	405.82				450.3	1166.3							
				SE=	28.29												

Table 7. Comparison density estimates from Black Lake Alaska using the bear-days estimator.

Bears of all ages

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*→+/-	DENSITY (PER 1000km²	DENSITY (PER 1000 mi²	Binomal Approx. Est. no. bears LOWER	Binomal Approx. Est. no. bears UPPER	CI range as % of est.	DENSITY (PER 1000km²) LOWER	DENSITY (PER 1000km²) UPPER	DENSITY (PER 1000mi²) LOWER	DENSITY (PER 1000mi²) UPPER
1	5/28	68	19	83	288.8	0.279	288.00	91.174	237.779	615.37	203.47	472.88	93.29	167.5	389.3	433.9	1008.4
2	5/30	67	41	97	157.7	0.612	201.27	30.369	165.713	428.86	165.73	254.72	44.21	136.4	209.7	353.4	543.2
3	5/31	65	30	98	209.0	0.462	205.08	25.490	168.853	436.99	174.43	247.74	35.75	143.6	204.0	372.0	528.3
4	5/31	63	34	132	242.2	0.540	216.76	22.936	178.464	461.87	188.18	254.55	30.62	154.9	209.6	401.3	542.8
5	6/1-3	61	21	100	283.6	0.344	227.30	23.067	187.144	484.33	199.02	263.95	28.57	163.9	217.3	424.4	562.9
6	6/4	59	22	96	252.0	0.373	231.07	22.237	190.249	492.36	203.94	265.64	26.70	167.9	218.7	434.9	566.5
		cumulative % =				43.603											
		mean daily L-P=			239.82				196.79	509.30							
			SE=		18.35												

Black Lake independent bears only

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*→+/-	DENSITY (PER 1000km²	DENSITY (PER 1000mi²	Binomal Approx. Est. no. bears LOWER	Binomal Approx. Est. no. bears UPPER	CI range as % of est.	DENSITY (PER 1000km²) LOWER	DENSITY (PER 1000km²) UPPER	DENSITY (PER 1000mi²) LOWER	DENSITY (PER 1000mi²) UPPER
1	5/28	41	11	53	188.0	0.268	188.00	76.579	154.787	400.59	120.20	378.23	137.25	99.0	311.4	256.3	806.5
8	5/30	43	25	65	110.7	0.501	136.19	27.111	112.129	290.19	105.90	187.75	60.10	87.2	154.6	225.8	400.4
3	5/31	42	19	58	125.9	0.432	133.47	21.474	109.891	284.40	108.64	171.50	47.10	89.4	141.2	231.7	365.7
4	5/31	41	21	83	159.4	0.512	141.57	19.433	116.558	301.65	118.27	174.91	40.00	97.4	144.0	252.2	373.0
5	6/1-3	39	15	61	154.8	0.385	144.25	18.483	118.766	307.37	122.18	174.87	36.53	100.6	144.0	260.5	372.9
6	6/4	37	14	61	156.1	0.378	146.39	17.751	120.525	311.92	125.23	175.18	34.06	103.1	144.2	267.8	373.4
		cumulative % =				43.218											
		mean daily L-P=			149.00				122.673	317.48							
			SE=		10.15												

Black Lake, number of bears >2.0 estimated age

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	Sight-ability	N* (est. No. bears	Normal approx. 95% CI for N*→+/-	DENSITY (PER 1000km²	DENSITY (PER 1000mi³	Binomal Approx. Est. no. bears LOWER	Binomal Approx. Est. no. bears UPPER	CI range as % of est.	DENSITY (PER 1000km²) LOWER	DENSITY (PER 1000km²) UPPER	DENSITY (PER 1000mi²) LOWER	DENSITY (PER 1000mi²) UPPER
1	5/28	52	19	69	184.5	0.365	184.50	52.911	151.905	393.13	131.25	297.82	90.29	108.1	245.2	279.9	635.1
2	5/30	51	31	81	132.3	0.608	153.46	24.311	126.349	326.99	124.16	199.15	48.87	102.2	164.0	264.8	424.7
3	5/31	49	23	75	157.3	0.469	155.42	20.773	127.965	331.17	129.95	192.14	40.01	107.0	158.2	277.1	409.7
4	5/31	47	24	99	191.0	0.511	165.57	19.495	136.316	352.79	141.13	199.00	34.95	116.2	163.8	301.0	424.4
5	6/1-3	45	18	76	185.4	0.400	169.19	18.776	139.298	360.50	145.85	200.33	32.20	120.1	164.9	311.0	427.2
6	6/4	43	14	66	195.5	0.326	172.26	18.579	141.831	367.06	149.53	202.08	30.51	123.1	166.4	318.9	430.9
		cumulative % =				44.948											
		mean daily L-P=			174.34				143.540	371.48							
			SE=		[illegible]												

This is an interim or draft document. Data presentation, analysis, interpretation, and conclusions [illegible] Alaska Department of Law before citing.

Brown bear density estimate in the Katmai Natl. Park study area using the mean of Lincoln Petersen estimates and confidence interval based on sampling mean (Eberhardt 1990). Additional estimates made using maximum and minimum numbers of offspring still with there mothers.

ears of all ages, most likely number of marks present

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k 1-e^(mbar+1) (eq. 13)	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
	6/3/90	62	11	91	482.0	482.0	1.0000				534.85	1385.25						
	6/5/90	62	13	113	512.8	497.0	1.0000	450.00	190.59	76.7	551.49	1428.36	306.4	687.6	340.00	762.98	131.28	294.59
	6/6/90	61	20	141	418.2	470.7	1.0000	2292.81	118.96	50.5	522.36	1352.91	351.8	589.7	390.36	654.36	150.72	252.65
	6/7/90	60	12	111	524.5	484.2	1.0000	2251.95	75.50	31.2	537.28	1391.56	408.7	559.7	453.50	621.06	175.10	239.79

Independent bears only, most likely number of marks present

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k 1-e^(-mbar+1) (eq. 13)	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	44	7	71	404.0	404.0	0.9997				448.29	1161.08						
2	6/5/90	44	11	83	314.0	359.0	1.0000	4050.00	571.77	318.5	398.36	1031.76	-212.8	930.8	****	1032.02	-91.16	398.77
3	6/6/90	43	13	101	319.6	345.9	1.0000	2543.20	125.29	72.4	383.78	993.98	220.6	471.1	244.75	522.80	94.50	201.85
4	6/7/90	43	9	88	390.6	357.0	1.0000	2195.95	74.56	41.8	396.19	1026.13	282.5	431.6	313.46	478.92	121.03	184.91

Bears > 2 only, most likely number of marks present

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k 1-e^(-mbar+1) (eq. 13)	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	52	8	76	452.4	452.4	0.9999				502.05	1300.31						
2	6/5/90	52	12	89	365.9	409.2	1.0000	3742.97	549.67	268.7	454.05	1175.98	-140.5	958.9	****	1063.98	-60.19	410.88
3	6/6/90	51	17	126	365.9	394.8	1.0000	2496.30	124.13	62.9	438.03	1134.51	270.6	518.9	300.30	575.77	115.95	222.30
4	6/7/90	50	9	98	503.9	422.0	1.0000	4642.52	108.40	51.4	468.31	1212.93	313.6	530.4	348.02	588.60	134.37	227.26

Bears of all ages, MAXIMUM NUMBER OF MARKS PRESENT

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k 1-e^(mbar+1) (eq. 13)	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	73	11	91	566.3	566.3	1.0000				628.43	1627.62						
2	6/5/90	71	13	113	585.3	575.8	1.0000	179.60	120.40	41.8	638.94	1654.86	455.4	696.2	505.34	772.55	195.11	298.28
3	6/6/90	69	20	141	472.3	541.3	1.0000	3658.91	150.27	55.5	600.67	1555.73	391.0	691.6	433.92	767.42	167.54	296.30
4	6/7/90	68	12	111	593.5	554.4	1.0000	3119.82	88.85	32.1	615.13	1593.20	465.5	643.2	516.54	713.73	199.43	275.57

able 8 (cont.)

Bears > 2.0 only, MAXIMUM NUMBER OF MARKS PRESENT

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k1-e^(-mbar+1) [eq. 13]	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	62	8	76	530.0	530.0	0.9999				596.99	1546.20						
2	6/5/90	60	12	89	421.3	479.7	1.0000	6808.55	741.35	309.1	532.24	1378.51	-261.7	1221.0	***	1354.07	-112.12	523.12
3	6/6/90	50	17	126	415.3	458.2	1.0000	4785.70	171.06	75.0	508.43	1316.04	286.3	630.1	317.73	699.14	122.67	269.94
4	6/7/90	57	9	98	573.2	486.9	1.0000	6496.99	128.24	52.7	540.34	1399.47	358.7	615.2	398.03	682.64	153.68	263.57

Bears of all ages, MINIMUM NUMBER OF MARKS PRESENT

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k1-e^(mbar+1) [eq. 13]	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	68	11	91	466.7	466.7	1.0000				517.83	1341.19						
2	6/5/90	60	13	113	495.7	481.2	1.0000	421.88	184.54	76.7	533.95	1382.93	296.7	665.7	329.18	738.72	127.09	285.22
3	6/6/90	59	20	141	404.7	455.7	1.0000	2160.48	115.47	50.7	505.66	1309.66	340.2	571.2	377.53	633.80	145.76	244.71
4	6/7/90	58	12	111	507.3	468.6	1.0000	2186.20	73.02	31.2	519.98	1346.74	395.6	541.6	438.96	601.00	169.48	232.05

Bears >2.0 only, MINIMUM NUMBER OF MARKS PRESENT

day	DATE	m1(marks present)	m2(marks seen)	n2(total seen)	Daily L-P	mean of L-Ps	k1-e^(-mbar+1) (eq. 13)	Sample Variance (eq. 2)	95%CI= +/-	95% CI as % of ESTIMATE	Density #/1000km²	Density #/1000mi²	95% CI FOR NO. OF BEARS LOWER	UPPER	95% CI FOR NO./1000km² LOWER	UPPER	95% CI FOR NO./1000mi² LOWER	UPPER
1	6/3/90	50	8	76	435.3	435.3	0.9999				483.06	1251.13						
2	6/5/90	50	12	89	352.1	393.7	1.0000	3465.81	328.93	268.7	436.87	1131.50	-135.2	922.6	***	1023.79	-57.93	395.29
3	6/6/90	49	17	126	351.8	379.7	1.0000	2318.88	119.63	63.0	421.36	1091.33	260.1	499.4	288.61	554.11	111.43	213.94
4	6/7/90	48	9	98	484.1	405.8	1.0000	4269.23	103.95	51.2	450.32	1166.32	301.9	509.8	334.96	565.67	129.33	218.40

Table 9. Brown bear population and density estimates in Katmai Natl. Park using a binomial extension to the maximum liklihood estimator of White and Garrett (1990) (White in prep.). Data based on most likely number of marks present when date of weaning was uncertain.

	T_i	Population estimate	Lower 95% CI	Upper 95% CI	Density (#/1000km^2)	Lower 95% CI	Upper 95% CI	Density (#/1000mi^2)	Lower 95% CI	Upper 95% CI
Bears of all ages	62	513.8	405	627	570.1	449.4	695.8	1476.7	1164.0	1802.0
Independent bears	44	388.3	292	493	430.9	324.0	547.1	1116.0	839.2	1416.9
Bears >2.0	52	473.3	341	568	525.2	378.4	630.3	1360.3	980.0	1632.4

Table 10. Katmai estimates with variable number of offspring still with marked mothers when date of weaning was uncertain.

	FOR NUMBER OF BEARS:			FOR DENSITY (NO./1000KM^2):			% DIFFERENCE
	EST.	LOWER CI	UPPER CI	EST.	LOWER CI	UPPER CI	FROM BEST EST.
BEAR-DAYS ESTIMATOR							
ALL BEARS							
MIN.	477	381	630	529	423	699	-3.2
BEST	493	394	651	547	437	722	
MAX.	565	452	747	627	502	829	14.6
BEARS > 2.0							
MIN.	411	319	560	456	354	621	-3.7
BEST	427	332	583	474	368	647	
MAX.	494	383	674	548	425	748	15.7
MEAN LINCOLN-PETERSEN ESTIMATOR							
ALL BEARS							
MIN.	468	395	541	519	438	600	-3.3
BEST	484	409	560	537	453	621	
MAX.	554	465	643	615	516	713	14.5
BEARS > 2.0							
MIN.	406	302	510	451	335	566	-3.8
BEST	422	314	530	468	348	589	
MAX.	584	456	712	648	506	790	38.4

Catalog # 6536

Summary of GERG Analytical Methods for U. S. Fish and Wildlife

The sediment samples were freeze-dried and extracted in a Soxhlet extraction apparatus. A flow diagram of the procedure is attached. Briefly, the freeze-dried sediment samples were homogenized and a 10-gram sample was weighed into the extraction thimble. Surrogate standards and methylene chloride were added and the samples extracted for 12 hrs. The extracts were treated with copper to remove sulfur and were purified by silica/alumina column chromatography (MacLeod *et al.*, 1985; Brooks *et al.*, 1989) to isolate the aliphatic and aromatic/pesticide/PCB fractions.

The tissue samples were extracted by the NOAA Status and Trends Method (MacLeod *et al.*, 1985) with minor revisions (Brooks *et al.*, 1989; Wade *et al.*, 1988). A flow diagram of the procedure is attached. Briefly, the tissue samples were homogenized with a Teckmar Tissumizer. A 1 to 10-gram sample (wet weight) was extracted with the Teckmar Tissumizer by adding surrogate standards, Na_2SO_4, and methylene chloride in a centrifuge tube. The tissue extracts were purified by silica/alumina column chromatography to isolate the aliphatic and PAH/pesticide/PCB fractions. The PAH/pesticide/PCB fraction was further purified by HPLC in order to remove interfering lipids.

The quantitative analyses were performed by capillary gas chromatography (CGC) with a flame ionization detector for aliphatic hydrocarbons, CGC with electron capture detector for pesticides and PCB's, and a mass spectrometer detector in the SIM mode for aromatic hydrocarbons (Wade *et al.*., 1988).

REFERENCES

Brooks, J.M., T. L. Wade, E. L. Atlas, M. C. Kennicutt II, B. J. Presley, R. R. Fay, E. N. Powell, and G. Wolff (1989) **Analysis of Bivalves and Sediments for Organic Chemicals and Trace Elements.** Third Annual Report for NOAA's National Status and Trends Program, Contract 50-DGNC-5-00262.

MacLeod, W.D., D. W. Brown, A. J. Friedman, D.G. Burrow, O. Mayes, R.W. Pearce, C.A. Wigren, and R. G. Bogar (1985) **Standard Analytical Procedures of the NOAA National Analytical Facility 1985-1986.** Extractable Toxic Organic Compounds, 2nd Ed. U.S. Department of Commerce, NOAA/NMFS. NOAA Tech. Memo. NMFS F/NWC-92.

Wade, T.L., E. L. Atlas, J. M. Brooks, M. C. Kennicutt II, R. G. Fox, J. Sericano, B. Garcia, and D. DeFreitas (1988) **NOAA Gulf of Mexico Status and Trends Program: Trace Organic Contaminant Distribution in Sediments and Oysters.** Estuaries, 11, 171-179.

SUMMARY TABLE

HYDROCARBON ANALYSIS OF BROWN BEAR FECAL SAMPLES

ID	SPECIES	DATECOL	LOCAT	OIL
27500	BRBE	05/25/89	BLACK L	NO
27501	BRBE	05/25/89	BLACK L	NO
27502	BRBE	05/25/89	BLACK L	NO
27503	BRBE	06/01/89	KATMAI	NO
27504	BRBE	06/01/89	KATMAI	NO
27505	BRBE	06/01/89	KATMAI	NO
27506	BRBE	06/01/89	KATMAI	NO
27507	BRBE	06/01/89	KATMAI	NO
27508	BRBE	06/01/89	KATMAI	NO
27509	BRBE	06/01/89	KATMAI	NO
27510	BRBE	06/01/89	KATMAI	NO
27511	BRBE	06/01/89	KATMAI	NO
27512	BRBE	06/01/89	KATMAI	YES
27513	BRBE	06/01/89	KATMAI	NO
27514	BRBE	06/01/89	KATMAI	NO
27515	BRBE	06/01/89	KATMAI	NO
27516	BRBE	06/01/89	KATMAI	NO
27517	BRBE	06/01/89	KATMAI	YES
27518	BRBE	06/01/89	KATMAI	YES
27519	BRBE	06/01/89	KATMAI	NO
27520	BRBE	05/22/89	BLACK L	NO
27521	BRBE	05/22/89	BLACK L	NO
27522	BRBE	05/22/89	BLACK L	NO
27523	BRBE	05/22/89	BLACK L	NO
27524	BRBE	05/22/89	BLACK L	NO
27525	BRBE	05/22/89	BLACK L	NO
27526	BRBE	05/22/89	BLACK L	NO
27527	BRBE	05/22/89	BLACK L	NO
27528	BRBE	05/22/89	BLACK L	NO
27529	BRBE	05/22/89	BLACK L	NO
27530	BRBE	05/22/89	BLACK L	NO
27531	BRBE	05/22/89	BLACK L	NO
27532	BRBE	05/22/89	BLACK L	NO
27533	BRBE	05/22/89	BLACK L	NO
27534	BRBE	05/22/89	BLACK L	NO
27535	BRBE	05/22/89	BLACK L	NO
27536	BRBE	05/22/89	BLACK L	NO
27537	BRBE	05/22/89	BLACK L	NO
27538	BRBE	05/22/89	BLACK L	NO
27539	BRBE	05/22/89	BLACK L	NO
27540	BRBE	06/01/89	KATMAI	NO
27541	BRBE	06/01/89	KATMAI	NO
27542	BRBE	06/01/89	KATMAI	NO
27543	BRBE	06/01/89	KATMAI	NO
27544	BRBE	06/01/89	KATMAI	NO
27545	BRBE	06/01/89	KATMAI	NO
27546	BRBE	06/01/89	KATMAI	NO
27547	BRBE	06/01/89	KATMAI	NO
27548	BRBE	06/01/89	KATMAI	NO
[redacted]	BRBE	06/01/89	KATMAI	YES

NATIONAL RESOURCE DAMAGE ASSESSMENT - ALIPHATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27549	27500	27501	27502	27503
LABSAMNO:	N7799	N7801	N7803	N7805	N7807
Alkanes and Isoprenoids	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
C10	4.68	10.98	3.38	11.00	0.00
C11	0.00	0.00	0.95	0.00	0.00
C12	22.10	2.34	4.01	29.89	1.06
C13	8.04	0.90	2.53	7.67	4.25
C14	11.30	9.54	2.85	11.00	7.65
C15	62.02	23.85	1.69	26.67	5.95
C16	30.75	39.24	9.61	19.44	22.22
C17	29.40	34.00	2.40	37.50	18.00
PRISTANE	13.90	4.60	0.50	24.00	5.70
C18	19.20	18.40	4.00	26.10	8.70
PHYTANE	3.60	3.40	18.70	11.60	19.90
C19	56.90	64.80	2.90	3.70	23.20
C20	65.10	59.10	15.10	74.80	56.30
C21	472.30	1359.00	381.50	316.50	710.30
C22	113.40	92.30	37.90	32.90	31.90
C23	969.20	940.57	720.72	701.09	569.14
C24	108.20	61.83	64.50	87.57	36.43
C25	1695.30	1579.00	2998.51	2995.60	1497.25
C26	80.10	37.06	52.10	60.17	35.40
C27	1865.30	1240.25	1367.43	1126.95	1387.01
C28	195.50	56.65	31.50	174.55	12.57
C29	4756.00	1344.11	181.72	562.48	522.79
C30	391.10	70.16	7.20	117.60	9.60
C31	7304.10	559.67	84.30	321.80	365.50
C32	117.20	18.84	1.90	70.30	1.20
C33	975.70	182.76	91.20	365.30	394.00
C34	191.40	84.22	114.00	15.00	140.30
TOT ALKANES	19561.8	7897.6	6203.1	7231.2	5886.3
UNIT:	ug/g	ug/g	ug/g	ug/g	ug/g
UCM	20.3	12.9	18.7	1.5	1.7
Surrogate Recoveries					
C12ALKD:	76.61	79.66	87.86	69.13	84.66
C20ALKD:	71.97	66.13	85.59	70.86	83.02
C24ALKD:	476.78 N	110.59	105.17	77.17	104.99
C30ALKD:	254.96 N	94.13	205.41 N	241.01 N	262.04 N

LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

ACE 30016129

NATIONAL RESOURCE DAMAGE ASSESSMENT - ALIPHATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27509	27510	27511	27512	27513
LABSAMNO:	N7819	N7821	N7823	N7825	N7827
Alkanes and Isoprenoids	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
C10	0.00	4.40	20.18	13.08	0.00
C11	5.83	1.57	3.68	4.08	3.05
C12	38.50	5.76	6.41	5.52	27.81
C13	19.91	8.06	16.74	10.44	3.84
C14	33.11	7.12	16.14	17.40	11.53
C15	591.36	367.64	40.24	36.84	9.95
C16	34.76	37.57	222.22	75.60	43.30
C17	54.20	10.90	46.40	36.40	18.40
PRISTANE	33.90	1.90	3.60	56.30	2.40
C18	16.30	1.70	3.00	20.50	13.20
PHYTANE	2.30	2.70	37.10	20.80	25.10
C19	672.80	23.40	14.40	49.30	7.20
C20	146.50	30.90	43.90	27.70	51.10
C21	2878.70	541.60	1086.80	771.50	1605.80
C22	195.40	35.20	71.20	30.60	57.40
C23	1746.99	569.63	1170.24	143.28	1244.90
C24	154.70	39.13	128.15	53.98	70.58
C25	1792.41	735.37	2909.47	428.51	3192.64
C26	110.20	32.97	215.60	43.33	59.58
C27	8327.71	1424.33	3155.92	300.15	1422.14
C28	344.47	91.31	376.77	42.21	80.63
C29	3114.22	5428.92	3776.22	516.18	432.10
C30	228.10	350.10	205.76	165.60	319.02
C31	1514.90	3891.90	2045.03	749.18	1146.21
C32	46.70	139.40	78.13	104.30	90.87
C33	496.20	147.50	396.91	460.44	791.70
C34	397.40	39.00	92.00	121.55	223.08
TOT ALKANES	22997.6	13970.0	16182.2	4304.8	10953.5
UNIT:	ug/g	ug/g	ug/g	ug/g	ug/g
UCM	72.8	31.8	189.6	70.3	68.4
Surrogate Recoveries					
C12ALKD:	82.15	65.13	91.59	84.13	81.54
C20ALKD:	83.36	62.87	100.29	93.13	85.03
C24ALKD:	117.70	67.24	100.20	99.25	97.84
C30ALKD:	260.22 M	142.35 M	81.84	41.81 M	25.98 M

LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

ACE 30016130

NATIONAL RESOURCE DAMAGE ASSESSMENT - ALIPHATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27514	27515	27516	27517	27518
LABSAMNO:	N7829	N7831	N7833	N7835	N7837
Alkanes and Isoprenoids	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
C10	2.64	3.17	1.77	0.00	4.42
C11	3.16	5.00	4.09	101.98	6.46
C12	37.42	4.51	2.87	15.66	4.76
C13	11.46	16.83	12.37	58.39	1.13
C14	9.22	11.34	8.39	21.42	25.38
C15	70.89	56.96	12.70	199.35	108.20
C16	15.81	18.78	29.81	562.56	114.20
C17	64.10	18.10	25.10	190.66	155.20
PRISTANE	157.50	9.30	9.40	420.03	104.40
C18	45.10	6.60	7.40	35.76	133.50
PHYTANE	2.80	4.40	3.20	142.80	52.30
C19	912.10	20.60	25.90	949.41	444.60
C20	168.40	27.20	24.00	707.76	207.50
C21	1661.30	929.30	615.10	5334.62	2060.80
C22	83.70	43.40	34.50	590.80	328.00
C23	1076.75	1067.85	721.13	11443.54	5418.12
C24	110.45	72.52	52.00	543.97	298.05
C25	296.67	2772.95	2256.01	3590.36	1945.41
C26	137.50	65.73	84.13	1142.44	532.18
C27	6174.14	2187.85	1594.35	28522.63	11920.42
C28	287.79	191.96	136.91	8.56	636.36
C29	934.50	1761.24	990.71	5682.79	4166.60
C30	146.77	148.82	87.76	120.98	380.59
C31	248.64	1547.94	1388.23	1923.26	8585.03
C32	209.92	13.76	155.18	529.73	280.74
C33	128.21	1000.67	1962.48	219.11	1464.12
C34	2552.43	62.18	284.35	176.53	298.38
TOT ALKANES	15549.4	12069.0	10529.8	63235.1	39676.8
UNIT:	ug/g	ug/g	ug/g	ug/g	ug/g
UCM	76.5	102.2	110.2	1526.6	107.5
Surrogate Recoveries					
C12ALKD:	67.43	82.85	83.49	126.40	87.70
C20ALKD:	87.88	99.95	91.18	124.20	98.28
C24ALKD:	90.83	87.94	87.19	133.50	98.44
C30ALKD:	86.71	103.19	77.85	135.40	89.71

LABNAME: GERG/TAMU   DATE: 11-Feb-91   LAB APPROVAL: Thomas J. Jackson

ACE 30016131

NATIONAL RESOURCE DAMAGE ASSESSMENT - AROMATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27549	27500	27501	27502	27503
LABSAMNO:	N7799	N7801	N7803	N7805	N7807
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
PNA Analyte	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
NAPHTHALENE	11.90	10.22	5.47	1.69	0.94
C1-NAPHTHALENES	1.93	1.35	1.23	2.95	1.63
C2-NAPHTHALENES	5.34	0.00	11.20	0.00	0.00
C3-NAPHTHALENES	5.86	0.00	0.00	0.00	0.00
C4-NAPHTHALENES	0.00	0.00	0.00	0.00	0.00
BIPHENYL	16.38	4.71	1.66	1.26	0.78
ACENAPHTHYLENE	0.06	0.52	0.15	0.35	0.27
ACENAPHTHENE	0.72	0.23	0.14	0.40	0.17
FLUORENE	0.39	0.27	0.14	0.56	0.28
C1-FLUORENES	0.00	0.00	0.00	0.00	0.00
C2-FLUORENES	0.00	0.00	0.00	0.00	0.00
C3-FLUORENES	0.00	0.00	0.00	0.00	0.00
PHENANTHRENE	2.54	0.98	0.48	1.67	1.13
ANTHRACENE	0.16	0.07	0.02	0.29	0.05
C1-PHEN_ANTHR	4.80	0.00	0.00	0.00	0.00
C2-PHEN_ANTHR	8.10	0.00	0.00	0.00	0.00
C3-PHEN_ANTHR	0.00	0.00	0.00	0.00	0.00
C4-PHEN_ANTHR	0.00	0.00	0.00	0.00	0.00
DIBENZOTHIO	0.77	0.28	0.08	0.34	0.12
C1-DIBEN	2.81	0.00	0.00	0.00	0.00
C2-DIBEN	4.67	0.00	0.00	0.00	0.00
C3-DIBEN	5.94	0.00	0.00	0.00	0.00
FLUORANTHENE	0.83	0.11	0.09	0.57	0.16
PYRENE	1.51	0.21	0.20	0.64	0.31
C1-FLUORAN_PYR	0.00	0.00	0.00	0.00	0.00
BENaANTHRACENE	0.21	0.03	0.02	0.25	0.08
CHRYSENE	0.71	0.08	0.03	0.25	0.08
C1-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C2-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C3-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C4-CHRYSENES	0.00	0.00	0.00	0.00	0.00
BENbFLUORAN	0.06	0.10	0.04	0.41	0.11
BENkFLUORAN	0.10	0.14	0.12	0.23	0.34
BENePYRENE	14.20	6.69	3.70	6.51	6.93
BENaPYRENE	0.25	0.15	0.77	0.37	0.16
PERYLENE	0.21	0.04	0.03	0.38	0.10
I123cdPYRENE	0.56	0.46	0.92	0.51	0.36
DBahANTHRA	11.59	79.64 M	42.95 M	9.39	8.09
BghiPERYLENE	0.28	0.11	1.38	0.37	0.28

LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

NATIONAL RESOURCE DAMAGE ASSESSMENT - AROMATIC HYDROCARBON DATA (CONT)- CATALOG # 6536

INVEST#:					
ID:	27549	27500	27501	27502	27503
LABSAMNO:	N7799	N7801	N7803	N7805	N7807
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
Analyte (Cont)	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
2-METHYLNAPH	0.99	0.75	0.47	1.39	0.76
1-METHYLNAPH	0.94	0.60	0.76	1.56	0.87
2,6-DIMETHNAPH	3.69	0.40	14.10	0.77	0.48
2,3,5-TRIMETHNAPH	1.05	0.43	0.29	0.90	0.48
1-METHYLPHEN	0.89	0.39	0.08	0.72	0.27
Surrogate Recoveries					
NAPHD8:	62.33	67.21	73.34	68.93	78.11
ACEND10:	70.50	73.79	80.98	80.53	97.51
PHEND10:	61.80	67.87	72.88	67.40	82.99
CHRYD12:	83.25	101.08	137.81	93.80	109.33
PERYD12:	42.50	44.76	45.80	44.84	31.52

This is an indication of data ... Data presentation, analysis, interpretation, and conclusions are subject to change. Readers are encouraged to contact the Environmental Section, Alaska Department of Law before citing.

LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

ACE 30016133

NATIONAL RESOURCE DAMAGE ASSESSMENT - AROMATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27509	27510	27511	27512	27513
LABSAMNO:	N7819	N7821	N7823	N7825	N7827
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
PNA Analyte	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
NAPHTHALENE	2.25	1.24	1.83	1.52	1.72
C1-NAPHTHALENES	4.58	2.69	4.53	3.28	3.04
C2-NAPHTHALENES	7.02	11.08	8.26	5.04	5.68
C3-NAPHTHALENES	8.33	5.36	8.30	7.41	5.06
C4-NAPHTHALENES	5.86	3.40	6.40	5.72	3.86
BIPHENYL	1.83	1.19	1.23	1.23	1.29
ACENAPHTHYLENE	0.03	0.58	0.84	0.26	0.32
ACENAPHTHENE	5.97	0.12	0.59	0.43	0.15
FLUORENE	0.28	0.18	0.49	0.38	0.32
C1-FLUORENES	0.00	0.00	0.00	0.00	0.00
C2-FLUORENES	0.00	0.00	0.00	0.00	0.00
C3-FLUORENES	0.00	0.00	0.00	0.00	0.00
PHENANTHRENE	1.88	1.46	1.66	1.98	1.40
ANTHRACENE	0.13	0.10	0.14	0.09	0.13
C1-PHEN_ANTHR	0.00	0.00	0.00	4.38	0.00
C2-PHEN_ANTHR	0.00	0.00	0.00	7.00	0.00
C3-PHEN_ANTHR	0.00	0.00	0.00	3.82	0.00
C4-PHEN_ANTHR	0.00	0.00	0.00	3.25	0.00
DIBENZOTHIO	0.13	0.14	0.21	0.37	0.14
C1-DIBEN	0.00	0.00	0.00	1.93	0.00
C2-DIBEN	0.00	0.00	0.00	3.75	0.00
C3-DIBEN	0.00	0.00	0.00	3.35	0.00
FLUORANTHENE	0.30	0.35	1.56	0.40	0.21
PYRENE	0.55	0.61	1.81	0.48	0.23
C1-FLUORAN_PYR	0.00	0.00	0.00	0.00	0.00
BENaANTHRACENE	0.20	0.02	0.09	0.09	0.07
CHRYSENE	0.20	0.15	0.08	0.70	0.10
C1-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C2-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C3-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C4-CHRYSENES	0.00	0.00	0.00	0.00	0.00
BENbFLUORAN	0.26	0.21	0.12	0.26	0.12
BENkFLUORAN	0.67	0.42	0.15	0.47	0.44
BENePYRENE	15.67	15.81	11.99	9.53	10.33
BENaPYRENE	0.49	1.08	0.49	0.38	0.36
PERYLENE	0.26	0.10	0.06	0.34	0.14
I123cdPYRENE	2.44	6.95	8.45	2.81	0.34
DBahANTHRA	141.39 N	360.31 N	152.77 N	21.84	8.46
BghiPERYLENE	0.32	3.16	0.10	0.45	0.20

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LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

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NATIONAL RESOURCE DAMAGE ASSESSMENT - AROMATIC HYDROCARBON DATA (CONT)- CATALOG # 6536

INVEST#:					
ID:	27509	27510	27511	27512	27513
LABSAMNO:	N7819	N7821	N7823	N7825	N7827
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
Analyte (Cont)	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
2-METHYLNAPH	2.07	1.15	2.33	1.60	1.47
1-METHYLNAPH	2.51	1.54	2.20	1.68	1.57
2,6-DIMETHNAPH	2.13	8.80	2.21	1.86	2.47
2,3,5-TRIMETHNAPH	1.07	0.56	1.30	1.26	0.86
1-METHYLPHEN	0.74	0.21	0.81	0.62	0.38
Surrogate Recoveries					
NAPHD8:	68.93	47.31	74.31	81.20	73.51
ACEND10:	87.43	64.89	99.78	92.59	87.52
PHEND10:	75.63	52.30	91.28	85.28	81.33
CHRYD12:	96.45	65.04	109.79 N	91.82	114.46
PERYD12:	79.14	52.61	143.45 N	38.31	34.76

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LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

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NATIONAL RESOURCE DAMAGE ASSESSMENT - AROMATIC HYDROCARBON DATA - CATALOG # 6536

INVEST#:					
ID:	27514	27515	27516	27517	27518
LABSAMNO:	N7829	N7831	N7833	N7835	N7837
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
PNA Analyte	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
NAPHTHALENE	1.54	8.09	1.45	25.83	6.64
C1-NAPHTHALENES	2.22	9.93	2.20	15.88	6.38
C2-NAPHTHALENES	0.00	0.00	0.00	0.00	0.00
C3-NAPHTHALENES	0.00	0.00	0.00	0.00	12.77
C4-NAPHTHALENES	0.00	0.00	0.00	0.00	15.74
BIPHENYL	0.80	14.52	0.74	3.76	5.50
ACENAPHTHYLENE	0.39	0.25	0.07	1.38	0.16
ACENAPHTHENE	0.63	0.70	0.19	2.96	0.18
FLUORENE	0.46	0.49	0.28	3.15	0.63
C1-FLUORENES	0.00	0.00	0.00	0.00	0.00
C2-FLUORENES	0.00	0.00	0.00	0.00	0.00
C3-FLUORENES	0.00	0.00	0.00	0.00	0.00
PHENANTHRENE	0.92	3.23	0.69	46.40	6.48
ANTHRACENE	0.42	0.54	0.04	3.29	0.28
C1-PHEN_ANTHR	0.00	0.00	0.00	29.77	19.42
C2-PHEN_ANTHR	0.00	0.00	0.00	35.08	26.48
C3-PHEN_ANTHR	0.00	0.00	0.00	34.34	18.42
C4-PHEN_ANTHR	0.00	0.00	0.00	0.00	9.51
DIBENZOTHIO	0.45	0.45	0.08	2.29	2.86
C1-DIBEN	0.00	0.00	0.00	0.00	10.67
C2-DIBEN	0.00	0.00	0.00	28.92	18.32
C3-DIBEN	0.00	0.00	0.00	39.58	18.35
FLUORANTHENE	0.56	0.18	0.20	26.20	0.44
PYRENE	0.55	0.41	0.29	18.41	0.69
C1-FLUORAN_PYR	0.00	0.00	0.00	0.00	0.00
BENaANTHRACENE	0.41	0.21	0.05	1.84	0.23
CHRYSENE	0.48	0.21	0.13	7.70	2.21
C1-CHRYSENES	0.00	0.00	0.00	0.00	3.43
C2-CHRYSENES	0.00	0.00	0.00	0.00	4.14
C3-CHRYSENES	0.00	0.00	0.00	0.00	0.00
C4-CHRYSENES	0.00	0.00	0.00	0.00	0.00
BENbFLUORAN	0.28	0.06	0.02	4.45	0.24
BENkFLUORAN	0.31	0.26	0.66	4.43	0.57
BENePYRENE	2.12	2.76	2.10	3.22	5.46
BENaPYRENE	0.48	0.77	1.03	9.43	0.18
PERYLENE	0.45	0.07	0.09	1.13	0.15
I123cdPYRENE	0.30	0.07	0.06	1.26	0.08
DBahANTHRA	0.40	0.28	0.28	2.73	0.11
BghiPERYLENE	0.62	0.08	0.08	1.67	0.28

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INVEST#:					
ID:	27514	27515	27516	27517	27518
LABSAMNO:	N7829	N7831	N7833	N7835	N7837
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
Analyte (Cont)	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
2-METHYLNAPH	1.09	2.77	1.22	11.03	2.27
1-METHYLNAPH	1.13	7.16	0.98	4.85	4.11
2,6-DIMETHNAPH	0.89	0.8[illegible]	0.65	7.96	1.06
2,3,5-TRIMETHNAPH	0.79	0.49	0.74	6.76	3.26
1-METHYLPHEN	0.70	0.59	0.20	5.68	5.32
Surrogate Recoveries					
NAPHD8:	78.82	96.56	98.44	97.50	98.97
ACEND10:	88.01	101.32	98.42	99.87	99.21
PHEND10:	74.67	80.60	82.88	81.74	90.37
CHRYD12:	69.81	99.36	91.03	95.19	91.60
PERYD12:	68.47	69.41	73.09	71.25	74.75

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LABNAME: GERG/TAMU DATE: 11-Feb-91 LAB APPROVAL: Thomas J. Jackson

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