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Cumulative Effects Model Verification, Sustained Yield Estimation, and Population Viability Management of the Kenai Peninsula, Alaska Brown Bear

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RESEARCH PROGRESS REPORT

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STUDY TITLE: Cumulative Effects Model Verification, Sustained Yield Estimation, and Population Viability Management of the Kenai Peninsula, Alaska Brown Bear

PERIOD: 1 July 1997–30 June 1998

SUMMARY

The Alaska Department of Fish and Game is concerned the Kenai Peninsula brown bear population may be threatened from pressures related to human-caused mortality, loss of habitat due to development and logging, and displacement of bears from feeding areas by increased recreational fishing. Development of a long-term management strategy for Kenai Peninsula brown bears will require determination of the sustainable yield of the population, as well as evaluation of a cumulative effects model (the latter to enable managers to predict the likely outcome of habitat changes).

This study was undertaken to address issues critical to effective management of Kenai Peninsula brown bears. Specific objectives were to 1) evaluate a cumulative effects model developed by the Interagency Brown Bear Study Team; 2) identify critical components of brown bear habitat and movement corridors between these habitats; 3) estimate survival rates of radiocollared female brown bears relative to human-caused mortality; and 4) develop a model of sustainable yield and population viability.

Using fixed-wing aircraft, we located adult female bears to collar and noted general habitat characteristics of nearby terrain. During the 1997 field season we captured 17 new bears and continued to monitor 24 previously captured individuals. Nine of the new animals were outfitted with GPS (Global Positioning System) Argos uplink satellite collars while the remaining 8 bears received GPS (Telonics Inc., Mesa Ariz USA) store-onboard transmitters. All bears were weighed and their body composition determined using bioelectrical impedance and isotopic dilution (Farley and Robbins 1994). Results from body composition work are summarized in Appendix A. During the 1997 field season GPS/Argos transmitters obtained fixes with nearly a 1:1 uplink rate to the Argos satellite. A possible seasonal effect was observed as fix rate significantly declined ($P < 0.05$) after spring. Store-onboard collars obtained more fixes per

collar than did Argos collars (50–74% of expected fixes vs 18–82%, respectively). Store-onboard collars had a higher overall fix rate per day (5 vs 1–2) than GPS Argos units. Over the course of the season, the 9 GPS/Argos collars obtained 1045 location fixes. GPS data have been analyzed and two manuscripts are in press.

During 1997 collared bears were located via fixed-winged aircraft 556 times at approximately weekly intervals from March–October or until they entered dens. Each location was photographed from the air to confirm vegetation type and the percentage of beetle-killed spruce. Aerial location data have been entered into a database for future analysis, though we have been unsuccessful in obtaining a Peninsula-wide GIS data layer of vegetative cover. Without this GIS layer, we cannot evaluate the cumulative effects model.

Potentially important feeding and movement corridors were identified for several geographic locations on the Kenai, including one at the outlet of Skilak Lake, which has been proposed for critical habitat status. Bears in the Skilak lake area using both the outlet and inlet of Skilak Lake and the Kenai River travel the north shore of the lake between areas. This information is significant to development within Skilak Loop area on the Kenai National Refuge and should be considered in recreational planning.

To identify critical components of brown bear habitat and movement corridors between habitats, we catalogued each location point for bears located with VHF transmitters to specific habitat type, using the Viereck system (Viereck et al. 1992) of habitat classification. Data from GPS store-onboard transmitters aided in the identification of possible critical travel corridors near the Skilak Lake area on the Kenai National Wildlife Refuge. In addition, the area below Skilak Lake has been identified as an important salmon spawning area where numerous bears feed. In 1997 we also witnessed a high level of use of the Kenai River above Skilak lake, where the river empties into the lake, and on nearby Hidden Creek. Bear locations during both 1996 and 1997 show that the Killey River provides a significant food source and travel corridor from the wilderness habitats between Skilak and Tustumena Lakes to the Kenai River. Part of the long-term management of the Russian River ecosystem for humans and bears must contain a plan to make human use compatible with brown bear conservation. Certain areas in the ecosystem must be identified as "bear-only areas," most will be identified as "bear and people" areas, and some will be classified as "people-only" areas.

We had 3 bear mortalities in 1997 for our estimation of survival rate of radiocollared female brown bears relative to human-caused mortality. We calculated Kaplin–Meyer survival coefficients for active and denning periods for 1995, 1996, and 1997 data. Annual rates did not differ between 1995 and 1996 ($X^2 = 0.165$, $P = 0.685$) or between 1996 and 1997 ($X^2 = 0.566$, $P = 0.452$), so we pooled data from the 3 years (Table 5). Survival from May through October was 0.909 (95% CI = 0.846–0.973). We did not observe any mortality from November to April, so survival was 1.0 during the denning period. Our estimate of annual survival was slightly higher during 1997 than that reported in 1996, although the difference was not statistically significant. We estimated survival of cubs to the yearling class to range from 0.77–0.89, and that for yearlings to two-year-olds to be 0.55 to 0.81.

We continued to refine our estimates of reproductive histories (Table 6) of marked bears. Data are still inadequate at this time to model the Kenai population. We observed 38 litters of cubs of the year. Mean litter size was 2.32. These litters comprised 2 singles (5.2%), 22 twins (57.9%), and 14 triplets (36.8%). We also observed 27 litters of yearlings. These litters comprised 4 singles (14.8%), 17 twins (63.0%), and 6 triplets (22.2%). Mean litter size was 2.07 yearlings. These estimates must be refined before a modeling exercise; we provide them for comparative purposes and to show that we may be experiencing a very high rate of yearling mortality.

This study includes results of a user survey on the Russian River to determine attitudes of anglers and campers toward brown bear conservation. The Interagency Brown Bear Study Team recognizes a need to develop a conservation strategy for Kenai brown bears. Recommendations for such a strategy, including biological concerns, are also included in this report. We recommend additional needs for research and include extensive appendices (A-I). The final report will contain the working copy of a Kenai Peninsula Brown bear conservation assessment.

We recommend that we (1) develop a conservation strategy for brown bears on the Kenai Peninsula, 2) evaluate mortality in yearling brown bears and impacts of reduced use of salmon feeding areas by bears due to human disturbance, (3) test the cumulative effects model using the 1995–1997 telemetry locations, and (4) once the vegetation GIS layer is developed, perform resource selection analysis.

Key Words: brown bear, cumulative effects, GIS, GPS, habitat use, movement corridors, reproduction, resource selection, survival, *Ursus arctos*.

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BACKGROUND

The Alaska Department of Fish and Game is responsible for management of the brown or grizzly bear (*Ursus arctos*) on the Kenai Peninsula (KP). We are concerned the viability of this brown bear population may be threatened from increased pressures related to human-caused mortality (sport harvest and defense of life or property killing), loss of habitat due to development and logging, and displacement of bears from feeding areas because of increasing recreational activities (primarily salmon fishing). In light of this, we must determine sustained yield for the population, evaluate a cumulative effects model that will allow predictions regarding effects of habitat changes, and develop a long-term management strategy for brown bears on the Kenai Peninsula.

The brown bear once ranged from Mexico to the Arctic Ocean and from the Mississippi River to the Pacific Ocean (Rausch 1963). Bear populations south of the Canadian border now exist in only 6 ecosystems, totaling 600–800 individuals. In the continental United States, the brown bear was listed as threatened under the Endangered Species act in 1975 (USDI Fish and Wildlife Service 1982, LeFranc et al. 1987) because it met the following criteria: (1) both present and threatened future destruction and/or modification of habitat; (2) a present loss or potential loss of bears by illegal killing and control actions involving brown bears threatening humans or killing livestock; (3) lack of critical data on brown bear habitat conditions, carrying capacity, population estimates, annual reproduction, mortality, and population trends; and (4) apparent isolation of some existing populations precluding movements from other areas (Servheen 1981).

In Alaska, brown bears range over most of the state and are estimated to number about 31,700 (24,990–39,136) (Miller 1993). In some areas, bear populations and their habitat are declining due to direct human-caused mortality, human encroachment, and habitat alteration.

Little information about brown bear natural history exists, and there is no population estimate for brown bears on the KP. Based on extrapolation from other areas with known bear density, ADF&G and USFWS biologists first estimated the KP population between 150–250 (Jacobs 1989). This estimate was based on the assumption that only 8800 km^2 of the 23,310 km^2 area on the KP was regularly used as brown bear habitat. More recently, Del Frate (1993) estimated the population at 277 based on the assumption of 13,848 km^2 of habitat and an average density of 20 bears/1000 km^2.

Annual sustainable harvests (allowable human kill) of brown bears are related to reproductive output of the population and natural mortality rates. Using the best available information for the Kenai Peninsula and elsewhere in Alaska, Jacobs (1989) estimated the sustained yield of bears should not exceed 7% of the population. This assumed a natural mortality rate of 5%. Based on a population estimate of 200–300 bears, the allowable harvest should not exceed 14–21 bears, including crippling loss and defense of life or property kills. In the years 1985–91, the total estimated kill on the KP was 18, 18, 12, 13, 7, 14, and 15, respectively.

The harvest of brown bears recently exceeded estimates of sustained yield, and hunting seasons have been shortened twice. In 1992, despite a season reduction in 1990, the total annual kill was 27 bears for Units 7 and 15, which encompass the KP. In addition to sport harvest, defense of life or property kills (DLPs) have continued to increase. The Board of Game again shortened the season for fall 1994 at their winter meeting in 1993. Because the harvest quota established in the brown bear management plan was exceeded, the fall bear season has been closed by emergency order in 1995, 1996, and again in 1997.

The KP brown bear population is probably isolated from the mainland population. The KP is connected to mainland Alaska by a narrow, 15-km-wide strip of land between Cook Inlet and Prince William Sound. Movement of brown bears through this strip is restricted by human development and physiographic features including 2 communities, 2 airstrips, 13 km of roads, 2 campgrounds, railroad tracks, a lake, and several glaciers. Of approximately 250 gray wolves (*Canis lupus*) marked on the KP over the past 20 years, only 5 have been documented to move off the KP, and marked wolves from elsewhere in Alaska have never been documented to move onto the KP (T. Bailey, pers. commun., KNWR). Brown bears, particularly females, are less inclined to disperse great distances than are gray wolves (Mech 1970, Craighead and Mitchell 1992); therefore, we believe movements of brown bears onto and off the KP are minimal.

The KP has received some of the most significant human impacts in Southcentral Alaska, much to the detriment of its wildlife populations and habitats. Gray wolves and caribou (*Rangifer tarandus*) were extirpated by poison and market hunting by 1915, and salmon populations were depressed by overfishing into the 1950s (Bangs et al. 1982). The human population increased from 24,600 to 43,600 from 1977 to 1987 (Bangs et al. 1982) and is currently estimated at 44,019 (Kenai Peninsula Borough records). Logging, mining, energy development, and water impoundments all occur on the KP and lead to modifications or destruction of habitat for brown bears.

The Kenai Peninsula is the most popular recreation area in Alaska. Each year 1,000,000 visitor days occur on the KP for camping, fishing, wilderness hiking, and other outdoor-related activities. In response to this pressure, the Kenai National Wildlife Refuge, the Chugach National Forest, and Alaska State Parks are developing or proposing to develop campgrounds, hiking trails, and backcountry hostels to accommodate users. Much of this activity is centered on the Kenai River watershed and the salmon associated with it.

The Kenai Peninsula is experiencing a widespread infestation of spruce bark beetle. Since the 1950s, over 1.2 million of the 2.2 million acres of forest in the Kenai Peninsula Borough have been infected with bark beetle (Hall 1992). The current estimate of active infestation is 397,771 acres (Hennon et al. 1994). In response to this, the state of Alaska, Division of Forestry, and many private citizens are advocating a rigorous timber harvest program including lands important to brown bears. For example, there are about 37,600 acres slated for harvest that have been identified as critical brown bear habitat by Jacobs (1989). With this harvest, many roadless areas will be developed. Logging and bark beetles will ultimately change the forest ecosystem on the KP. The effects of these changes on brown bears are unknown.

The Interagency Brown Bear Study Team (IBBST) was formed by the USFWS, USDA Forest Service, and ADF&G in 1984 to foster cooperative collection of information needed to manage KP brown bears. The National Park Service joined the effort in 1990. The goal of the IBBST is to develop management strategies to maintain a viable population of brown bears on the KP despite increasing human development and recreation. Research was initiated in 1984 and a draft management plan developed in 1989 (Jacobs 1989). This plan did not include a means to evaluate the effects of human development and habitat modification on brown bears and their habitats. Next the IBBST designed a cumulative effects model to assess effects of management practices on brown bear habitats (Suring et al. 1994).

The cumulative effects model for brown bears on the KP provides an analytical tool to simultaneously evaluate the cumulative effects of human actions on all state, federal, and private lands on brown bear habitat. Habitat capability/cumulative effects models for brown bears have been created for other populations and are being used frequently by land and wildlife management agencies (Christensen and Madel 1982, Christensen 1985, Weaver et al. 1985, Young 1985, Schoen et al. 1994). The brown bear is a management indicator species on both the Chugach National Forest and the Kenai National Wildlife Refuge and represents other animals that require large expanses of relatively undisturbed habitat and quality riparian areas. The direct effects of management activities on the brown bear population on the KP are also a significant management issue.

OBJECTIVES

1. To evaluate a cumulative effects model developed by the Interagency Brown Bear Study Team.

2. To identify critical components of brown bear habitat and movement corridors between these habitats.

3. To estimate the survival rates of radiocollared female brown bears relative to human-caused mortality.

4. Develop a model of sustainable yield and population viability.

METHODS

Job. 1. To evaluate a cumulative effects model developed by the Interagency Brown Bear Study Team

Using fixed-wing aircraft, we initially located bears and noted activity and habitat characteristics. Adult bears were immobilized with a combination of tiletamine and zolazepam (Telazol®, Fort Dodge Laboratories, Inc., Fort Dodge, Ia.) at mean dosages of 6.5 mg/kg during spring and 9.8 mg/kg during fall. We darted bears from a Bell Jet Ranger, Robertson R44, or Hughes 500 helicopter, using a Cap-Chur® gun (Palmer Chemical and Equipment Co., Douglasville, Ga.).

Adult female bears were fitted with either conventional or GPS radio collars (Telonics Inc., Mesa Ariz.). A premolar was extracted for age determination. Teeth were decalcified and stained using techniques described by Matson (1993) at Matson Laboratories in Milltown, Montana. Age was estimated by counting cementum annuli (Willey 1974, Rogers 1978). Teeth were not extracted from cubs of the year or from most yearlings. We estimated age for yearlings by comparing the length of the incisor bar to the length of the erupting canine. In almost all cases, the newly erupted canines were shorter than or approximately the same length as the incisors. For our study, cubs were <1-year-old, yearlings were ≥1 and <2, and 2-year-olds were ≥2 and ≤3. We set birth dates at 1 February because we assumed that parturition occurred in the den sometime in late January or early February.

Bears that were fitted with GPS transmitters were weighed, and body composition was determined using bioelectrical impedance and isotopic dilution (Farley and Robbins 1994). Bears fitted with conventional collars were handled only once when initially captured. GPS collared bears were handled up to 3 times: at initial capture (May, July, or August), in midsummer (July or August), and again in late fall (October) when the GPS collar was replaced with a conventional transmitter. In addition, we visited locations of bears indicated by the GPS data and noted evidence of bear activity and habitat conditions. We entered all locations of bears into a GIS and identified movement corridors and areas of intense activity.

To test for changes in fix rate over time of GPS collars, we restricted the analysis to 5 collars that were active over the entire season (May–Nov) in 1996. We divided the season in to 10, 15-day periods. Collars were treated as a random variable rather than a fixed variable, allowing inference beyond just the 5 collars tested. We used SAS PROC MIXED (Littell et al. 1996) with an Arcsine transformation (arcsine [sqrt p]) (Ostle and Mensing 1975) on proportional data (p = percent of successful fix attempts). We used the following approach: (1) specify the model configuration, (2) select a covariance structure, and (3) fit the model. This process was repeated until model fits had the following covariance structure: (1) compound symmetry, (2) first order auto-regressive, (3) antedependence, (4) unstructured, or (5) Toeplitz. Akaile's Information Criteria (AIC) and Schwartz's Bayesian Information Criterion (BIC) were then used to select the best model.

Bears with conventional collars were tracked at nearly weekly intervals, whereas bears with GPS collars were located via fixed-wing aircraft less frequently. At each telemetry fix, we noted the bears' activity, the vegetation type and terrain, photographed the site, and recorded a GPS fix. Data will be analyzed following recommendations of Manly et al. (1993). If the predictions of the cumulative effects model differ from field results, the model will be adjusted based upon the field data. Additional information will be collected to evaluate changes.

Job. 2. To identify critical components of brown bear habitat and movement corridors between these habitats

Critical habitat components were identified using radiotelemetry. Although the cumulative effects model will identify critical components of habitat, it is not designed to identify important travel corridors between these. GPS collars will provide data on bear movement.

Job. 3. To estimate the survival rate of radiocollared female brown bears relative to human-caused mortality

To estimate survival rates of female brown bears, we developed a model that divided the year into 2 periods: (1) active period starting 1 May and continuing through 31 October, and (2) the inactive period or denning season encompassing 1 November through 30 April. We defined these periods to satisfy the survival model's requirement of constant survival rates within each period. Although some bears were out of dens during late April and early November, we recorded no deaths during these periods. Data were entered into the model monthly, accounting for newly collared animals and those lost to censoring and death.

Survival and cause-specific mortality were calculated using the Kaplan–Meier procedure (Pollock et al. 1989). Sample size was determined following recommendations presented by Schwartz and Franzmann (1991) for black bears. Their results indicate that a minimum of 19 bears/death must be sampled to be 95% certain the survival estimate is within 10% of the true values. With a survival rate >85% and a censuring rate <15%, this would require 25 bears. If mortality is high (i.e., >15%), we will mark additional individuals.

Job. 4. Model the brown bear population to establish sustainable yields and assess population viability with the ultimate goal of developing a brown bear management plan

Data obtained from Jobs 1, 2, & 3 were used in a deterministic population model (Miller 1988) to evaluate whether the current level of harvest is within the bounds of a sustainable yield of brown bears. In addition, the computer modeling software GAPPS (Harris et al. 1986) was used to evaluate population changes relative to human-caused mortality. GAPPS is a stochastic model that considers random population variation. Such programming should improve our ability to evaluate population viability and determine consequences of harvest. The modeling program was coordinated with Sterling Miller, ADF&G, Anchorage.

The cumulative effects model was used to identify and/or verify critical components of brown bear habitat previously identified in the management plan published by Jacobs (1989). This management plan is being refined and should ultimately represent a working plan used by all land-management agencies for decision-based resource management.

Job. 5. Prepare a final report

An annual progress report will be prepared each year with a due date of 31 December. A final report will be prepared at the conclusion of the study on 31 December 1998.

RESULTS AND DISCUSSION

Job. 1. To evaluate a cumulative effects model developed by the Interagency Brown Bear Study Team

During 1997, 17 new bears (14 females, 3 males) were captured and 24 previously marked bears were recaptured (Table 1) Seventeen females were equipped with GPS collars; 9 collars relayed the data via satellite (ARGOS uplink) and 8 stored the data onboard. The other female bears were equipped with conventional VHF collars. One of the 3 males was fitted with a VHF transmitter.

We tested 9 GPS/Argos collars in 1997. The first GPS fix after initializing the collar occurred at 23:00 GMT. Subsequent fixes were obtained at intervals of 13 hours. The uplink duty cycle was set at 4 h on - 32 h off. The GPS receiver attempted to obtain a position fix at preprogrammed intervals over a 2-minute period. If no fix was obtained, the unit shut off and did not attempt another fix until the next programmed time. Data were stored temporarily on board the collar in a nonvolatile storage unit. GPS data were transmitted to a low earth orbiting (LEO) relay satellite constellation, the NOAA/LEO system, at programmed intervals. Fixes were incorporated into the Argos data stream and transmitted from the PTT (platform transmitter terminal) within the collar to the satellite. In this fashion, we used Argos as a data transfer system rather than solely as a positioning system, although we could have used Argos positioning as a backup. Duty cycles, which controlled when the PTT attempted to transmit data to the Argos satellite, were chosen to optimize transmission times relative to satellite overpasses of the study area and the angle of a satellite above the horizon (Fancy et al. 1988). During the "on" period of the duty cycles, the PTT transmitted data in approximately 840 millisecond bursts once every 90 seconds. Signals acquired by the satellite (here referred to as an "uplink") were processed on board, stored to tape, and later transmitted to ground stations (Fancy et al. 1988). We obtained these data from the Argos Data Processing Center in Landover Maryland via telephone modem to a computer in our office in Soldotna, Alaska. With this frequency of fix/uplink transmissions, the collars were designed to deplete the power supply in approximately 4 months. The GPS store-onboard collars attempted GPS fixes at intervals of 5.75 hours (4 or 5 fixes per day). All data were stored within the collar. With this frequency of fixes, these collars also would deplete the power supply in approximately 4 months.

During 1997 we monitored 37 collared bears. These were located via fixed-winged aircraft 556 times by air at approximately weekly intervals from March–October or until they entered dens. In addition, the 9 GPS/Argos collars obtained 1045 location fixes. Performance of the GPS collars was extremely variable. We evaluated the performance of the GPS/Argos collars deployed both in 1996 (n = 10) and 1997 (n = 9; Table 2). When evaluated over the entire field season, success rates for obtaining a GPS fix by individual collars ranged from 10–62% and 25–82% in 1996 and 1997, respectively. Mean locations/collar/season were 50 vs. 116 in 1996 vs.1997, respectively. These differences were caused by different programmed fix rates (23 hrs vs. 13 hrs) between the two years.

When evaluated over both years, successful fix rate decreased significantly (P = 0.0002) over time. We tested this by comparing 15-day periods using arcsine-transformed data, which was an order-preserving scale. Hence, the trend was also evident on the proportional scale. Based on backward elimination, we were able to rule out a reproductive effect (females with cubs vs. yearlings vs. alone). Fix rates were greatest during May and June, declining thereafter, indicating that habitat changes, geographic features, or bear behavior reduced performance. Brown bears on the Kenai Peninsula generally move to salmon streams to feed on fish in early July.

Uplink success with the ARGOS satellite was similar to the GPS fix rate, ranging from 13–63% and 30–96% in 1996 and 1997, respectively (Table 2). We detected a highly significant correlation (P <0.01, r = 0.91) between the proportion of successful GPS fixes and the successful Argos uplinks (Fig. 1). Rates of successful uplinks by individual collars ranged from 12-65%. Success rates were greatest during May and June and declined during July and August, again suggesting that habitat changes, geographic features, or bear behavior reduced performance when bears moved to salmon streams.

We combined data from 1996 with 1997 to evaluate the GPS store-onboard collars. Successful fix rate ranged from 50–74% (Table 3). Because units attempted multiple fixes per day, there were very few days (3%) when no fix was obtained (Fig. 2). Our success rate for GPS fixes with the store-onboard collars (x = 66.7%) was significantly higher (t = -4.009, P < 0.001) than the success rate for the GPS-Argos system (x = 43.1%). This difference suggests that some data from the GPS–Argos units may have been lost due to failed uplinks. The tradeoff is the possibility of lost data if the collar is not retrieved. This has not happened to date; however, we did lose contact with a GPS/Argos-equipped bear in September 1997 for unknown reasons.

All GPS data have been analyzed and two manuscripts were prepared and accepted for presentation at the 1998 IBA conference.

Aerial location data have been entered into a database for future analysis. Each location was photographed from the air to confirm vegetation type and the percentage of beetle-killed spruce. We have been unsuccessful to date in obtaining a Peninsula-wide GIS data layer of vegetative cover. Plans are underway to contract development of the map, and we should begin resource selection analysis during the next report period. At this time, however, no progress was made relative to this objective.

Several of the females were captured 2 or 3 times in May, July–August, and October to assess body condition and obtain blood and hair samples for a graduate study by Grant Hilderbrand of Washington State University. Results of that project are presented in Appendix A.

Job. 2. To identify critical components of brown bear habitat and movement corridors between these habitats

We catalogued each location point for bears located with VHF transmitters to specific habitat type, using the Viereck system (Viereck et al. 1992) of habitat classification. In addition, each location was photographed for further classification and confirmation as needed. Vegetation descriptions and codes have been incorporated into a database for future analysis.

We deployed GPS store-onboard transmitters to aid in the identification of critical travel corridors near the Skilak Lake area on the Kenai National Wildlife Refuge. The Interagency Brown Bear Study Team identified the area west of Skilak Lake as a potentially important travel corridor for brown bears. This area was deemed important because it represented the last undeveloped tract of lowland habitat in this area connecting the large wilderness area on the northern refuge to the Andy Simons Wilderness Area between Skilak and Tustumena Lakes. The land west of this corridor is in private ownership and rapidly being developed (Fig.3).

In addition to being an important movement corridor, the area below Skilak Lake has been identified as an important salmon spawning area where numerous bears come to feed. Bears rely heavily on dead or dying salmon that have already spawned. These fish concentrate on gravel bars and below bends in the river. Movements of other radiocollared bears during late August–September also support our contention that this area is important to brown bears. In 1996 and again in 1997, a large number of spawning red salmon were just below Skilak Lake in the Kenai River. We have been working with the local legislative office through ADF&G to develop a critical habitat designation for bears (see Appendix B).

This area is very important to brown bears for feeding, particularly female bears with offspring. On one day in 1996, we located 12 radiocollared adult females with a total of 20 offspring: this is 32 known different bears in an area of about 10 mi^2. Use was somewhat lower in 1997 because of flood stage conditions in this area of the river during the time bears normally feed here. A large glacier lake dumped its water load, causing the flooding. High water washed many of the fish carcasses out of the area, reducing the normally abundant supply of fish. After the water level dropped to normal levels, bears again moved into the area. Females used this area with cubs from August through November, with the most intensive use in late October. Several females were still active in the area during early November. Combining both 1996 and 1997, we found that at least 14 radiomarked bears and several unmarked bears used the area.

In 1997 we also witnessed a high level of use of the Kenai River above Skilak lake, where the river empties into the lake, and on nearby Hidden Creek. Locations of radiomarked bears indicate that this area is also an important travel corridor and bear feeding area (Fig. 3). Data from 1996 and 1997 indicated that 8 radiocollared bears and several unmarked bears used this area. We recommend no new development in this area, particularly along Hidden Creek and at the confluence of the Kenai River with Skilak Lake. We also recommend that the Kenai National Wildlife Refuge staff consider discouraging overnight camping along the banks of the Kenai River from Skilak Lake upstream for approximately 1.5 miles. Camping should be provided at suitable sites along the north shore of Skilak Lake, west of the confluence with the river in sections 22, 24, and 25. Refuge staff should work closely with the IBBST to ensure that brown bears are not displaced from critical feeding areas above and below Skilak Lake.

Bear locations during both 1996 and 1997 show that the Killey River provides a significant food source and travel corridor from the wilderness habitats between Skilak and Tustumena Lakes to the Kenai River. We had several bears move along this stream. Most of the land in the lower 2 miles of both forks of the Killey is currently in private ownership. To date, little development has occurred on these lands.

However, one large platted subdivision of 160 acres is located right in the middle of this travel corridor. This area has been included within the boundaries of the Critical Habitat Area (CHA). Although legislation for critical habitat areas only impacts state-owned lands, it is our intention to focus attention on this private parcel. If this area becomes developed with recreational or residential housing, it will become a major bear sink (place where bears are killed by humans). Bears traveling down the Killey to the Kenai will be forced to travel through a development. An analysis of defense of life or property kills (DLP's) (Appendix C) from the Kenai Peninsula shows that about 1/3 of all bears killed by people are shot in defense of property at a residence. Improper handling and disposal of garbage, fish waste, livestock offal, dog food and other foods, and confined livestock attract bears into residential areas. Residential development in this area has the potential to impact a significant portion of the entire Kenai brown bear population. We have documented nearly every marked bear from Unit 15B and most from Unit 15A traveling to this ecocenter to feed. The Killey River represents the major travel corridor for bears moving from the mountains between Skilak and Tustumena Lakes to the Kenai River. Consequently, we strongly recommend that these parcels be purchased and protected. The need to act immediately in purchasing these lands is amplified by the newest proposal to complete the bridge across the Kenai River, connecting the Sterling Highway via Scout Lake Road to the Funny River Road. Such a bridge will increase human activities, real estate development, and defense of life or property killing in this area.

During 1996 and 1997 at least 3 bears used both the inlet and outlet at the 2 ends of Skilak Lake. Radio locations for bear number 12 were obtained from a store-onboard GPS unit. This bear moved between the 2 ends of the lake along the north shore (Fig. 4). We did not obtain enough locations to document the exact path taken by the other 2 bears moving between these areas. However, all location points of these bears were on the north side of the lake.

Movements of bears in both 1996 and 1997 were used to identify potential travel corridors connecting large blocks of undisturbed habitat. In 1996, we selected the ends of several large lakes as travel corridors; movement data in 1997 have added other areas (Fig. 5). Several of these possible travel routes include salmon spawning streams and may be important feeding areas for bears.

The first bears entered dens during mid-September, and the last entered dens during late November. Of 12 bears collared during both 1995 and 1996, 7 denned in virtually identical locations in both years. Of the others, 3 denned within 3 miles of their previous dens, 1 denned about 5 miles away, and 1 denned 12 miles away. Bears denned in both mountainous areas and lowland forests. Documentation of radiocollared bears denning in the lowland forests is a new finding; previous studies of brown bears on the Kenai (Jacobs 1989) indicated they denned in rugged mountainous terrain.

Part of the long-term management of the Russian River ecosystem for humans and bears must contain a plan to make human use compatible with brown bear conservation. Certain sections or areas in the ecosystem must be identified as "bear-only areas," most will be identified as "bear and people" areas, and some will ultimately be classified as "people-only" areas. For example, Russian Creek (also referred to as Goat Creek) has been identified as a critical bear ecocenter (here we use the term originally defined by Craighead et al. 1995:322 to refer to areas where bears concentrate at a food source) during the month of August. Bears from much of Unit 15B and parts of Unit 7 migrate here to feed on the spawning red salmon. Human activity in this area is increasing as tourism and sportfishing encroach in Russian Creek. Because of this, we will propose to close the area to sportfishing when bears are using the area. (Appendix D).

The Russian River above the intensive salmon fishery should be managed as a "bear and people" area, whereas the area intensively used by anglers should probably be managed as a "people only" area, where the presence of brown bears will be discouraged. We conducted a user survey (Appendix E) to determine (Appendix F) attitudes of Russian River anglers relative to brown bear conservation and anglers' willingness to change certain activities relative to the fishery and fish waste management. This survey had a confidence level of 95%. Annually brown bear–human conflicts occur, a direct result of anglers' recycling fish waste into the Russian/Kenai

River after harvesting red salmon. The recycling is encouraged by ADF&G Sport Fish Division to return nutrients to the aquatic system where they are used by rearing salmon and trout. This creates an unnatural food source because historically bears probably did not fish for red salmon in these sections of the Russian and Kenai Rivers. In these stretches of river, the fish are not vulnerable to bear predation because of the depth of the river, the glacial silt in the Kenai, and the lack of concentrations of fish. In the past, bears probably used the area below the Russian River Falls as a feeding area, but human activity now precludes use by bears. Results of the survey are presented in Appendix G.

Job. 3. To estimate the survival rate of radiocollared female brown bears relative to human-caused mortality

We had 3 mortalities in 1997. One bear (12) was found dead near the Kenai River where it enters Skilak Lake. She moved to this location on 13 September 1997. We examined the carcass using a metal detector, and no bullet was found. Maggots had consumed the carcass; all that remained was hair and bones. One rear leg was disarticulated from the carcass and moved approximately 50 meters away, evidently by a scavenging coyote. The bones showed no sign of chewing by either small or large carnivores. All bones were visually inspected; none was broken. Because no signs to indicate cause of death were apparent, we recorded the cause of death as unknown. A train hit female 997 on 7 September 1997 5 miles north of Moose Pass while female 997 was defending a moose carcass killed by a previous train. A moose hunter killed female 65 in defense of life or property (DLP) near Lonely Street and Tote Road (Unit 15B). The hunter reportedly encountered the bear at close range on a foggy trail.

We calculated Kaplin–Meyer survival coefficients for active and denning periods for 1995, 1996, and 1997 data (Table 4). Annual rates did not differ between 1995 and 1996 ($X^2 = 0.165$, $P = 0.685$) or between 1996 and 1997 ($X^2 = 0.566$, $P = 0.452$), so we pooled data from the 3 years (Table 5). Survival from May through October was 0.909 (95% CI = 0.846–0.973). We did not observe any mortality from November to April, so survival was 1.0 during the denning period.

Our estimate of annual survival was slightly higher during 1997 than that reported in 1996 (although the difference was not statistically significant). This was expected because in 1996 we had only 15 marked bears and recorded 1 death during the month of May, resulting in a substantial initial drop in survival. The pooled estimate of survival for the active bear season (May–October) represents a better estimate with a 33% tighter confidence interval $\pm$ 0.064 vs. $\pm$ 0.0963. With additional years of data, our estimates of survival will continue to improve.

Job. 4. Model the brown bear population to establish sustainable yield and assess population viability with the goal of developing a brown bear management plan

We continued to refine our estimates of reproductive histories (Table 6) of marked bears. Data are still inadequate at this time to model the Kenai population. We observed 38 litters of cubs of the year. Mean litter size was 2.32. These litters comprised 2 singles (5.2%), 22 twins (57.9%), and 14 triplets (36.8%). We also observed 27 litters of yearlings. These litters comprised 4 singles (14.8%), 17 twins (63.0%), and 6 triplets (22.2%). Mean litter size was 2.07 yearlings.

During the 1995–1997 field seasons we observed 84 cubs of the year, 53 yearlings, and 13 2-year-olds. At least 65 COY and 29 yearlings survived until the next year. All 2-year-old cubs were presumed to have dispersed by June of their third year. Including cubs with unknown fates, we estimated survival of cubs to the yearling age class to be between 0.77 and 0.89. Likewise, survival of yearlings to the 2-year-old age class was between 0.55 and 0.81. These estimates must be refined before a modeling exercise. We provide them for comparative purposes and to show that we may be experiencing a very high rate of yearling mortality.

Job. 5. Prepare a final report.

No work was performed on this job during this report period because of focus on the annual progress report amid personnel changes.

RECOMMENDATIONS

This project is scheduled to run a minimum of 3 years. We recommend continuing data collection through summer field season of 1998.

We also have the following recommendations:

- Develop a conservation strategy for brown bears on the Kenai Peninsula. The IBBST should take the lead in the scientific data analysis and document preparation.

- Consider development of a new field study to evaluate mortality in yearling brown bears.

- Consider development of a new field study in cooperation with Dr. Charles Robbins at Washington State University to evaluate the impacts of reduced usage of salmon feeding areas by bears due to human disturbance. A study design could consider using the 8 GPS store-onboard transmitters programmed to take multiple fixes/day (i.e., every 30 minutes) for a short period (i.e., 1 month). Collars would be used to evaluate the temporal use of streams for bears impacted by human activity (i.e., Goat Creek, Kenai River) vs. bears not disturbed by humans (i.e., Glacier Creek, Bear Creek). Body composition and mass change should be monitored in conjunction with temporal usage to evaluate fat deposition rates. The overall objective of the study would be to determine if bears are capable of obtaining the necessary mass to reproduce and survive the winter when disturbed by humans.

- The cumulative effects model should be tested using the 1995–1997 telemetry locations. Following this test, those model variables that are incorrect should be changed to reflect the test. The new improved model should be verified using 1998 location data. This process should be lead by Lowell Suring of the U.S. Forest Service. Results should be incorporated into the next annual report.

- The cumulative effects model should be tested using the 1995–1997 telemetry locations. Following this test, those model variables that are incorrect should be changed to reflect the test. The new improved model should be verified using 1998 location data. Gino Del Frate, ADF&G, should prepare the UCU map and work in close cooperation with Lowell Suring, USFWS, to do the analysis. Results should be incorporated into the next annual report.

- Once the vegetation GIS layer is developed, resource selection analysis should be performed. An example protocol established for Kenai black bears (Appendix H) lays out the basics for the analysis.

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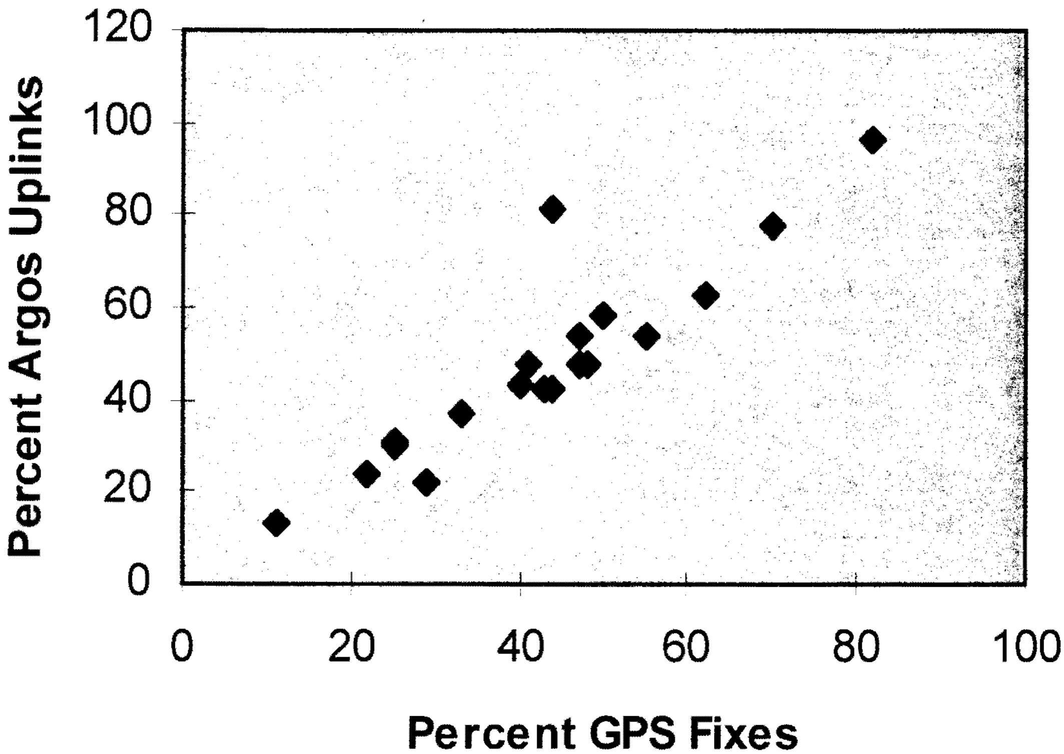

Figure 1. Relationship between the percentage of successful GPS fixes and successful Argos uplinks. Data are from GPS-Argos collars deployed in both 1996 (n = 10) and 1997 (n = 9), respectively.

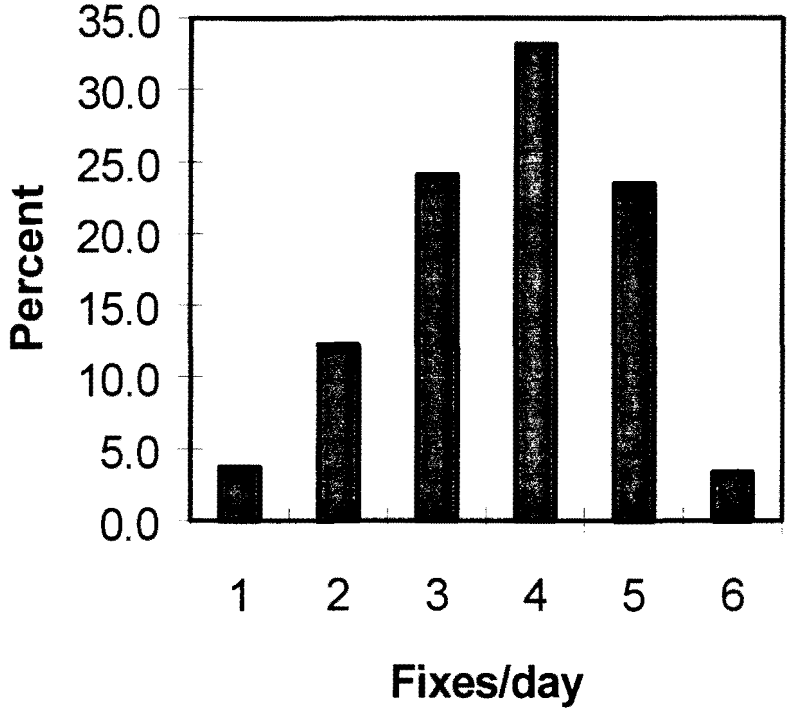

Figure 2. Distribution of actual GPS fixes obtained from the GPS store-onboard collars programmed to take 5 fixes per day.

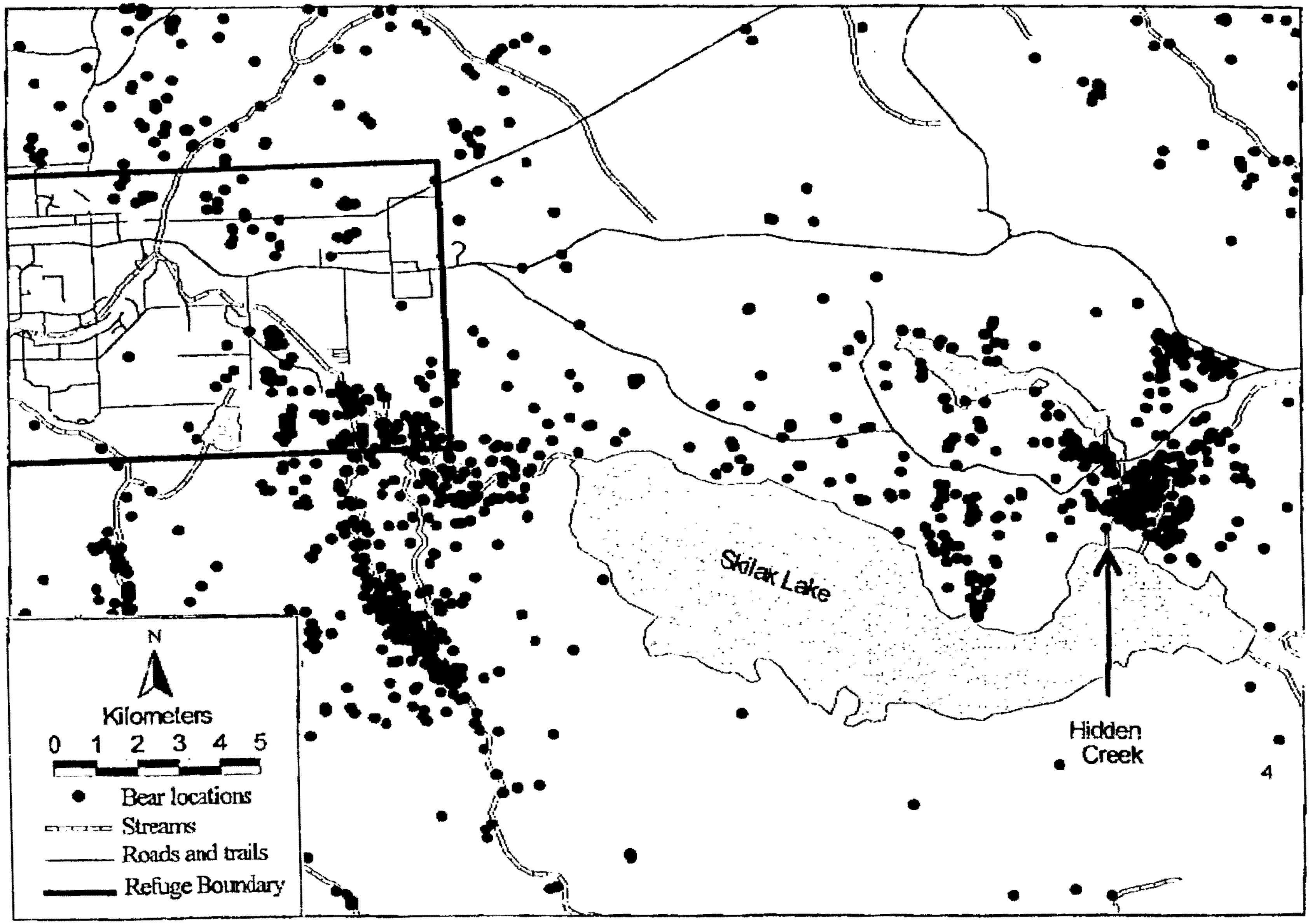

Figure 3. Movements of radiomarked brown bears around Skilak Lake on the Kenai Peninsula, Alaska, 1996–1997

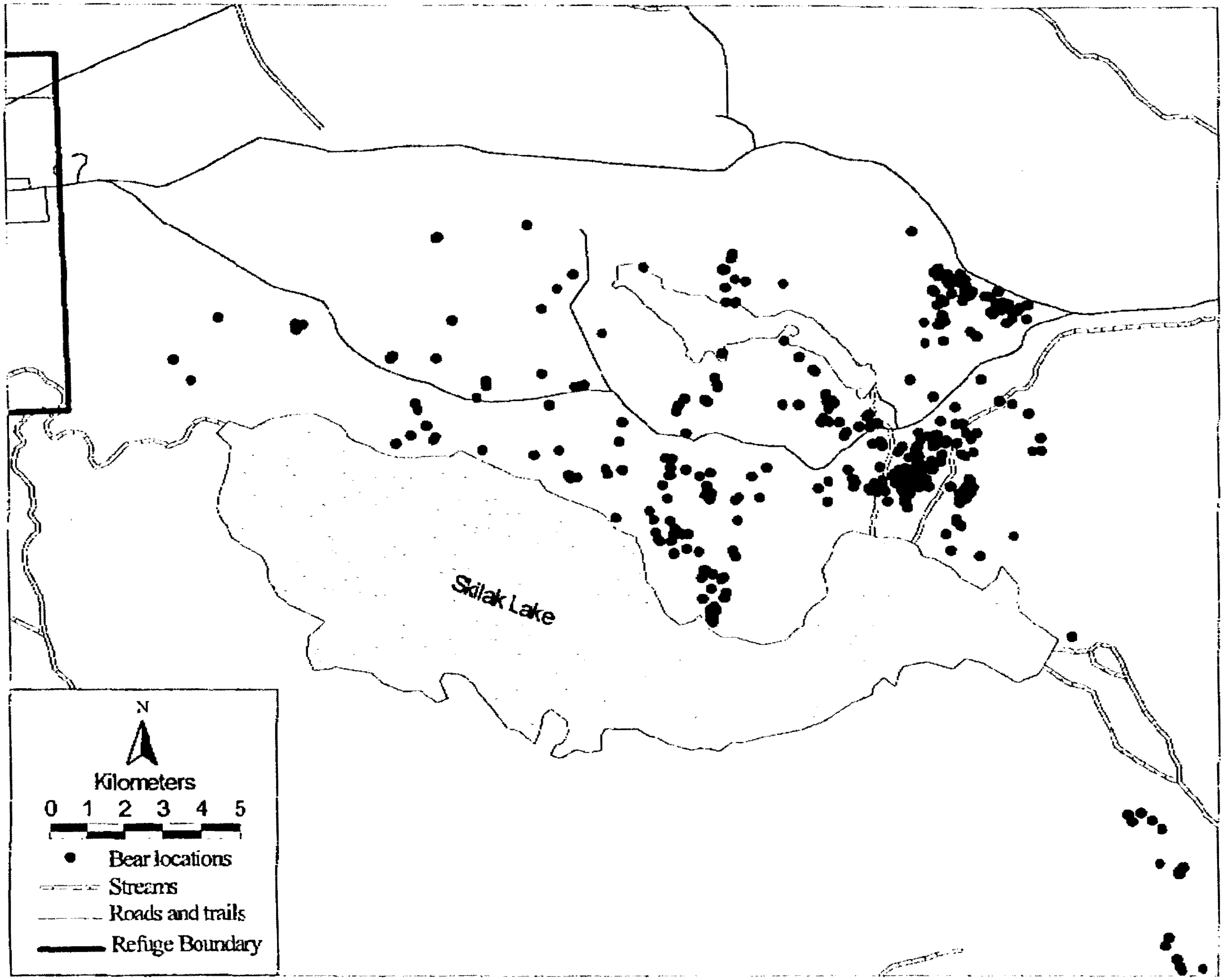

Figure 4. Locations of Bear Nr 12 near Skilak Lake, May–October, 1997

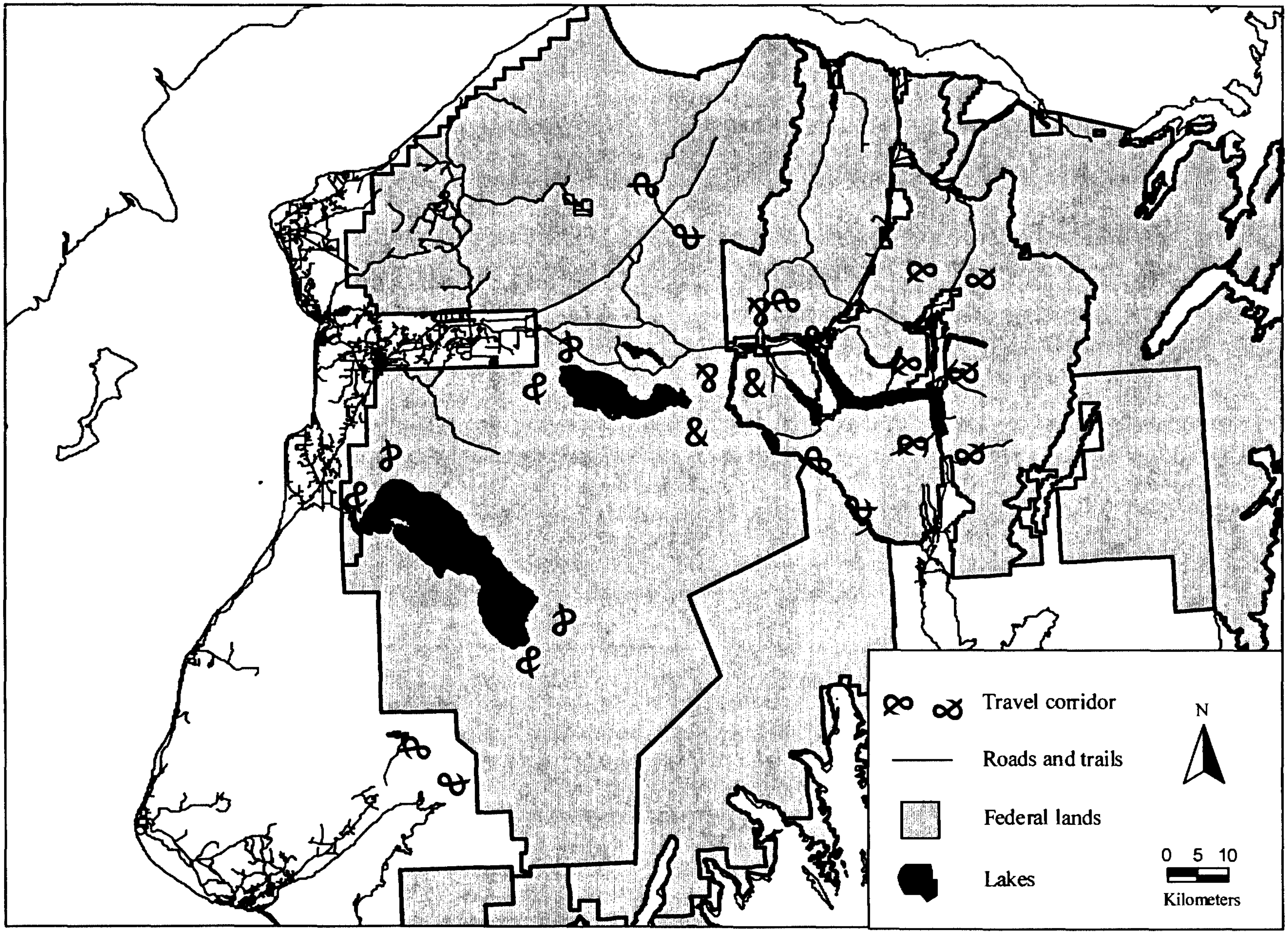

Figure 5. Critical travel corridors for brown bears on the Kenai Peninsula, Alaska.

Table 1 Brown bear radiocollaring and tagging status by sex and age, Kenai Peninsula 1995-1997.

Bear No.	Capture Date	Sex	Age	Tagging Location	Accompanying Bears	Transmitter Type	Last Date Located	Current Status
01	5/19/95	F	3	UPPER MOOSE. CR	alone	Conventional	7/13/95	dead, brwn br predation
02	5/19/95	F	4	TIMBERLINE LK	alone	Conventional	12/3/97	denned
03	5/19/95	F	3	TIMBERLINE LK	With # 02	Conventional	6/2/95	shed collar
04	5/22/95	F	13	BALD MT. S. SIDE	2 yearlings	GPS-PTT*	12/3/97	denned
05	5/30/95	M	13	5 MI S. BIG BAY	alone	Conventional	6/2/95	shed collar
06	5/30/95	F	3	BEAR CREEK	alone	Conventional	5/1/97	shed collar
07	5/30/95	M	1	UPPER MOOSE CREEK	alone	None	5/30/95	unknown
08	5/30/95	M	1	UPPER MOOSE CREEK	alone	None	5/30/95	unknown
09	5/31/95	F	7	N. TIMBERLINE LK	alone	Conventional	12/3/97	denned
11	5/31/95	F	12	W. KILLEY RIVER	3- c.o.y.	Conventional	5/22/97	active
12	5/31/95	F	16	SKILAK GLACIER	3-2 yr. olds	GPS-stored*	10/8/97	dead, cause unknown
13	6/2/95	F	7	HW. COTTONWOOD CR	alone	Conventional	12/3/97	denned
14	6/5/95	F	7	GOAT LAKE	2-yearlings	Conventional	12/3/97	denned
15	6/5/95	F	20	GOAT LAKE	2- c.o.y.	Conventional	12/3/97	denned
16	6/5/95	F	5	EMMA LAKE	alone	Conventional	5/7/96	denned
17	6/8/95	M	2	FOREST LANE	alone	Conventional	6/8/95	unknown
18	6/9/95	F	7	CARIBOU HILLS	2 2-year olds?	Conventional	8/10/95	shed collar
19	6/20/95	F	5	S. SIDE MT. ADAIR	2- c.o.y.	Conventional	12/3/97	denned
20	7/26/95	M	0	PIPELINE		None	7/26/95	unknown
21	8/14/95	F	8	GLACIER CREEK	1- c.o.y.	Conventional	12/3/97	denned
22	10/4/95	F	3	GLACIER FLATS	alone	Conventional	5/7/96	dead, cause unknown

Table 1 Continued

Bear No.	Capture Date	Sex	Age	Tagging Location	Accompanying Bears	Transmitter Type	Last Date Located	Current Status
23	4/30/96	M	3	CHICKALOON FLATS	alone	None	4/30/96	capture mortality
24	4/30/96	F	7	ELEPHANT LAKE	3- c.o.y.	GPS-PTT*	12/3/97	denned
25	5/6/96	M	4	CARIBOU HILLS	alone	None	5/6/96	unknown
26	5/16/96	M	12	CARIBOU HILLS	alone	Ear tag	6/4/96	unknown
27	5/16/96	M	4	CARIBOU HILLS	alone	None	5/16/96	unknown
28	5/17/96	F	8	BALD MOUNTAIN	3 cubs	GPS-PTT*	10/10/96	shed collar
29	5/17/96	F	6	ANCHOR RIVER	2- c.o.y.	GPS-PTT*	12/3/97	denned
30	5/19/96	F	9	TRUULI CANYON	2 yearlings	GPS-PTT*	10/8/96	dead? not confirmed
31	5/20/96	F	10	MYSTERY CREEK	3- c.o.y.	Conventional	8/14/97	shed collar
32	5/21/96	F	8	FALLS CREEK	3- c.o.y.	Conventional	12/3/97	denned
33	5/22/96	F	7	THURMAN CREEK	1-yearling	GPS-stored*	12/3/97	denned
34	5/22/96	F	2	DIKE CREEK	2- c.o.y.	Conventional	12/3/97	denned
35	5/22/96	M	2	DIKE CREEK	alone	None	5/22/96	unknown
36	5/23/96	M	10	MYSTERY CREEK	alone	Ear tag	5/28/96	unknown
37	5/28/96	F	8	SKILAKE OUTLET	3- c.o.y.	Conventional	12/9/97	denned
38	5/29/96	M	6	SHAFT CREEK	with #32	Ear tag	11/1/96	denned
39	7/1/96	F	6	TUSTUMENA BENCH	alone	Conventional	4/3/97	denned
40	7/15/96	F	13	MYSTERY CREEK	2-yearlings	Conventional	12/9/97	denned
41	7/16/96	F	9	MOOSE CREEK	2-yearlings	Conventional	12/3/97	denned
42	7/16/96	F	10	SLIKOK LAKE	2-yearlings	GPS-stored*	12/9/97	denned
44	10/17/96	F	15	SKILAK OUTLET	3-c.o.y.	Conventional	7/30/97	shed collar
45	10/17/96	F	10	SKILAK OUTLET	3-yearlings	Conventional	12/3/97	denned

Table 1 Continued

Bear No.	Capture Date	Sex	Age	Tagging Location	Accompanying Bears	Transmitter Type	Last Date Located	Current Status
46	10/17/96	F	10	SKILAK OUTLET	2-yearlings	GPS-stored*	12/3/97	denned
47	10/22/96	F	8	SKILAK OUTLET	2-yearlings	Conventional	12/3/97	denned
48	10/22/96	F	10	SKILAK OUTLET	alone	Conventional	4/3/97	denned
49	10/22/96	F	8	SKILAK OUTLET	1-yearling	GPS-stored*	12/9/97	denned
50	10/22/96	M	1	SKILAK OUTLET	alone	Conventional	10/6/97	shed collar
51	5/11/97	F	15	DEEP CREEK	alone	GPS-PTT*	12/3/97	denned
52	5/16/97	F	10	THURMAN CREEK	alone	GPS-PTT*	5/18/97	shed
53	5/16/97	F	3	MYSTERY HILLS	alone	Conventional	5/21/97	shed
54	5/16/97	F	6	GOLD GULCH	alone	GPS-PTT*	12/3/97	denned
55	5/18/97	F	13	HILL 26	3-c.o.y.	GPS-PTT*	12/3/97	denned
56	5/18/97	M	0	NOT RECORDED	unknown	None	00/00/00	unknown
57	5/18/97	M	3	NOT RECORDED	unknown	None	00/00/00	unknown
58	5/19/97	F	10	ICE LAKE	1-c.o.y.	GPS-PTT*	12/9/97	denned
59	5/20/97	F	8	NOT RECORDED	3 yearlings	GPS-PTT*	12/3/97	denned
60	5/20/97	F	12	NOT RECORDED	2 yearlings	GPS-PTT*	8/29/97	missing
61	5/30/97	F	12	NOT RECORDED	2-c.o.y.	Conventional	12/3/97	denned
62	5/30/97	F	5	SHAFT CREEK	alone	Conventional	12/3/97	denned
63	5/31/97	F	8	GRANT LAKE	alone	GPS-stored*	12/3/97	denned
64	6/2/97	M	15	NOT RECORDED	unknown	None	00/00/00	unknown
65	7/18/97	F	3	FUNNY RIVER	alone	Conventional	9/2/97	dead, recorded DLP
66	9/10/97	F	7	HIDDEN CREEK	2-c.o.y.	Conventional	12/9/97	denned
67	9/10/97	F	6	HIDDEN CREEK	2-c.o.y.	Conventional	12/3/97	denned

Table 1 Continued

Bear No.	Capture Date	Sex	Age	Tagging Location	Accompanying Bears	Transmitter Type	Last Date Located	Current Status
68	9/11/97	F	12	JOHNSON CREEK	2-c.o.y.	Conventional	12/3/97	denned
69	10/6/97	F	11	FOX RIVER	alone	Conventional	12/3/97	denned
70	10/8/97	F	7	UPPER RUSSIAN LAKE	2-c.o.y.	Conventional	12/3/97	denned
71	10/13/97	F	8	UPPER RUSSIAN LAKE	3-c.o.y.	Conventional	12/3/97	denned
72	10/13/97	F	10	UPPER RUSSIAN LAKE	2-c.o.y.	Conventional	12/3/97	denned
997	5/30/97	F	10	SHAFT CREEK	alone	GPS-stored*	9/2/97	dead, hit by train

*GPS-PTT collars contain satellite transmitters; GPS-stored collars stored location data on-board. GPS collars were replaced with conventional collars during September - October 1997, except for bear #32, who was already in a den.

Table 2 Success rates for good fixes and uplinks for GPS-Argos transmitters deployed on brown bears on the Kenai Peninsula, Alaska, 1996 and 1997. GPS units were programmed to take 1 fix every 23 hours in 1996 and every 13 hours in 1997.

PTT #	Days Deployed	Fixes (n)	Percent Fixes	Possible Uplinks (n)	Actual Uplinks (n)	Percent Uplinks
10911	101	29	29	41	9	22
10916	93	44	47	37	20	54
10918	146	70	48	58	28	48
10919	164	72	44	65	27	42
10920	147	91	62	59	37	63
10921	147	63	43	59	25	42
10922	145	36	25	58	18	31
10923	116	64	55	46	25	54
10924	94	21	22	38	9	24
10925	94	10	11	37	5	13
1996 Total	1247	500	38(16)[1]	498	203	39(16)[1]
10911	148	140	47	100	48	48
10916	148	119	40	100	43	43
10918	124	61	25	84	25	30
10919	146	96	33	98	36	37
10920	62	54	44	43	35	81
10921	114	94	41	77	37	48
10922	117	117	50	79	46	58
10924	141	198	70	95	74	78
10925	101	166	82	68	65	96
1997 Total	1101	1045	48(18)[1]	744	409	58(22)[1]
Both Years	2348	1545	43[2]	1242	612	48[2]

[1]Weighted by PTT, standard deviation in parentheses.
[2]Weighted by year.

Table 3 GPS fix rate for store on board collars deployed on brown bears on the Kenai Peninsula, Alaska, 1996 and 1996. GPS units were programmed to take 5 fixes/day.

Year	Days Deployed	Potential Fixes (*n*)	Actual Fixes (*n*)	Percent Fixes	Days Fixed	Percent Days Fixed
1996	142	593	299	50	127	89
1996	87	367	246	67	86	99
1997	162	674	423	63	155	96
1997	170	705	521	74	169	99
1997	152	630	389	62	146	96
1997	176	732	528	72	168	96
1997	104	431	250	58	103	99
1997	137	568	401	71	136	99
1997	101	418	267	64	98	97
Total	1231	5118	3324	65[1]	1188	97[1]

[1]Weighted by GPS unit.

Table 4 Annual Kaplin-Meyer survival estimates for female brown bears on the Kenai Peninsula. Survival was based on a year which began on 1 November and ended 31 October, except in 1995 when the study began.

Period	Year	Month	At Risk	Deaths	Censors	Captures	Survival	Lower	Upper
1	1995	06	8	0	1	6	1.00000	1.00000	1.00000
1	1995	07	13	1	0	0	0.92308	0.78391	1.00000
1	1995	08	12	0	1	2	0.92308	0.77822	1.00000
1	1995	09	13	0	0	0	0.92308	0.78391	1.00000
1	1995	10	13	0	0	1	0.92308	0.78391	1.00000
2	1995	11	14	0	0	0	1.00000	1.00000	1.00000
2	1995	12	14	0	0	0	1.00000	1.00000	1.00000
2	1996	01	14	0	0	0	1.00000	1.00000	1.00000
2	1996	02	14	0	0	0	1.00000	1.00000	1.00000
2	1996	03	14	0	0	0	1.00000	1.00000	1.00000
2	1996	04	14	0	0	1	1.00000	1.00000	1.00000
3	1996	05	15	1	1	8	0.93333	0.81138	1.00000
3	1996	06	21	0	0	0	0.93333	0.83026	1.00000
3	1996	07	21	0	0	4	0.93333	0.83026	1.00000
3	1996	08	25	0	0	0	0.93333	0.83887	1.00000
3	1996	09	25	0	0	0	0.93333	0.83887	1.00000
3	1996	10	25	1	1	6	0.89600	0.78273	1.00000
4	1996	11	29	0	0	0	1.00000	1.00000	1.00000
4	1996	12	29	0	0	0	1.00000	1.00000	1.00000
4	1997	01	29	0	0	0	1.00000	1.00000	1.00000
4	1997	02	29	0	0	0	1.00000	1.00000	1.00000
4	1997	03	29	0	0	0	1.00000	1.00000	1.00000
4	1997	04	29	0	1	0	1.00000	1.00000	1.00000
5	1997	05	29	0	3	11	1.00000	1.00000	1.00000
5	1997	06	37	0	3	0	1.00000	1.00000	1.00000
5	1997	07	34	0	0	1	1.00000	1.00000	1.00000
5	1997	08	35	0	3	0	1.00000	1.00000	1.00000
5	1997	09	32	2	0	3	0.93750	0.85629	1.00000
5	1997	10	33	1	0	4	0.90909	0.81557	1.00000
6	1997	11	36	0	0	0	1.00000	1.00000	1.00000
6	1997	12	36	0	0	0	1.00000	1.00000	1.00000

Table 5 Non-denning period Kaplin-Meyer survival estimates for female brown bears on the Kenai Peninsula from May through October. Survival estimated for years 1995–1997 were not significantly different ($P < 0.05$) so all years are combined.

MONTH	AT RISK	DEATHS	SURVIVAL	LOWER	UPPER
5	44	1	0.97727	0.93374	1.00000
6	66	0	0.97727	0.94173	1.00000
7	69	1	0.96311	0.91946	1.00000
8	72	0	0.96311	0.92038	1.00000
9	70	2	0.93559	0.87997	0.99122
10	71	2	0.90924	0.84552	0.97295

Table 6 Reproductive status of radiocollared brown bears on the Kenai Peninsula Alaska, 1993-1997. Bears were collared beginning in 1995. Question marks indicating unknown litter sizes are back projections based upon the reproductive status of the female at time of capture. COY are cubs of the year, 1YR are yearlings, and 2YR are 2-year-old offspring; numbers of offspring are listed in parentheses.

Bear ID	Birth Year	1993	1994	1995	1996	1997	Comments
01	1992			0			DEAD 7/95
02	1991	COY(?)	1YR(?)	2YR(1)	COY(2)	1YR(2)	
03	1992			0	LOST		
04	1982		COY(?)	1YR(2)	COY(2)	1YR(2)	NOTE 1
06	1992			0	0	0	SHED 5/97
09	1988		COY(?)	1YR(2)	COY(3)	1YR(3)	NOTE 1
11	1983			0	COY(3)	1YR(3)	SHED 6/97
12	1979			COY(3)	1YR(3)	2YR(3)	DEAD 9/97
13	1988			0	COY(2)	1YR(2)	
14	1988		COY(?)	1YR(2)	2YR(2)	COY(2)	
15	1975	COY(?)	1YR(?)	2YR(2)	0	COY(2)	
16	1990		COY(?)	1YR(2)	2YR(2)		SHED 5/96
18	1988	COY(?)	1YR(?)	2YR(2)			SHED 8/95
19	1990			0	COY(2)	COY(2)	
21	1987		COY(?)	1YR(2)	0	COY(1)	NOTE 2
22	1992			0	0		DEAD 5/96
24	1987				COY(3)	COY(3)	NOTE 3
28	1986				COY(3)		SHED 10/96
29	1991			COY(?)	1YR(1)	COY(2)	
30	1984			COY(?)	1YR(2)		DEAD 10/97
31	1978			COY(?)	1YR(3)	COY(3)	NOTE 4
32	1987				0	COY(3)	
33	1991				COY(2)	1YR(1)	
34	1994				0	0	
37	1983				0	COY(3)	
39	1989			COY(?)	1YR(2)		SHED 5/97
40	1977				COY(2)	1YR(2)	
41	1987				COY(2)	1YR(2)	
42	1988				COY(2)	1YR(2)	
44	1988				0	COY(3)	SHED 8/97
45	1988				COY(3)	1YR(3)	
46	1986				COY(2)	1YR(2)	
47	1982				COY(2)	1YR(2)	
48	1989				COY(3)	0	
49	1990				COY(1)	1YR(1)	
51	1981					0	
52	1985			COY(?)	1YR(?)	2YR(1)	SHED 6/97
53	1995					COT(2)	SHED 6/97
54	1990			COY(?)	1YR(?)	2YR(2)	
55	1987					COY(3)	
58	1989				COY(?)	1YR(1)	
59	1991				COY(?)	1YR(3)	
60	1987				COY(?)	1YR(2)	
61	1990					COY(2)	

Table 6 Continued

Bear ID	Birth Year	1993	1994	1995	1996	1997	Comments
62	1994					0	
63	1991					COY(2)	
65	1995					0	DEAD
9/97							
66	1990					COY(2)	
67	1992					COY(2)	
68	1986					COY(2)	
69	1990					0	
70	1991					COY(2)	
71	1989					COY(3)	
72	1987					COY(2)	
997	1993				0	0	DEAD

Notes:

1. '95 yearlings were never seen after the mother was captured.
2. '95 yearlings were seen with the mother after capture (Jul–Aug) but not seen in 1996.
3. Ages of bears 24–49 were estimated in the field based on tooth eruption and wear.
4. 96 yearlings were never seen after the mother was captured, #31 shed collar 8/97

APPENDIX A. Diet and Body Composition of Brown Bears of the Kenai Peninsula.

Grant Hilderbrand
Washington State University

BACKGROUND

The objective of this study is to determine the seasonal importance of food resources available to brown bears (*Ursus arctos*) on the Kenai Peninsula (KP) and the impact of these resources on bear body mass and composition. Additionally, the diet and productivity of the KP's brown bear population will be compared to those of other brown bear populations in Alaska, Canada, Pakistan, and the lower 48 states which differ in their available food resources. Finally, the annual diet of the KP's black bears (*U. americanus)* will be assessed to determine if resource partitioning occurs between the peninsula's sympatric brown and black bear populations.

METHODS

Bear Captures

To assess the seasonal changes in body mass and composition and determine the importance of available food resources, adult female brown bears were captured during three time periods: 1) early spring, after den emergence, 2) mid-summer, concurrent with the arrival of the summer runs of salmon, and 3) fall, prior to denning. The third capture was conducted in two phases. The first phase focused on solitary females which were likely pregnant and, therefore, likely to den early. The second phase occurred later and focused on females with offspring. At each capture, the bears were weighed using an electronic load cell (+/- 0.2 kg) and their body composition estimated. Samples of hair and blood were also collected for isotopic analyses of bear diet. Samples of brown bear hair from other populations were donated by various researchers and black bear hair samples were collected from bears harvested on the KP.

Body Composition

The body composition of captured bears was determined by bioelectrical impedance analysis (BIA) and/or isotopic water dilution according to Farley and Robbins (1994). When possible, both methods were performed as this results in the most accurate measure of body composition (Hilderbrand et al., in press).

Stable Isotope Analyses

The contribution of salmon, terrestrial meat, and vegetation to the diet of the KP's brown bears was determined by isotopic analyses of collected hair, blood, and food samples according to Hilderbrand et al. (1996). Brown bear hair samples from several populations in Alaska, Pakistan, Russia, Canada, and the lower 48 states and black bear hair samples from KP have been collected and analyzed for their isotopic content.

Statistical Analyses

Paired samples were compared using paired t-tests and results were reported as p-values (designated as p_p). Independent samples were compared using two-sample t-tests and results were reported as p-values (designated as p_i). If paired data occurred within the two samples, one value was randomly removed from each pair prior to analysis.

RESULTS AND DISCUSSION

Body Composition

Body mass ($p_i = 0.9930$), LBM ($p_i = 0.7956$), and body fat (kg: $p_i = 0.8265$; %: $p_i = 0.9820$) did not differ between the two phases of fall captures and the values from the two captures were therefore combined for statistical analyses. Adult female body mass increased between spring and summer (spring = 151.0 kg, summer = 191.2 kg, $p_p = 0.0009$, $p_i = 0.0224$). The difference in body mass was due to an increase in lean body mass (LBM; spring = 120.1 kg, summer = 157.7 kg, $p_p = 0.0024$, $p_i = 0.0017$) as body fat did not change significantly (spring = 32.2 kg, summer = 35.7 kg, $p_p = 0.7283$, $p_i = 0.9756$). Adult female mass increased significantly between summer and fall (fall = 224.9 kg, $p_p < 0.0001$, $p_i = 0.0401$). During this period, LBM did not change significantly (fall = 157.5, $p_p = 0.0907$, $p_i = 0.7414$) while stores of body fat increased (fall = 67.3 kg, $p_p = 0.0044$, $p_i = 0.0004$). The proportion of body fat did not change between spring and summer (spring = 21.3 %, summer = 17.6 %, $p_p = 0.2031$, $p_i = 0.0611$) but increased between summer and fall (fall = 30.5 %, $p_p = 0.0135$, $p_i = 0.0001$). Fall body mass ($fall_{96}$ = 263.8 kg, $p_i = 0.0056$) and body fat ($fall_{96}$ = 106.1 kg, $p_i < 0.0001$; $fall_{96}$ = 40.3 %, $p_i < 0.0001$) were lower in 1997 than in 1996. Fall LBM did not change between years ($fall_{96}$ = 157.8, $p_i = 0.9794$). No other differences between years were detected.

Stable Isotopic Analyses (1996 samples)

The spring diet of the KP's brown bears was composed of terrestrial meat (83.2 +/- 21.2%) and vegetation (16.8 +/- 21.1%). Fall diets were composed of salmon (61.7 +/- 24.3%), terrestrial meat (13.3 +/- 22.7%), and vegetation (25.0 +/- 15.6%). The contribution of salmon ($p_p = 0.0001$, $p_i < 0.0001$) and terrestrial meat ($p_p = 0.0001$, $p_i < 0.001$) differed between seasons but the contribution of vegetation did not ($p_p = 0.1318$, $p_i = 0.6416$). The diet of the KP's black bears, determined by isotopic analyses of hair, consisted of salmon (8.2 +/- 18.4%), terrestrial meat (34.2 +/- 25.0%), and vegetation (57.5 +/- 21.7%). The contribution of salmon ($p_i < 0.001$), terrestrial meat ($p_i = 0.0088$), and vegetation ($p_i < 0.0001$) differed by species.

CONCLUSIONS

The period between the summer and fall captures was important for bears to attain fat stores which are necessary to support cub production and lactation (Farley and Robbins 1995). Salmon was the most important nutritional resource available to brown bears during this time interval. Additionally, resource partitioning does occur between the KP's sympatric brown and black bear populations.

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HILDERBRAND, G.V., S.D. FARLEY, C.T. ROBBINS, T.A. HANLEY, K. TITUS, AND C. SERVHEEN. 1996. Use of stable isotopes to determine diets of living and extinct bears. Can. J. Zool. 74:2080-2088.

Table 1 Seasonal body composition of adult female brown bears

Bear ID	Date	Mass (kg)	Fat (%)	Fat (kg)	LBM (kg)
Spring					
49	113	129.7	-----	-----	-----
42	113	117.1	25.7	30.1	87.0
12	120	191.5	29.4	56.3	135.2
04	131	203.0	19.0	38.6	164.4
29	131	123.1	21.2	26.1	97.0
51	131	156.0	17.3	27.0	129.3
46	132	176.8	23.9	42.3	134.5
33	135	150.0	8.9	13.4	136.7
52	136	151.2	26.5	40.0	111.1
54	136	134.8	10.1	13.6	121.9
55	138	142.9	19.5	27.9	115.0
58	139	166.7	20.4	34.0	132.7
32	140	153.4	23.1	35.4	118.0
59	140	131.8	21.2	27.9	103.9
60	140	129.8	23.0	29.9	99.9
61	150	152.5	27.4	41.8	110.7
62	150	138.8	19.3	26.8	112.0
997	150	160.1	22.7	36.3	123.8
63	151	147.9	27.5	40.7	107.2
24	152	162.0	17.8	28.8	133.2
Summer					
12	198	232.0	14.5	33.6	198.4
33	198	171.3	9.4	16.1	155.2
54	198	171.6	12.9	22.1	149.5
58	198	203.4	26.9	54.7	148.7
59	199	151.6	12.2	18.5	133.1
60	199	140.0	11.9	16.7	123.3
63	199	189.4	16.6	31.4	158.0
42	200	205.5	23.1	47.5	158.0
04	201	-----	-----	-----	-----
41	201	256.4	23.8	61.0	195.4
Fall					
66	253	246.2	38.2	94.0	152.2
67	253	215.8	23.5	50.7	165.1
58	253	240.0	27.4	65.8	174.2
63	254	248.5	37.2	92.4	156.1
68	254	178.5	26.8	47.8	130.7
55	255	219.5	29.8	65.4	154.1
51	255	-----	-----	-----	-----
29	279	184.2	32.6	60.0	124.2
04	279	-----	-----	-----	-----

Table 1 Continued

Bear ID	Date	Mass (kg)	Fat (%)	Fat (kg)	LBM (kg)
Fall continued					
69	279	271.8	41.1	111.7	160.1
70	281	226.0	27.6	62.4	163.6
59	281	197.4	29.3	57.8	139.6
49	282	213.8	28.6	61.1	152.7
54	282	210.4	29.3	61.6	148.8
71	286	223.0	30.4	67.8	155.2
72	286	240.2	28.1	67.5	172.7
33	286	223.5	27.6	61.7	161.8
24	288	232.5	26.5	61.6	170.9
42	288	250.7	27.0	67.7	183.0

Appendix B. Leaflet prepared for public information about the Kenai River Critical Habitat Area

Kenai River Critical Habitat Information Leaflet

Why a Critical Habitat Area?

The purpose of a Critical Habitat Area (CHA) as defined under Alaska Statute AS16.20.500-16.20.690 "is to protect and preserve habitat areas especially critical to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose." This document contains information about a proposal to develop a critical habitat area for fish and wildlife below Skilak Lake on the Kenai River.

The Proposed Area

The Kenai River immediately below Skilak Lake, from river mile 50 downstream to about mile 41, represents very valuable and unique fish and wildlife habitat. The boundaries of the proposed area (Fig. 1) include a mix of land ownership. The CHA legislation will only impact state-owned lands.

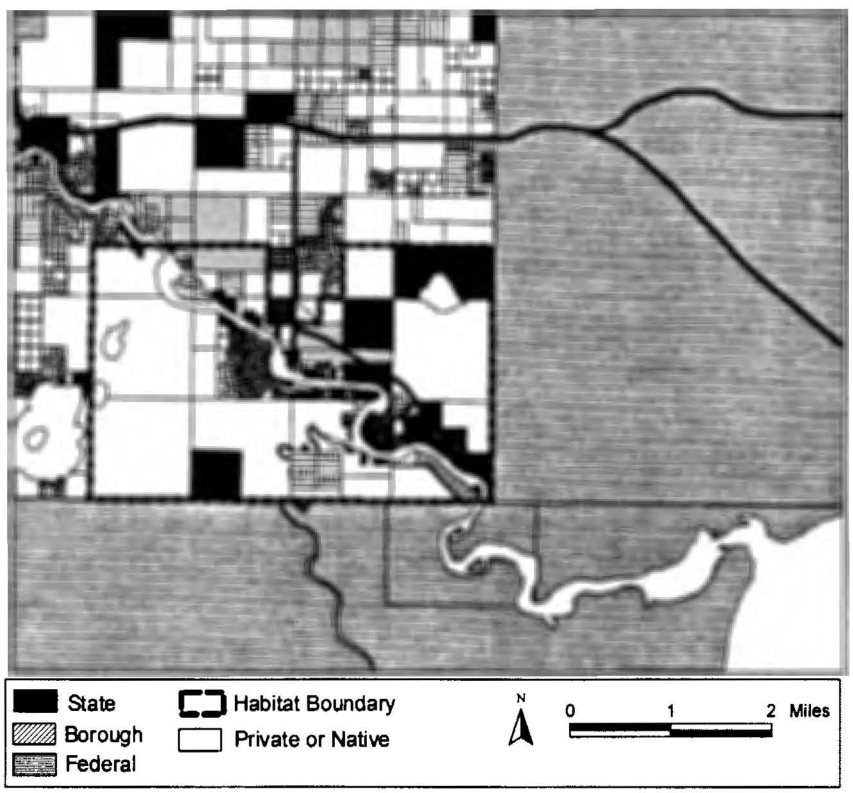


Figure 1. Proposed boundaries of the CHA. Skilak Lake is located in the lower right of the figure with the Kenai River in white. The black lines represent the Sterling highway and Skilak Loop Roads.

The boundaries were chosen to include areas important to brown bears, which feed on the river but rest during the day 1-2 miles from the river bank. Additionally, it is clear from research programs that brown bears use the Killey River as a travel corridor to move from the high mountain bench between Skilak and Tustumena Lakes to the Kenai River. Within the CHA, most of the "private" lands with the exception of the Kenai Keys and Dow Island are native corporation lands. These lands were included within the CHA with the hope of future purchase. Nearly all these lands are currently undeveloped (Fig. 2). Additionally, a large block of land on the Kenai National Wildlife Refuge has been identified for inclusion in the CHA (Fig 3). The US Fish & Wildlife Service can enter into a cooperative agreement with the state to manage their lands in accordance with the legislation of the CHA. Such an agreement will ensure protection of all critical habitat components.

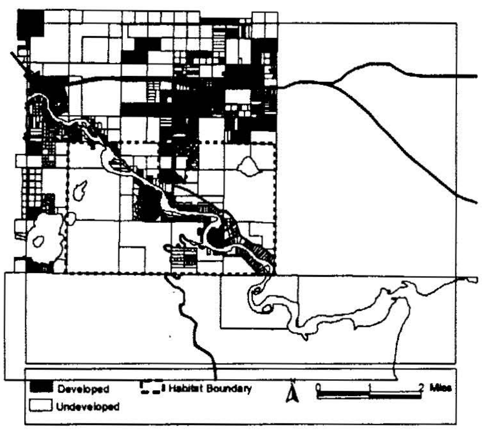


Figure 2. Undeveloped lands within the CHA.

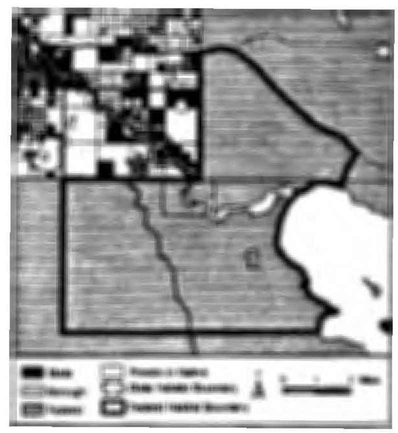


Figure 3. Lands on the KNWR included in CHA

Unique Features of the CHA

Identifying this area under the "critical fish and wildlife habitat" classification will maintain the integrity of this portion of the Kenai Peninsula ecosystem for spawning salmon and the mammals and birds that rely on this fish resource. This area has been identified for the following reasons:

Fish

- This area represents a major spawning area for most of the second run of Kenai River red salmon. Up to 50% of the total 2nd run (600,000–800,000 fish escapement) spawn in this section of the river, making it the most important red salmon spawning area in the Kenai River below Skilak Lake. The area is also a major spawning area for pink, king, and silver salmon during the summer and fall.
- This area is the only known spawning habitat area of winter silver salmon in the lower river.
- The area is also an important rearing and migratory habitat for juvenile king and sockeye salmon. Red salmon fry emerging from the gravel rear in this area and move through this section of river on their way to Skilak Lake. Maintaining streamside vegetation is critical to maintaining correct water velocity to ensure ease of migration.

- This section of river contains some of the best rainbow trout and Dolly Varden habitat in the lower river and is well known for its excellent fishery.
- In addition, there are at least 11 other species of freshwater fish inhabiting this section of river.

Mammals

- Because of this rich salmon resource, many species of mammals concentrate here to feed on spawned-out and dead fish. The area is critical to the Kenai Peninsula brown bear population. Studies by Alaska Department of Fish & Game identified at least 34 individual bears feeding in this area on one day. Thirty-four bears represents 12% of the estimated brown bear population of 277 bears on the peninsula. No other stream on the Kenai Peninsula is known to have such high brown bear use (Fig. 4).

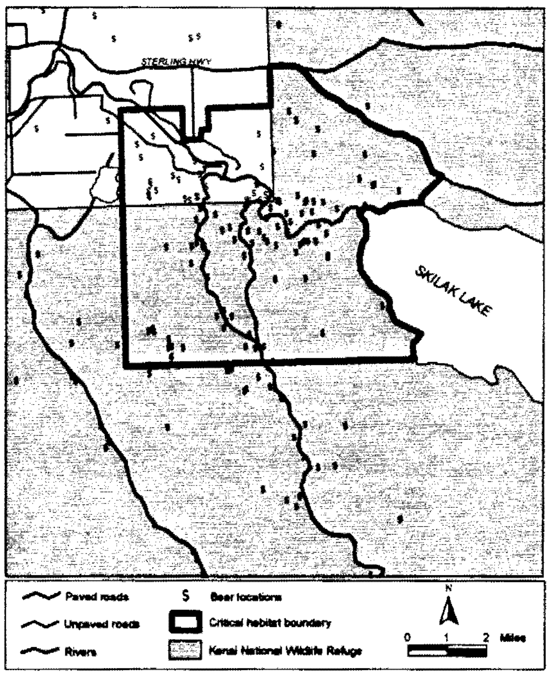


Figure 4. Brown bear locations within the CHA

- Of particular importance is the fact that most of the bears using the area are adult females with cub or yearling offspring. Bears of all ages, but especially females with young, come to this area to feed on salmon. A large amount of stored fat is necessary for bears to survive during denning, and carcasses of spawned-out salmon are an abundant and easily obtainable food source. Bears from as far north as Point Possession and as far south as Tustumena Lake migrate to this area to feed. Loss of streamside habitats due to developments represent a direct threat to long-term survival of the population. Bears use this area intensively from mid-September through October.

- Females with cubs loose weight in early summer due to lactation demands. These females gain most of their weight in late summer, but must feed longer than males and lone females to replenish their reserves. This area provides that important nutrient source.
- River otter, wolves, mink, weasel, coyotes, lynx and black bears also use the area. These species also are attracted to the area's salmon resource. There is probably no other location on the peninsula where all of the major carnivores concentrate in a single place.

Birds

- Because of the thermal nature of Skilak Lake, this section of the Kenai River remains open during much of the winter. This open water habitat is an important feeding area to numerous bald eagles, attracted to the area by the spawning salmon. Studies by Kenai National Wildlife Refuge biologists document bald eagle numbers along Kenai River that are second only to eagle concentrations on the world famous Chilkat River.
- This area is a staging area for trumpeter swans and many species of ducks. This section of river also provides some of the first open water to returning waterfowl in the spring.

Proposed Legislation

There is no bill drafted at this time. The bill will contain language that provides permanent protection for the riparian habitat that supports the unique populations of fish and game using the area, including salmon, bald eagles, and furbearers. It will also provide protection for a significant portion of the Kenai Peninsula brown bear population that use the area as a critically important feeding and travel area. The bill will manage human uses and activities in a manner that is compatible with the protection of habitat and fish and game populations.

Human Use Management

The proposed critical habitat is intended to protect state lands. Very little change should result to existing human uses. The only activities that might change are associated with separating humans and brown bears during the period when the bears are actively feeding on fish. Bears use the area at night, so very little change is anticipated. The following briefly describes possible management actions:

- **Fishing.** Most fishing activity is currently compatible with the CHA designation. Most king, red, and silver salmon fishing occurs from boats during the day and has no impact on bears. The red salmon fishing that occurs from the bank is during the summer before large numbers of brown bears arrive in the area to eat the spawned-out fish. The only fishing that may be incompatible is bank fishing during late September and October. The large number of bears feeding in the area at this time creates a public safety problem. Two fishermen were mauled by a brown bear in September of 1996. The area is currently closed to silver salmon fishing after September.

- **Hunting.** Hunting activity is compatible with the CHA designation and would not change because of it.

- **Camping and Hiking.** Most camping and hiking are compatible with the CHA designation. The only exception would be during late September and October when there is a large concentration of bears using the area. Both uses have the potential for bear/human encounters and would also discourage bears from freely using the area to feed.

- **Boating.** The current forms of boating are compatible with the CHA designation.

- **Airplane/helicopter fly-over.** Aircraft use in the area is compatible with CHA designation.

Endorsements

The CHA concept has received endorsements from the following groups:

- Alaska Flyfishers
- Cooper Landing Fish & Wildlife Advisory Board
- Safari Club
- Alaska Bowhunters
- Alaska Outdoor Council
- Kenai River Watershed Forum
- Kenai River Landowners Association

Additionally the area has been identified in the Kenai River Special Management Plan as an area for Critical Habitat designation.

Senator John Torgerson, Representing the Kenai Peninsula has agreed to introduce legislation contingent upon public support including Sterling and Funny River areas, and the Kenai Peninsula Borough Assembly. Meetings with these groups are currently being planned.

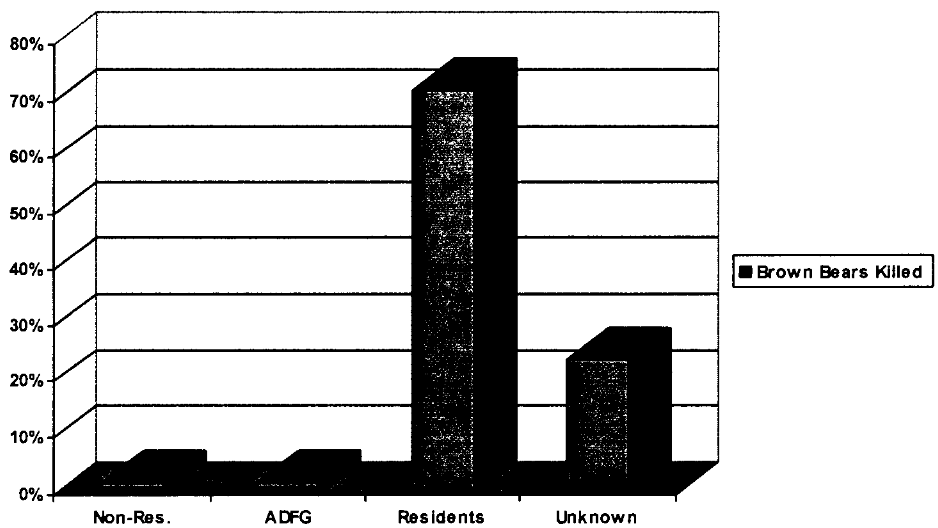
APPENDIX C. Brown Bear DLP Data 1964–1996. Prepared by Gino Del Frate, Sarah Richards, and Chuck Schwartz.

Total Bears Killed

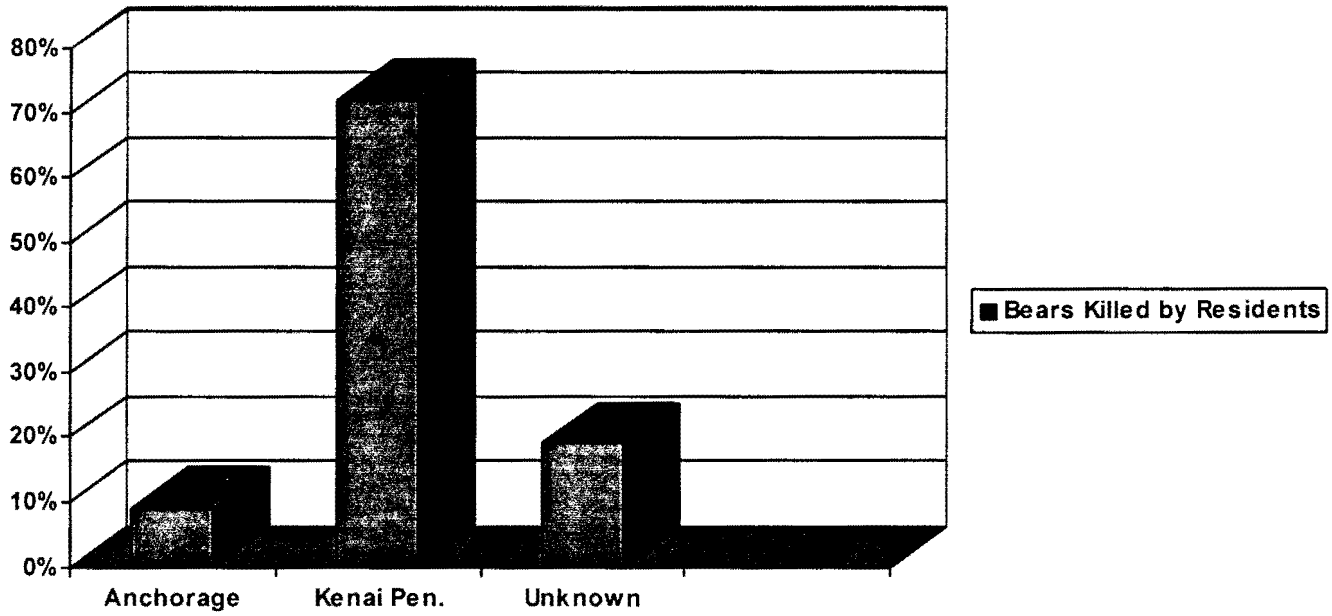
From 1964–1996, a total of 85 brown bears have been killed in Defense of Life or Property. Of those 85, 38 (45%) were female, 35 (41%) were male, and 12 (14%) were of unknown sex.

Brown Bear DLP Data	
Sex	Total
Female	38
Male	35
Unknown	12
Total	85

Only 2 (2%) nonresidents have killed a brown bear in Defense of Life or Property, while 2 (2%) have been killed by ADF&G, 61 (72%) by residents, and 20 (24%) by people of unknown residency.

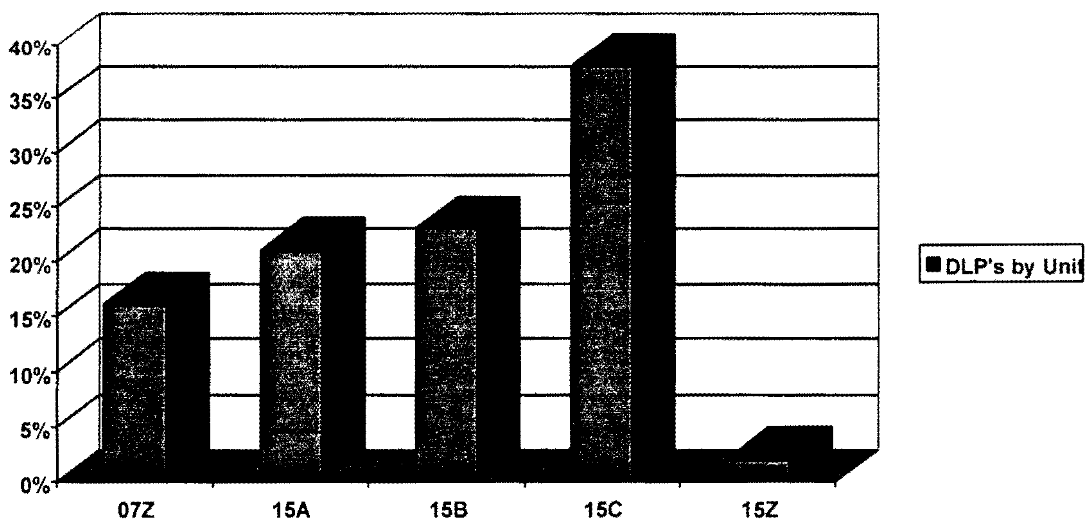


Of the 61 bears killed by residents of Alaska, 7 (9%) of the residents were from Anchorage, 59 (72%) were from the Kenai Peninsula, and 16 (19%) were of unknown residency and from other parts of the state.



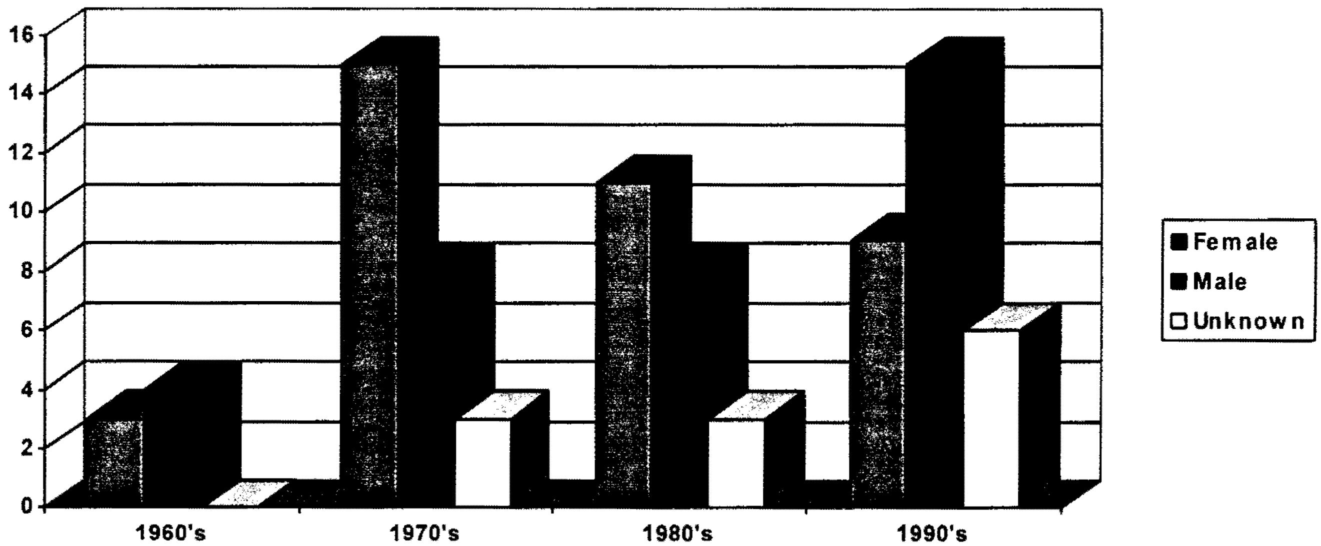
Location of Kill

Of the 84 brown bears killed from 1964 to the present on the Kenai Peninsula, 12 (16%) have been killed in Unit 07Z (2 in minor 202, 1 in minor 304, 2 in minor 500, 1 in minor 501, 1 in minor 600, 3 in minor 60 1 in minor 700, and 1 in minor 701), 16 (21%) have been killed in unit 15A (2 in minor 101, 1 in minor 301, 1 in minor, 1 in minor 401, 7 in minor 501, 4 in minor 601 and 1 in minor 701), 18 (23%) in unit 15B (1 in minor 201, 1 in minor 302, 1 in minor 401, 3 in minor 501, 2 in minor 502, 2 in minor 301, 2 in minor 602, 1 in minor 664, 1 in minor 700, 2 in minor 702, and 2 in minor 703), 29 (38%) have been killed in unit 15C (1 in minor 000, 5 in minor 101, 2 in minor 102, 5 in minor 201, 5 in minor 301, 1 in minor 401, 9 in minor 501, and 1 in minor 701) and 2 (2%) in unit 15Z (Unknown).



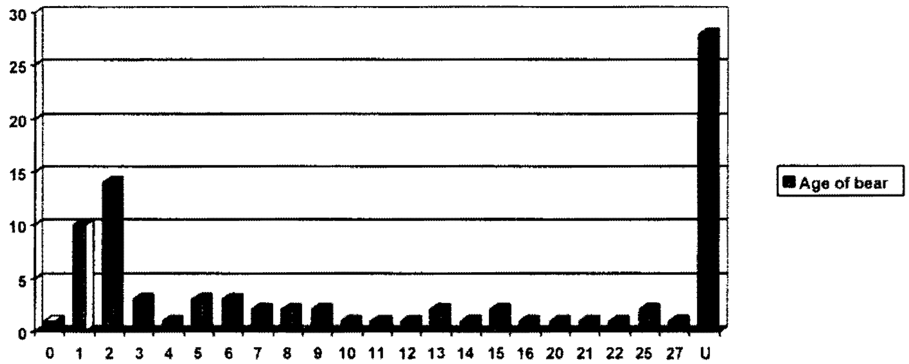
DLP's by Year and Sex

From 1964 to 1995 85 brown bears were killed in Defense of Life or Property, 38 Females, 35 Males and 12 Unknowns. In 1964 two males were killed; 1965 1 Female and 1 Male; 1967, 1 Female, 1 Male; 1968, 1 Female; 1970, 1 Female, 2 Males; 1971, 1 Male; 1972, 1 Female, 1 Male; 1974, 3 Females and 1 Unknown; 1975 3 Females and 2 Males; 1976 1 Female, 1 Male and 1 Unknown; 1977, 3 Females; 1978, 3 Females and 1 Male; 1979, 1 Unknown; 1981, 3 Females, 4 Males and 1 Unknown; 1982, 2 Females, 1 Male; 1983, 1 Female; 1984, 1 Female and 2 Males; 1985, 2 Females and 1 Male; 1986, 1 Unknown; 1988, 1 Female; 1989, 1 Female and 1 Unknown; 1990, 2 Males and 1 Unknown; 1991, 2 Females, 1 Male and 3 Unknowns; 1992, 1 Female, 2 males and 1 Unknown; 1993, 3 Females, 5 Males and 1 Unknown; and in 1995, 2 Females and 1 Male Brown Bears were killed in DLP.

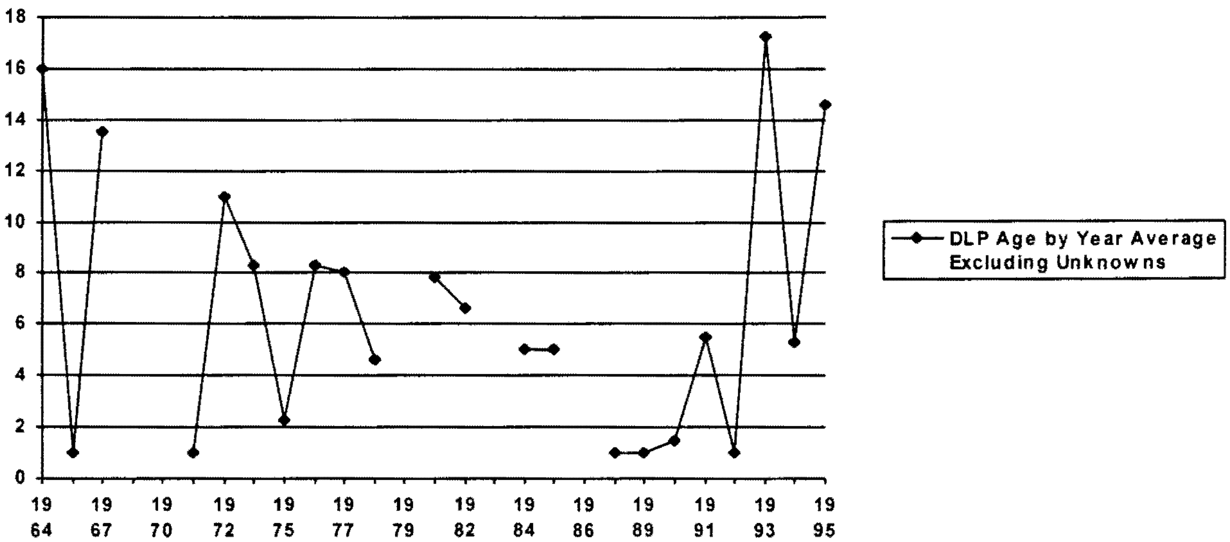


DLP's by Age and Year

Brown Bears from age 0-27 have been killed since 1964 in the Defense of Life or Property. 1 Brown Bear killed was 0 (a spring-cub), 10 were one, 14 were 2, 3 were 3, 1 was 4, 3 were 5, 3 were 6, 2 were 7, 2 were 8, 1 was 9, 1 was 10, 1 was 11, 1 was 12, 2 were 13, 2 were 14, 2 were 15, 1 was 16, 1 was 20, 1 was 21, 1 was 22, 2 were 25, 1 was 27 and 28 were of unknown age.



The brown bears killed in Defense of Life or Property have varied in age over the years. In 1964 two bears were killed, one male aged 16 and one male unknown, in 1965 two unknown (one male and one female), in 1967 one female aged 7 and one male aged 20, in 1968 one female unknown, in 1970 two unknowns (one female and one male), in 1971 one male aged 1, in 1972, one female aged 11 and one male unknown, in 1974 one female aged 3, one aged 9 and one 13 and one male unknown, in 1975 one female aged 2, one aged 6, one of unknown age and two males, one 0 and one 1. In 1976 one female aged 2, one male aged 21 and one female aged 2 were killed, in 1977 one female aged 2 one female aged 14 and one female unknown, in 1978 two females aged 5, one unknown and male aged 4 were killed, in 1979 one bear of unknown sex and age was killed in DLP, and in 1981 two females aged 2, one female aged 10, two males aged 1, one male aged 15, one 25 and one bear of unknown age or sex. In 1982 two females aged 6 and one male aged 8 were killed and in 1983 one female unknown. In 1984 one female aged 8 were killed and one male aged 2 and in 1985 one female aged 3, one aged 7 and one male unknown. In 1986 one bear of unknown age or sex was killed and in 1988 one 1-year-old female. In 1989 one female aged one and one bear of unknown age or sex was killed as did one in 1990 as well as one male aged 1 and one male aged 2. In 1991 one female aged 9, one female unknown and one male aged 2 were killed with three bears of unknown sex or age and in 1992 one female unknown, one male unknown, one male aged one and one unknown-unknown were killed. In 1993 one female aged 12, one male aged 5, one aged 25, and one aged 27 were killed as well as one male of unknown age. In 1994 one female aged 1, one aged 13, three males aged 2, one male aged 15, one male of unknown age and one 2-year old bear were killed while in 1995. One female aged 3, one aged 19, and one male aged 22 were killed in DLP.


18
16
14
12
10
8
6
4
2
0
19 64
19 67
19 70
19 72
19 75
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19 79
19 82
19 84
19 86
19 89
19 91
19 93
19 95
DLP Age by Year Average Excluding Unknowns

APPENDIX D. Proposal to Close Fishing on Russian Creek for brown bear conservation and human safety.

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

TONY KNOWLES, GOVERNOR

DIVISION OF WILDLIFE CONSERVATION

The Alaska Department of Fish and Game, Division of Wildlife Conservation, in cooperation with the U.S. Fish and Wildlife Service, Forest Service, and the National Park Service, is concerned about the future of the Kenai Peninsula brown bear population. This brown bear population is estimated by ADF&G biologists to number between 250-300 bears. To maintain the population at this level, the average annual allowable human harvest has been established at 5.6 female bears with a total of 14 bears per year. Since 1989, the Board of Game has reduced the brown bear season twice, and this fall (1995) the season was closed by emergency order. Reduced allowable harvest is a direct result of increased defense of life and property (DLP) kills.

In 1984, the Alaska Department of Fish & Game, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the National Park Service established an Interagency Brown Bear Study Team (IBBST). The team's role is to ensure the health and viability of the Kenai Peninsula brown bear. This proposal developed by the IBBST addresses one conservation issue.

The Kenai/Russian River watershed represents a major land form essential to Kenai Peninsula brown bears. Each year nearly a million salmon spawn in these systems. These fish represent a major source of food for Kenai brown bears. The first run of red salmon into the Kenai River migrate up the Russian River into Upper Russian Lake. When ready to spawn (around 1st week of August), they enter Goat Creek, a small stream flowing from Goat Lake into Upper Russian Lake. The fish spawning in Goat Creek represent some of the first available salmon to brown bears on the Kenai Peninsula, attracting bears from a wide geographic area.

Radio-telemetry studies conducted by the IBBST in the 1980's identified Goat Creek as essential brown bear habitat. Current studies evaluating brown bear habitat reconfirm this fact. Four of 11 brown bears initially captured and collared between Bald Mountain near Homer and Kenai Lake are known to use this stream. In addition, during a single radio-tracking flight in mid-August 14 bears were observed feeding on salmon on Goat Creek. Mark-recapture estimates suggest that the minimum number of bears utilizing Goat Creek could be as high as 20, or at least 8% of Kenai Peninsula brown bears rely on Goat Creek red salmon for food. Additional tracking flights confirmed heavy usage by brown bears during August. By 2 September, all marked bears had left Goat Creek and moved to other habitats confirming that the August closure is adequate.

Until the late 1980s there was very little human activity on Goat Creek. ADF&G personnel conducted stream surveys in the 1970's and early 1980's, and an occasional fisherman were the only humans to venture up this stream. However in the late 1980's, concurrent with the development of the Princes Lodge, a sport fishery has developed on Goat Creek. Today, it is not uncommon for 5-10 fisherman per day to venture up this stream in pursuit of rainbow trout.

This developing fishery compromises brown bear conservation and human safety. The situation is unsafe safe for fishermen. The potential for a mauling or a bear being shot a in defense of life incident is great. For example, one bear was killed by ADF&G personnel as a DLP incident. This year alone, on three overflights, fishermen have been observed walking up the stream while bears have been seen in stream side vegetation. Signs placed at the mouth of Goat Creek warning fishermen about brown bears were destroyed by the public in less than one week. Many of the fisherman using this area are non-residents and unfamiliar with how to act in bear country. Additionally, fishermen are known to displace bears. Radio telemetry studies conducted in the 1980's by the IBBST on Goat Creek clearly demonstrated that some radio-collared bears were intolerant of human activity. When IBBST personnel began investigating this stream, 2 radio-marked bears left the area and did not return. Some bears learn to use the area when fisherman are not present, and the occasional bear will even fish when humans are present. However, in general, when people are present bears are not.

Brown bears have been displaced from many of their traditional feeding areas on the Kenai Peninsula as salmon sport fishing has developed. ADF&G and the IBBST are concerned that the fishery on Goat Creek, like other Kenai Peninsula sport fisheries, will continue to grow leading to an increased displacement of bears from the area. There are no other undisturbed streams where early run red salmon spawn available to these bears.

Loss of Goat Creek as a feeding area will negatively impact brown bears. Reproduction and survival of bears is directly related to the availability of quality food. The IBBST has identified salmon as the most important summer/fall food of brown bears on the Kenai Peninsula. There is clear information from the literature that bear reproduction is keyed to summer/fall food abundance. In years of good food abundance females produce cubs. In years of poor food abundance, they do not reproduce. Female bears with good nutrition breed earlier in life, produce larger litters, and reproduce more often. Goat Creek red salmon are critical to a significant portion of the brown bear on the Kenai Peninsula.

ADF&G and the IBBST are concerned about the long-term health of the Kenai Peninsula brown bear population and are involved in a multi-staged effort to gather information to assist in management activities. The IBBST is currently involved in a major telemetry study evaluating habitat usage and bear survival. A cumulative effects model has been developed to aid biologist with in management decisions on land use actions.

The human population on the Kenai Peninsula has more than doubled since the 1970s. As humans spread into areas that were once wilderness, brown bear habitat is lost. In addition, the Kenai Peninsula is experiencing a widespread infestation of spruce bark beetle. Since the 1950's over 1.2 of the 2.2 million acres of forest have been infected. The current estimate is nearly 400,000 acres. There are about 37,600 acres slated for timber harvest in critical brown bear habitat and many roadless areas will be developed. These changes will impact the Kenai brown bear population.

The IBBST has undertaken studies in the Kenai-Russian River ecosystem to ensure that human activities are compatible with brown bears. Stream surveys, human dimension research, and public information and education have been initiated to help reduce conflicts between fisherman and brown bears on the Kenai-Russian Rivers.

This proposal protects a very critical component of Kenai Peninsula brown bear habitat. It is only one small component of a much larger comprehensive effort to ensure that the Kenai brown bear population remains viable. Your consideration of our recommendations is appreciated by adoption of proposal #301.

This proposal is not without precedent. A part of McNeil River is closed to fishing to protect brown bears.

Proposal Language:

ALASKA BOARD OF FISHERIES REGULATION PROPOSAL

1 Alaska Administrative Code No. 5AAC 56.050 Regulation Book Page 20.

2. What is the problem you would like the Board to address?

Russian Creek, which drains from Goat Lake to Upper Russian Lake has been identified as a critical brown bear feeding area. This area has one of the earliest runs of accessible salmon on which bears depend. It is well documented that human activity along salmon streams displaces bears. With the development of the Princes Lodge in Cooper Landing, the number of people fishing Russian Creek has increased substantially via air taxi day charters. The Kenai Peninsula brown bear population is both isolated and small (less than 300 bears). The ADF&G, Division of Wildlife Conservation is concerned that the loss of this bear feeding areas will jeopardize brown bear conservation.

3. What will happen if this problem is not solved?

The brown bear resource will be displaced from this area as fishing activity increases. The loss of this food resource will reduce population productivity and habitat carrying capacity. This is one of the last secure bear feeding areas within the Russian River drainage.

4. What solution do you prefer? In other words, if the Board adopted your solution, what would the new regulations say?

5AAC 56.050. WATERS CLOSED TO FISHING. (b) Russian Creek which drains from Goat Lake into Upper Russian Lake is closed to all fishing during August.

5. Solutions to difficult problems benefit some people and hurt others:

A. Who is likely to benefit if your solution is adopted?

The brown bear resource. People who value the brown bear as an important wildlife species on the Kenai Peninsula.

B. Who is likely to suffer if your solution is adopted?

Those people who fish Russian Creek in August and the air charter operators who fly them to Upper Russian Lake.

6 List any other solutions you considered and why you rejected them.

The U.S. Fish and Wildlife Service and the U. S. Forest Service have authority to close lands under their jurisdiction for wildlife protection. Under their authority, this area could be closed to all human use. This solution was rejected because most human activity on Russian Creek is fisherman. A total closure of the stream to all fishing year around was also discussed. This would be unduly restrictive since most of the concern for the human bear interactions occur in August when the sockeye salmon are spawning. Additionally, department staff are developing a management plan to address all types of brown bear mortality and include a hunting closure option.

APPENDIX E. Instrument used to survey anglers on the Russian River.

Good (morning, afternoon), my name is Sarah Richardson, I am a student intern working for the Alaska Department of Fish and Game in cooperation with the U. S. Forest Service. I am conducting interviews with Russian River Anglers to learn more about how they use the Russian River area. Would you be willing to take about 5 minutes to assist me?

If the answer is yes, conduct survey; if the answer is no, record a *no* and proceed to next person.

Persons sex ( )M ( )F Persons Age ( ) Ask them.

1) Are you an Alaska Resident
   ( ) yes
      Do you live on the Kenai Peninsula? ( )yes ( )no, where______________
   ( ) no, go to next question
2) Is this your first fishing trip to the Russian River
   ( ) yes GOTO QUESTION 3.
   ( ) no
      How often have you fished here?
         How many years have you fished here?________
         How many times per year do you fish here?_______
3) Is this a day trip ( ) or
   Are you camping here ( )
   How many day will you be here?________
4) When you catch fish, where do you clean them?
   ( ) On the river COMPLETE BELOW and GO TO QUESTION 5.
      ( ) where you catch them
      ( ) at fish cleaning station
      ( ) other (describe)
   ( ) At home. GO TO QUESTION 7.
   ( ) At your camper.
      What do you do with the carcass and guts? GOTO QUESTION 6.
   ( ) Other (describe) GOTO QUESTION 6.
5) When you clean your fish do you
   ( ) fillet them.
   ( ) only gut them.
   ( ) head and gut them
   ( ) other . Describe
6) What do you do with your fish waste?
   ( ) return it to the river.
   ( ) leave it on the bank.
   ( ) Pack it to a dumpster
   ( ) Other.
7) Have you ever seen a brown bear on the Russian River? ( )yes ( )no?
8) Have you ever had a brown bear problem on the Russian River? ( )yes ( )no.
9) What sort of precautions do you take to help prevent an encounter?
   ( ) do nothing

( ) carry a gun
( ) make noise
( ) stay near people
( ) only fish during the day
( ) other

The Kenai Peninsula brown bear population is currently estimated at somewhere between 250-300 bears. Biologist believe that increasing human activity in the form of logging, agriculture, housing development, and recreation could jeopardize this population. Fishing activities here on the Russian River have created problems for bears. Each year anglers harvest around 40,000 red salmon. Many of these fish are cleaned on the river bank and the carcass returned to the river. Although these carcasses help the stream, they also attract brown bears. Each year there are several dangerous encounters between brown bear and human here on the Russian River. Some encounters have resulted in injury to humans. And, each year a few bears removed.

10) Do you think steps should be taken to try to reduce encounters that may be dangerous to bears or people? ( )yes ( )no.

11) There are a limited number of ways to do this. If you were given the following choices, which would you find acceptable and which would be unacceptable.

a) Regulations that require removal the entire fish (guts and all) from the area for cleaning at home.

( ) acceptable ( ) unacceptable

b) Regulations that require the transport of your catch to a designated fish cleaning area which may be some distance from where you catch the fish.

( ) acceptable ( ) unacceptable

c) Regulations that allow only the removal of the guts and gills here on the river, and the rest of the fish must be taken home.

( ) acceptable ( ) unacceptable

d) The river would be closed from midnight to 5:00 A.M. to allow the bears some time to feed undisturbed.

( ) acceptable ( ) unacceptable

Do you fish during these hours? ( ) yes ( ) no

e) If there was a cleaning station at the Kenai River that had running water and a disposal capable of grinding your carcass and guts , would you be willing to transport your fish and clean them there?

( ) acceptable ( ) unacceptable

Now I want you to rank the above in order of preference. (1 = most preferred, 4 = least preferred)

______ Remove entire fish
______ Transport fish to cleaning site
______ Only remove guts and gills, take rest home
______ Close river at night.
______ Transport fish to Kenai River Station.

Now I want to ask you some questions about bears. Please indicate if you strongly agree, agree, disagree, or strongly disagree with the following statements.

9) I am willing to give up some of my fishing opportunity to help the Kenai Peninsula brown bears
( ) SA ( ) A ( ) D ( ) SD.
10) There are too many brown bears on the Kenai Peninsula. I would like their number reduced..
( ) SA ( ) A ( ) D ( ) SD.
10) There should be more camping facilities created even if it means a further decline in the Kenai brown bear population.
( ) SA ( ) A ( ) D ( ) SD.

13) Do you have any other suggestions that might help us make Russian River fishing more compatible with brown bears?

I would like to thank you for cooperating in this survey. Your cooperation will help us conserve brown bears and provide fishing opportunity.

APPENDIX F. Sampling protocol used to determine sample size used in the Russian River fisher study.

The chart summarizes the level of error and confidence required for estimates obtained from various sample sizes. These estimates assume our population of interest is at least in the tens of thousands; slightly smaller n's are needed if the population is smaller than this.

estimate	Confidence Level	
error	95%	90%
±3%	n = 1067	n = 747
±5%	n = 384	n = 269
± 7%	n = 196	n = 137
±10%	n = 96	n = 67

In this study we try to obtain an error of the estimate of ±5% at at the 95% confidence level. Unless respondents are really skewed (at least 70%/30%), 10% error on the estimate prohibits identifying where even the majority preference falls. If we have time and bodies available, n = 384 would be a good target.

APPENDIX G. Results of the Russian River Angler Survey

Prepared by Sarah Richards, Chuck Schwartz, and Grant Hilderbrand

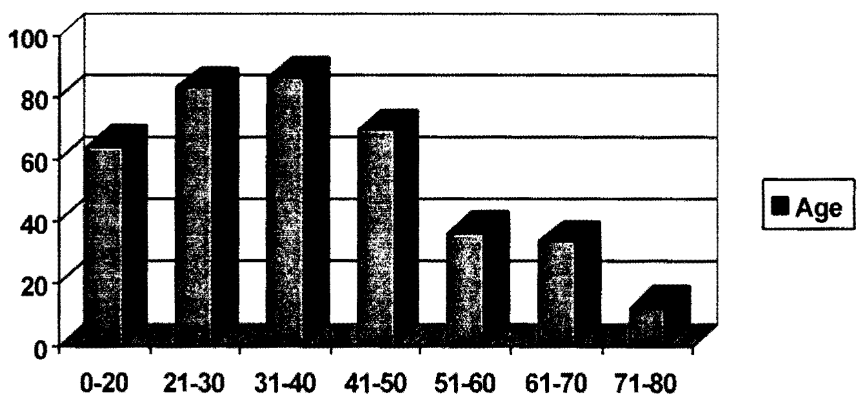
Anglers' Sex, Residency, and Age

Out of a total of 447 individuals surveyed, 74 (17%) were female, 335 (75%) were male and 38 (8%) were unknown. Out of the 74 females 28 (38%) were nonresidents and 46 (62%) were residents; out of the 335 males, 134 (40%) were nonresidents while 201 (60%) were residents and 17 (45%) of the unknown were nonresidents while 21 (55%) were residents.

Two of those surveyed were aged 0-10, 62 were aged 11-20, 83 were aged 21-30, the majority 86 (22%) were aged 31-40, 69 were aged 41-50, 36 were aged 51-60, 33 were aged 61-70, and 12 were aged 71-80.

One hundred seventy-nine (40%) of the 447 individuals surveyed were nonresidents of Alaska while 268 (60%) were residents. 15 (6%) of the residents surveyed lived on the Kenai Peninsula while 73 (27%) lived in Anchorage and 180 (67%) were unspecified Alaskan residents.

1997 Russian River Angler-Bear Survey	Sex			
Alaska Residency	**Female**	**Male**	**blank**	**Total**
Nonresident	28	134	17	179
Resident	46	201	21	268
(blank)	0	0	0	0
Total	74	335	38	447



Trips to Russian River

Out of the 445 answering this question, **317 (71%)** had been to Russian while for **128 (29%)** it was their first time.

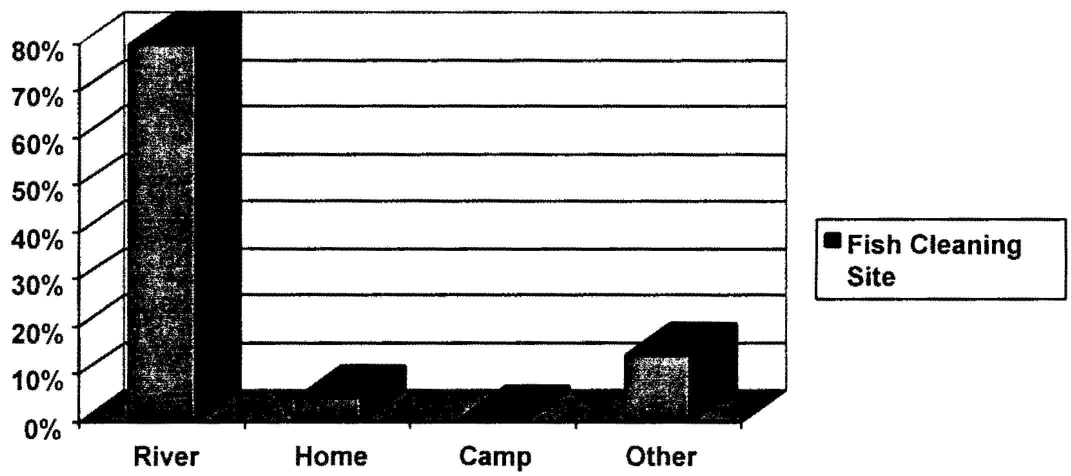
For **259 (58%)** of our surveyed anglers, their day on the Russian was only a day trip while **185 (42%)** were camping there from 1 night to 2 months and **1** angler lived there.

Fishing at Night

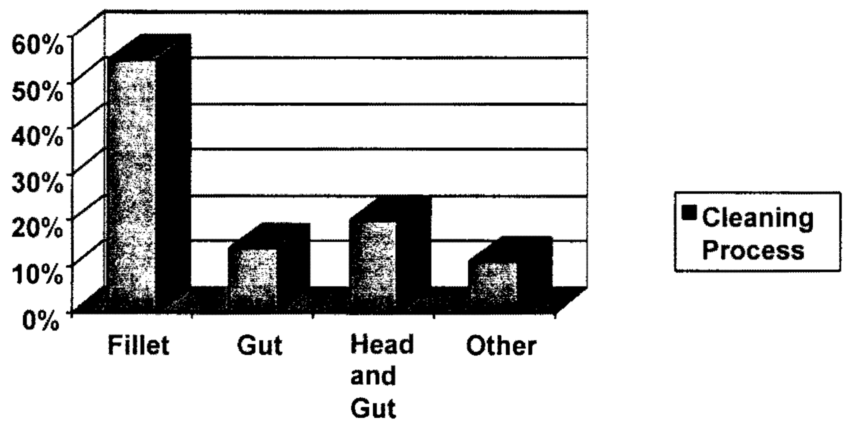
Two hundred forty-nine (57%) of those surveyed admitted they fished at night (including 26 Nonresident Females, 7 Resident Females, 136 Nonresident Males, 61 Resident Males and 1 Male of unspecified residency, 15 Unspecified Sex Nonresidents, and 3 Unspecified Sex Residents)while **186 (43%)** stated they didn't fish at night on the Russian (including 19 Nonresident Females, 21 Resident Females, 58 Nonresident Males, 69 Resident Males and one Male of Unspecified Residency, 6 Unspecified Sex Nonresidents and 12 Unspecified Sex Residents).

Fish-Cleaning Sites, Processes, and Refuse-Removal

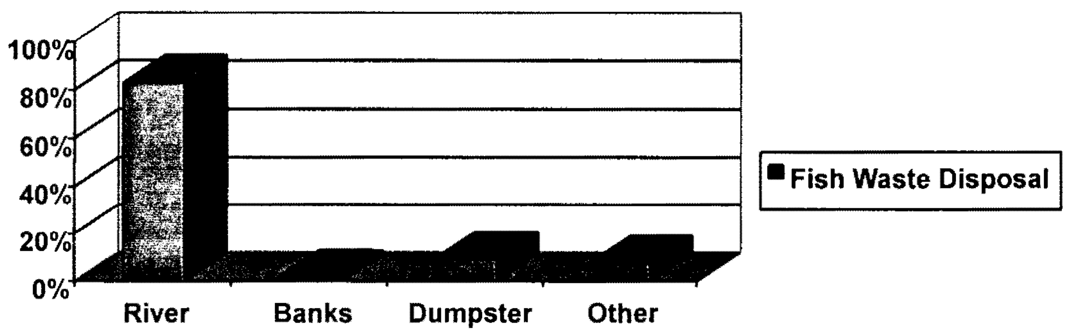
Out of the 447 individuals surveyed, **362 (80%)** stated they cleaned their fish on the river (Specifically 143 (47%) where they caught them and 159 (53%) at the Cleaning Stations), **22 (5%)** cleaned their fish at home, and **3 (1%)** cleaned them at their campsites. **Sixty-two (14%)** surveyed had a combination of the possibilities depending on their situations.



Out of the 447 individuals surveyed, **244 (55%)** filleted their catch, **64 (14%)** only gutted them and **88 (20%)** head and gutted them (many of them removing the tails and the gills at the same time). **Fifty-one (11%)** surveyed did a combination of the possibilities depending on their situations.



Out of the 447 individuals surveyed, **372 (83%)** reported they returned their fish waste to the river, **3 (1%)** left it on the banks, and **38 (9%)** packed it to a dumpster (the majority of those who stated they cleaned at home reported using the dumpster) while **34 (7%)** surveyed did a combination of the possibilities depending on their situations.



<u>Brown Bear Sightings and Problems:</u>

Out of the 447 individuals surveyed, **165 (37%)** (12 Nonresident Females, 15 Resident Females, 45 Male Nonresidents, 79 Male Residents, 8 Nonresidents of Unspecified Sex and 6 Residents of Unspecified Sex) stated they had seen a brown bear on the Russian River, while **280 (63%)** (16 Female Nonresidents, 30 Female Residents, 86 Male Nonresidents, 122 Male Residents, 2 Males of Unspecified Residency, 9 Unspecified Sex Nonresidents and 15 Unspecified Sex Residents) reported never seeing one. Only **13 (3%)** (2 Male Nonresidents and 11 Male Residents) individuals surveyed had ever had a brown bear problem while **432 (97%)** (28 Female Non-

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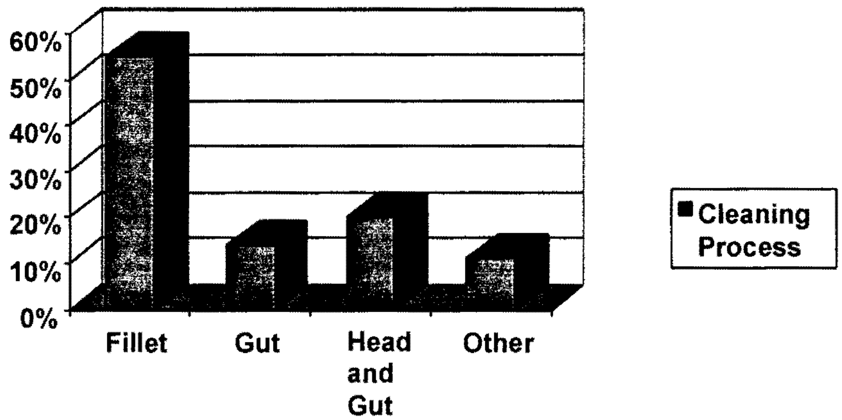

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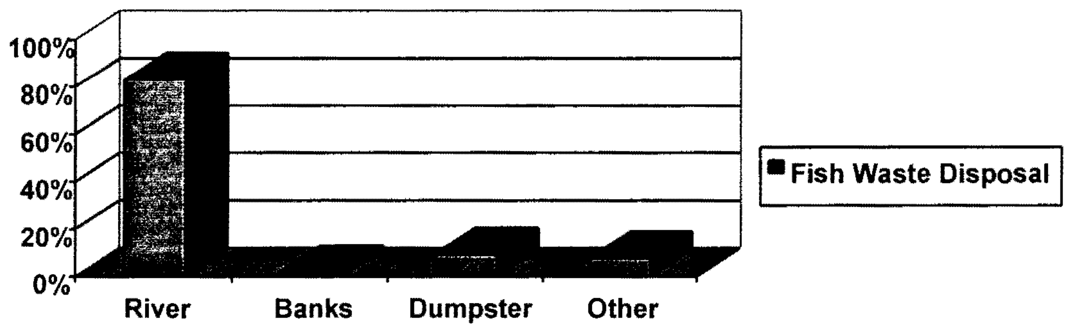

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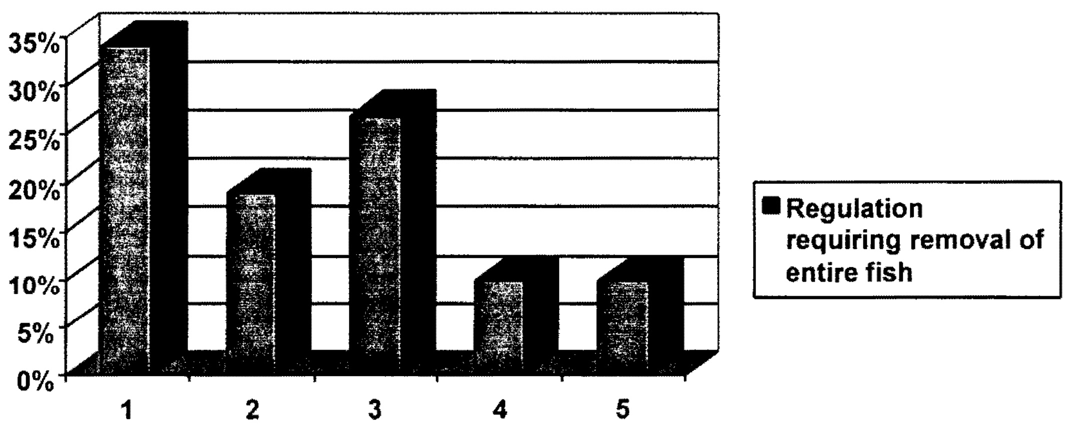
Residents, 45 Female Residents, 129 Male Nonresidents, 190 Male Residents, 2 Males of Unspecified Residency, 17 Nonresidents of Unspecified Sex and 21 Residents of Unspecified Sex) had never had a problem with a brown bear on the Russian River.

The majority of people, **369 (84%),** surveyed stated they took some sort of precautionary measures to prevent encounters with bears with many varied answers, while **71 (16%)** admitted they did nothing. **141 (43%)** (15 Female Nonresidents, 19 Female Residents, 32 Male Non-Residents, 63 Male Residents, 1 Male of Unspecified Residency, 2 Nonresidents of Unspecified Sex and 9 Residents of Unspecified Sex) of those individuals surveyed stated they thought steps should be taken to try to reduce encounters that may be dangerous to bears or people, while **188 (57%)** (6 Female Nonresidents, 11 Female Residents, 68 Male Nonresidents, 89 Male Residents, 9 Nonresidents of Unspecified Sex, and 5 Residents of Unspecified Sex) were against the idea.

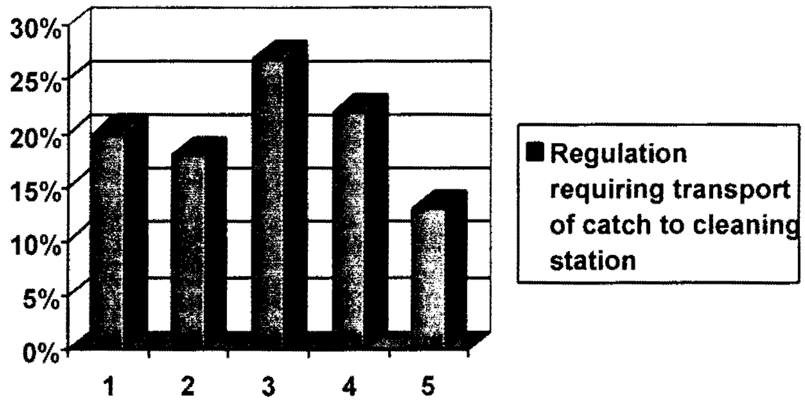
Possible Steps

Using a rank of 1–5 of acceptability (1 being highly Unacceptable, 2 Moderately Unacceptable, 3 Neutral, 4 Moderately Acceptable, and 5 Highly Acceptable), we asked the individuals taking the survey to rank a number of proposed ideas and regulations

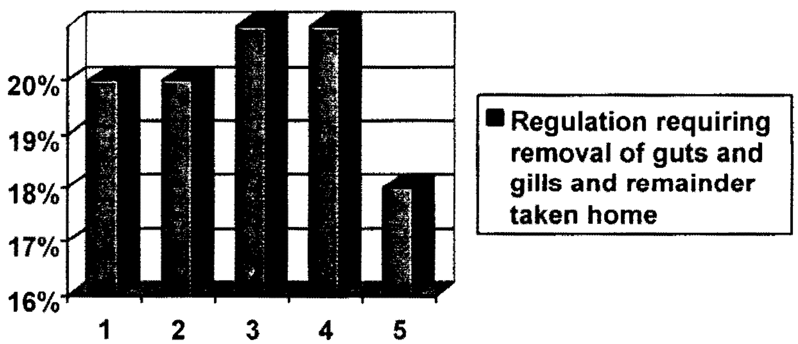
After being asked whether a regulation that would require the removal of the entire fish from the River for cleaning at home was acceptable or unacceptable, the majority **(34%)** stated that it was **highly unacceptable** (1=145, 2=81, 3=115, 4=41, 5=41).



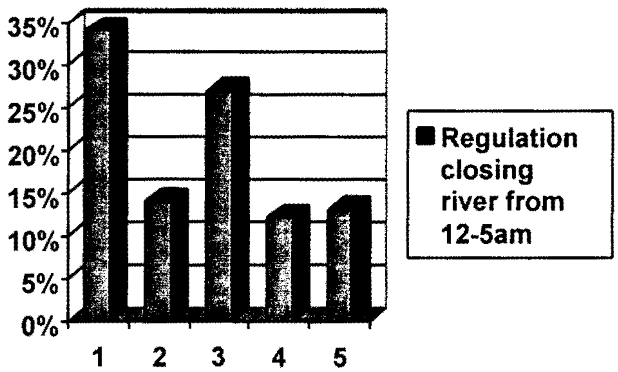
After being asked whether a regulation requiring the transport of the catch to a designated fish cleaning station was acceptable or unacceptable, the majority **(27%)** stated they were **neutral** about the idea (1=83, 2=78, 3=112, 4=94, 5=55).



After being asked whether a regulation that would allow only the removal of the guts and gills on the river and the rest taken home, the majority **(21% each)** tied with **neutral and moderately acceptable** (1=86, 2=89, 3=90, 4=90, 5=68).

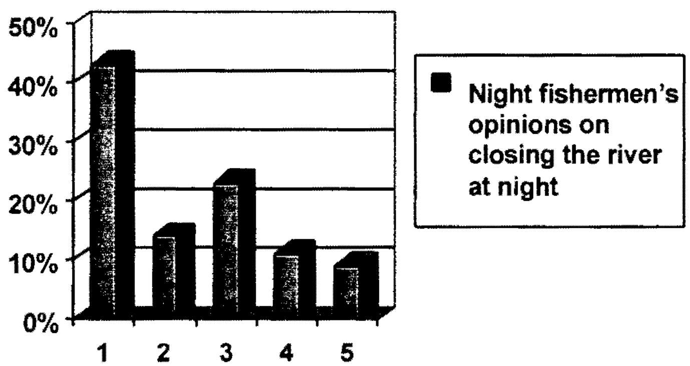


After being asked whether a regulation requiring that the Russian River be closed at night from midnight to five am to allow the brown bears to feed undisturbed, the majority **(34%)** stated that it was **highly unacceptable** (1=144, 2=59, 3=113, 4=52, 5=56).

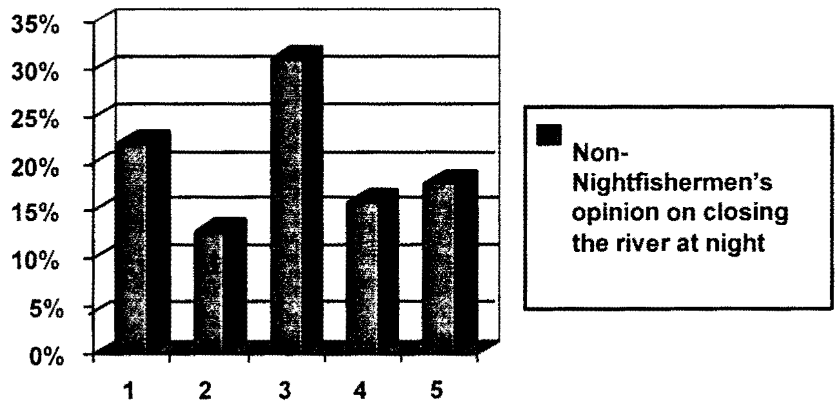


The following two graphs show the different opinions on whether or not the Russian River should be closed at night, depending if one fishes at night.

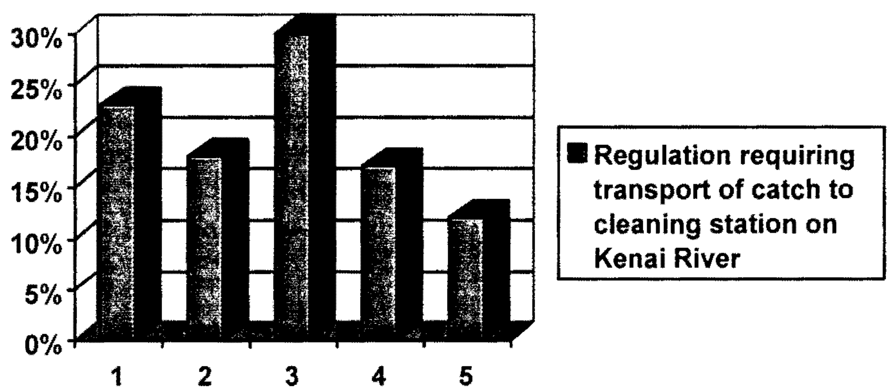
Night fishermen were strongly opposed to closing the river with **43% choosing highly unacceptable**.



Non-night fishermen were noncommittal to the idea with the majority choosing **neutral at 31%.**

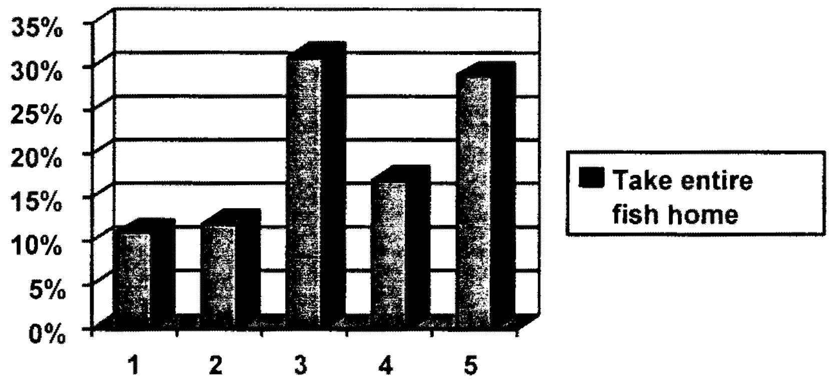


After being asked whether a regulation requiring transporting their catch to a cleaning station on the Kenai River that has running water and a grinder capable of disposing fish waste, the majority **(30%)** stated they were **neutral** to the idea (1=95, 2=77, 3=124, 4=70, 5=51).

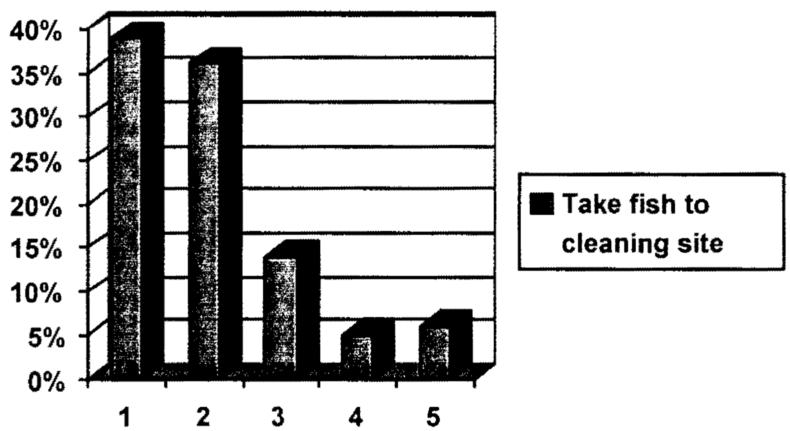


The individuals surveyed were then asked to rank a series of actions in order of preference from 1–5 (1=most preferred and 5=least preferred)

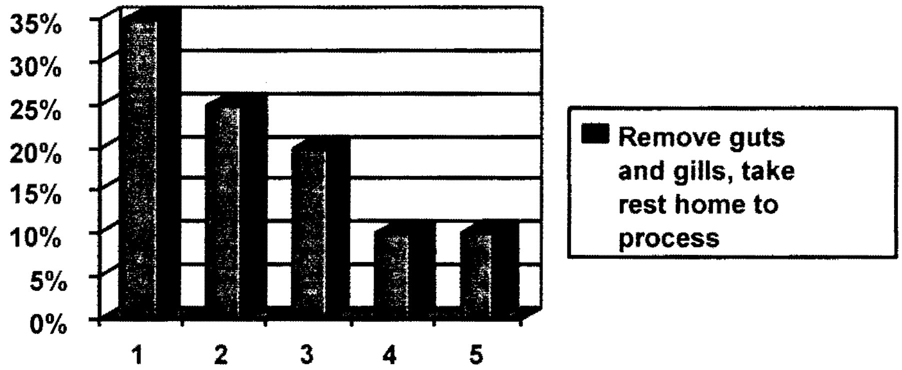
The possibility of taking the entire fish home to clean received an average of **3.41** rank



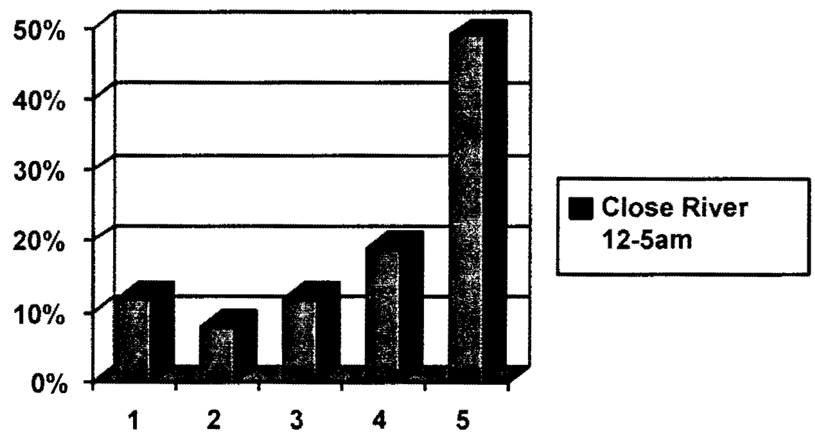
The possibility of taking the fish to a designated cleaning station to clean it was the most preferred by average with an average of **2.02** rank



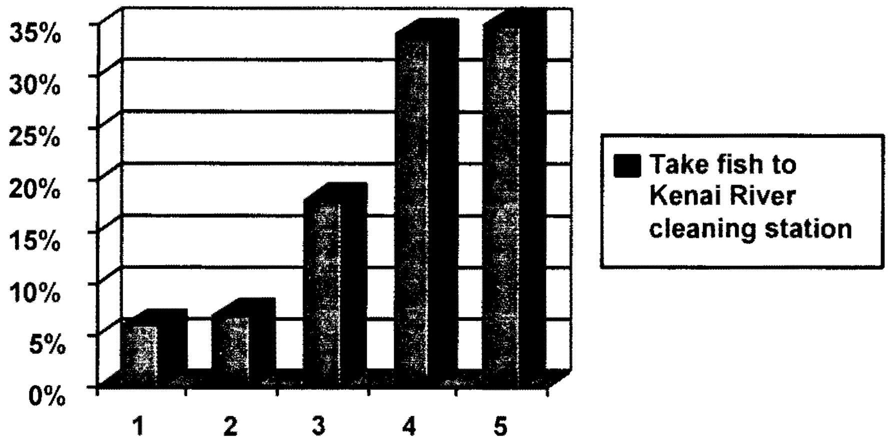
The possibility of removing the guts and gills and taking the rest of the fish home to process received an average of **2.34** rank



The possibility of closing the river at night from midnight to 5 am to allow time for the bears to feed undisturbed was the least preferred with an average of **3.87** ranking.

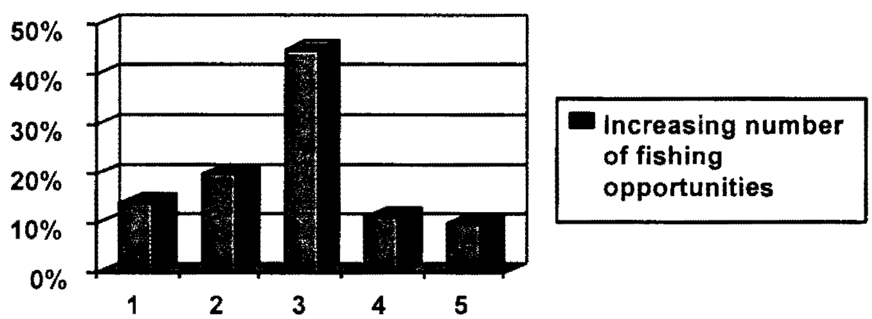


The possibility of taking caught fish to a Cleaning Station at the Kenai River also was not liked with an average of **3.85** rank.

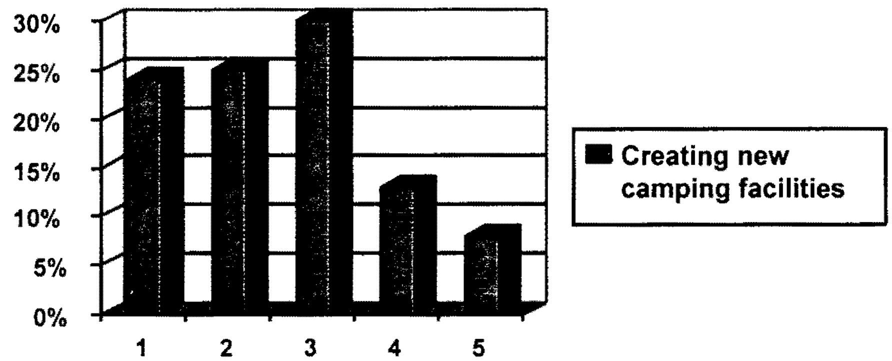


The individuals surveyed were then asked to rank the importance of protecting brown bears on the Kenai Peninsula compared to other things. Each question asked whether something was 1=much less important, 2=somewhat less important, 3=equally as important, 4=somewhat more important, or 5=much more important to them than protecting the brown bear population on the Kenai.

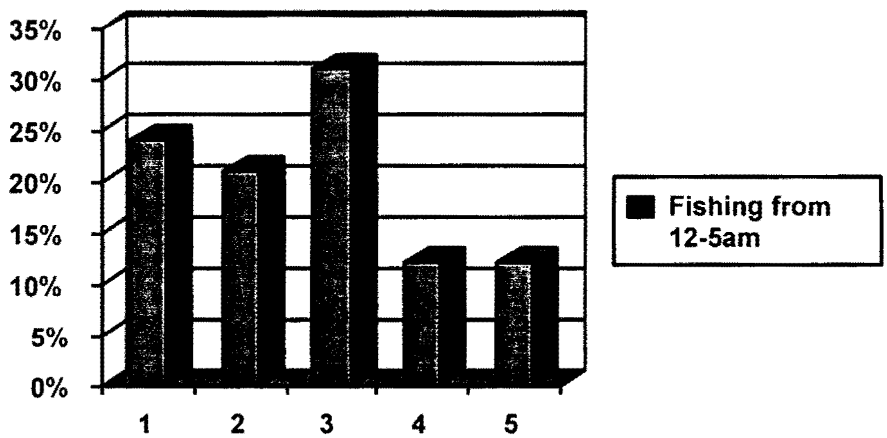
When asked whether increasing the number of fishing opportunities was more or less important the majority **(45%)** stated that it was **equally important** (1=58, 2=84, 3=185, 4=45, 5=41).



When asked whether creating new camping facilities were more or less important, the majority **(30%)** stated that it was **equally important** (1=97, 2=103, 3=121, 4=55, 4=34).

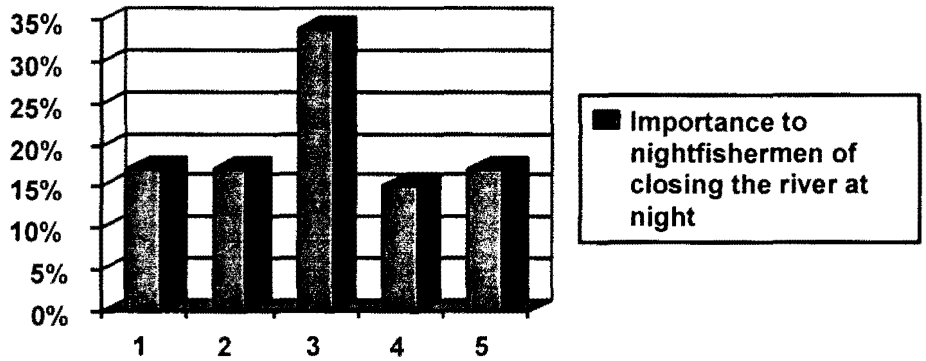


When asked if fishing at night from midnight to 5 am was more or less important, the majority **(32%)** stated that it was **equally important** (1=98, 2=85, 3=130, 4=50, 5=50).

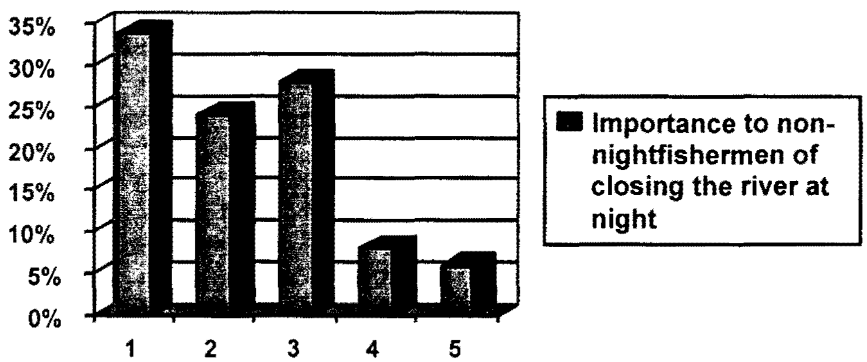


However, when the tallies were broken down into two more categories, those who night fish and those who don't, the answers were slightly different as seen in the following two graphs.

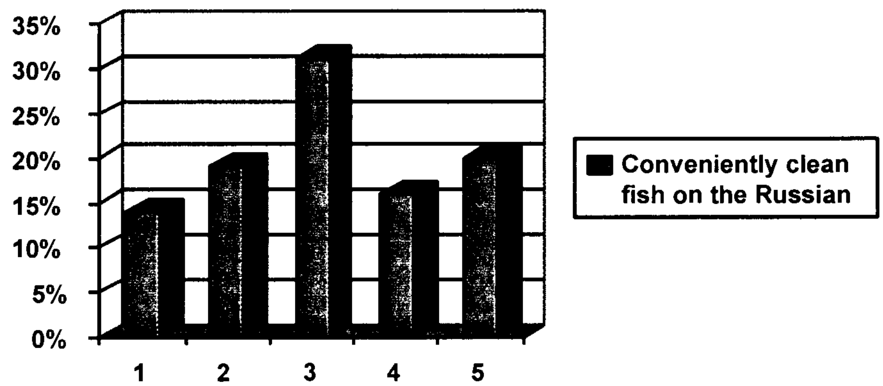
Night fishermen determined that being able to fish at night was **equally important** as protecting the brown bear population by **34%**



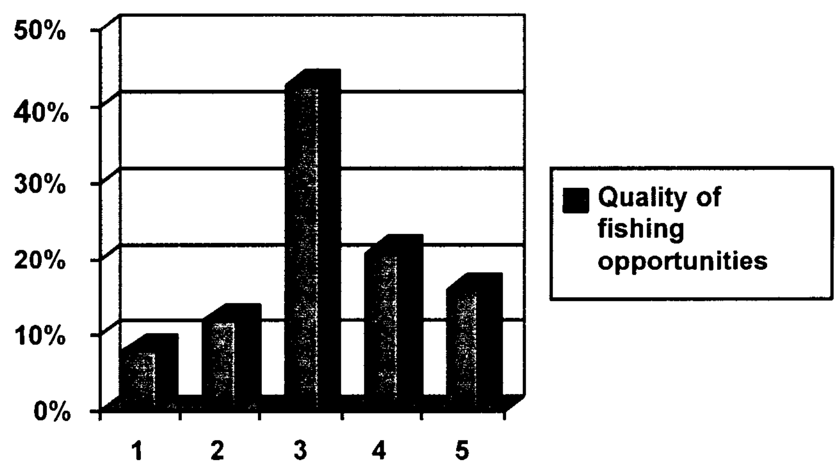
Non-Night fishermen determined, also by **34%,** that being able to fish at night was **much less important.**



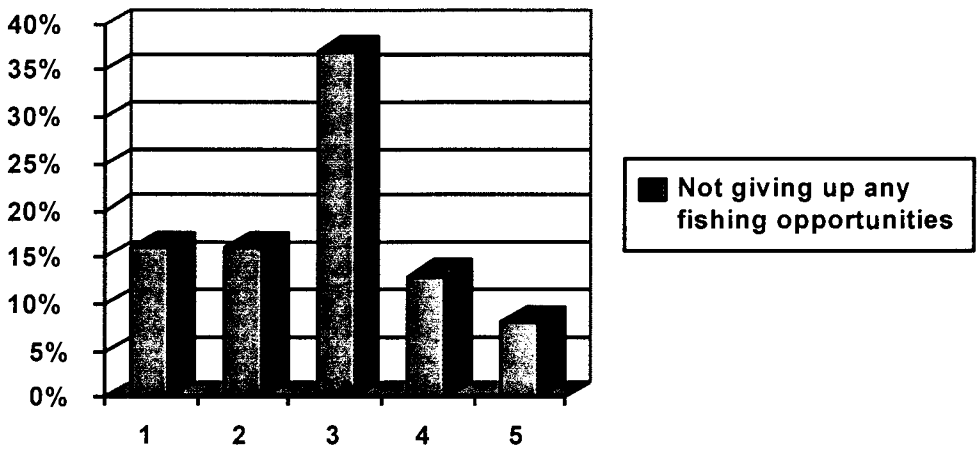
When asked whether being able to conveniently clean fish on the river was more or less important, the majority **(31%)** said that it was **equally important** (1=56, 2=76, 3=128, 4=67, 5=80).



When asked whether the quality of fishing opportunities was more or less important, the majority **(43%)** stated it was **equally important** (1=31, 2=49, 3=181, 4=88, 5=68).

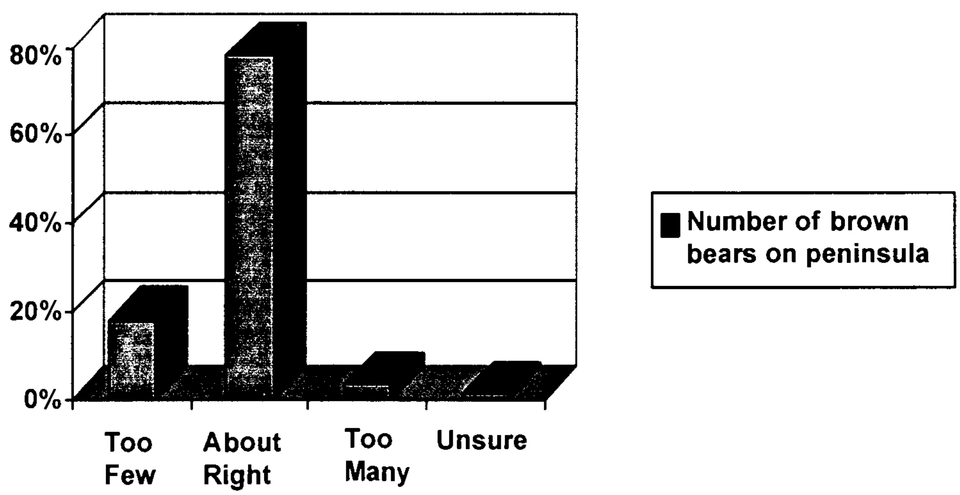


When asked whether not giving up any fishing opportunities was more or less important, the majority **(37%)** stated that it was **equally important** (1=66, 2=68, 3=154, 4=54, 5=72).

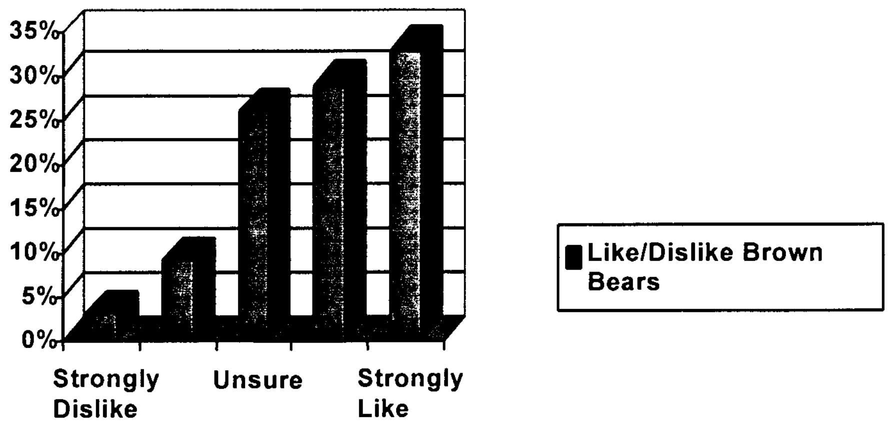


Anglers' Opinions on Brown Bears

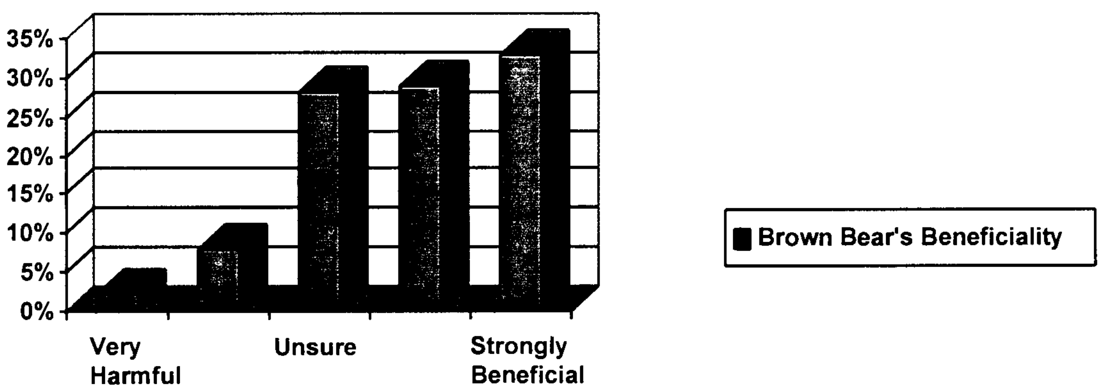
When asked whether they thought there were too many, too few or about the right number of brown bears on the Kenai Peninsula, **13** stated there were too many, **3** stated that they were unsure, **75** stated too few, and the majority **(78%)** with **317** individuals stated that the number of brown bears on the Kenai Peninsula was **about right**.



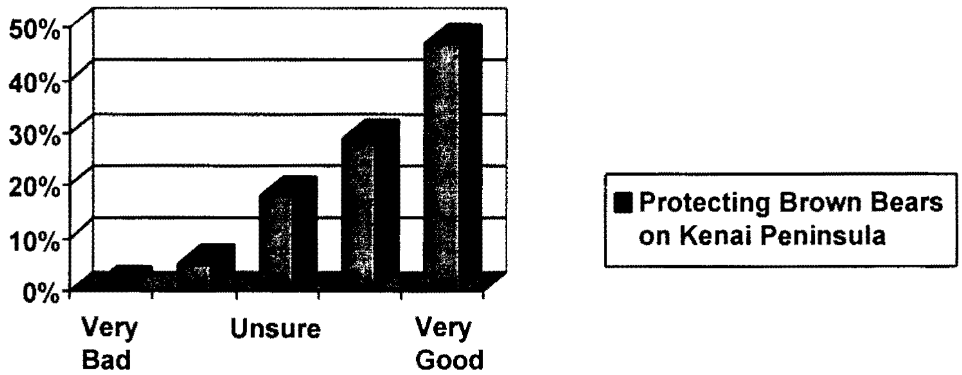
When asked if they liked or disliked brown bears, **10** stated that they strongly disliked brown bears, **36** stated that they moderately disliked them, **112** stated they were unsure, **125** stated that they moderately liked brown bears, and **142 (33%)** stated they **strongly liked** brown bears.



When asked if they thought brown bears were harmful or beneficial, **6** stated they were very harmful, **34** stated that they were moderately harmful, **121** stated that they were unsure, **125** stated they were moderately beneficial, and **143 (33%)** stated they were **very beneficial.**

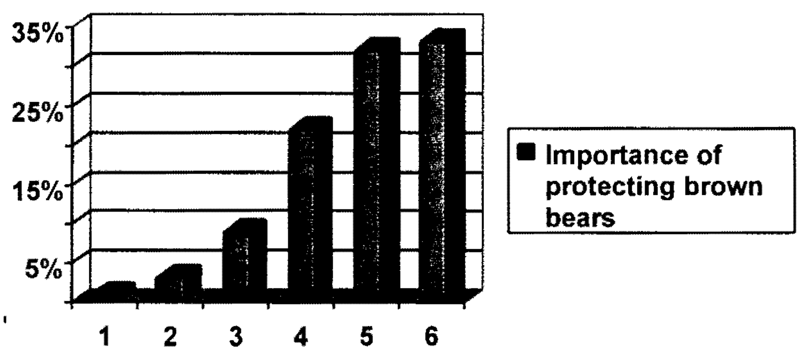


When asked if they thought protecting brown bears was good or bad, **5** stated that it was very bad, **20** stated it was moderately bad, **80** stated that they were unsure, **127** stated that it was moderately good, and **202 (47%)** stated that it was **very good**.



Importance of brown bear protection to Russian River Anglers

When asked "In general, how important would you rate protecting brown bears on the Kenai on a scale of 1 to 7" with the options of 1 = not at all important, 4 = neutral, and 6 = extremely important, **7 (1%)** anglers answered nr 1, **14 (3%)** anglers answered nr 2, **37 (9%)** anglers answered nr 3, **93 (22%)** anglers answered nr 4, **137 (32%),** answered nr 5, and the majority of anglers, **142 (33%),** answered **nr 6**.



APPENDIX H. Evaluation of Habitat Relationships of Black Bears on the Kenai Peninsula - A Draft Proposal prepared by Lowell Suring.

The black bear (*Ursus americanus*) population on the Kenai Peninsula currently appears healthy at approximately 3,000 animals (Abbott 1993). This population has supported an annual harvest of approximately 140 males and 60 females in recent years (Abbott 1993). Black bear hunting in this area is increasing in popularity (Hicks 1996). However, increasing human developments on the Kenai Peninsula (Suring et al. *in press*) have the potential to negatively affect black bear populations (e.g., Brody and Pelton 1989, Rudis and Tansey 1995). In order to continue successful management of this black bear population and its habitat, information is needed on how these bears use their habitat and how they respond to human developments and disturbance. Reproduction in black bears and growth of individuals on the northeastern portion of the Kenai Peninsula were shown to be linked to superior nutrition (Schwartz and Franzmann 1991). Black bears in this area selected habitats that provided high quality for in the fall (i.e., American devilsclub *(Oplopanax horridus)* in old-growth forests). More specific information is needed on black bear use of habitats at landscape and home range levels to guide management of vegetation. This is especially relevant as forests infested with spruce bark beetles (*Dendroctonus rufipennis*) throughout the Kenai Peninsula are harvested and rehabilitated.

The greatest source of mortality in most North American populations is human-caused through hunting and other activities. This pattern is also evident on the Kenai Peninsula (Schwartz and Franzmann 1991). Previous reports have provided analysis of population demographics, including survival, within black bear populations with limited assessment relative to proximity to human developments (e.g., residences, roads) (Schwartz and Franzmann 1991). An examination of the spatial relationships of survival of black bears in relation to human development will provide insights to management of landscapes to ensure healthy populations of black bears on the Kenai Peninsula.

AVAILABLE DATA

A field study was conducted on the Kenai Peninsula that investigated the relationship of black bears to moose (*Alces alces*) and forest succession following fire (Schwartz and Franzmann 1991). During this study conventional VHF radio collars were attached to 134 black bears captured between 1977 and 1985. Information on black bears' use of the landscape was collected via aerial radio-tracking techniques from 1978 through 1987. Under a separate study, a land cover map was developed that included Schwartz and Franzmann's (1991) study area using Landsat MSS imagery acquired in 1980 (Talbot *et al.* 1984) (Table 1). Spatial data from digital maps of the land cover, human developments (Table 2), and black bear radio locations will be combined through geographic information system (GIS) techniques and analyzed.

OBJECTIVES

The primary objectives of these analyses will be to:

1) determine whether black bears use habitats available to them at random,

2) rank habitats by degree of use by black bears,

3) and examine the effect of human activities and proximity of developments on habitat use and survival of black bears.

DATA ANALYSIS

Several techniques are available to use data collected through radiotelemetry to achieve these objectives (White and Garrot 1990). The efficiency and reliability of some of these techniques have been evaluated (Alldredge and Ratti 1986, 1992, Aebischer et al. 1993).

Level of Sampling

Radio locations provide an insight to an individual animal's habitat use patterns. Some investigators pooled radio locations from several animals and used those data as the sample (e.g., Smith et al. 1982, Byers et al. 1984). Pooling locations across animals is acceptable only if use patterns do not differ between animals. This is a difficult assumption to make. The individual animal rather than the individual radio location should be used as the sample unit to provide information about the population of animals. It should also be recognized that animals from different categories (e.g., age, sex, region) may use habitats differently.

Habitat Availability

Determination of the amount of habitat that is available for use by an individual animal or a population may be one of the most perplexing tasks in this analysis. Although black bears are wide-ranging animals and an individual animal could conceivably have the entire Kenai Peninsula available for use (e.g., Rogers 1977), this probably does not occur (Schwartz and Franzmann 1992). Confounding factors may include interaction with other bears, terrain features, and human use. Aebischer et al. (1993) defined the study area as the boundary of all habitat patches containing at least one radio location, habitat patches that overlapped any home range, and habitat patches surrounded by the previous designations. The final determination of a study area boundary for these analyses will probably be a somewhat arbitrary decision.

Comparison of habitat use with availability may be evaluated at different levels to reduce the consequences of a possible inappropriate definition of study area. Johnson (1980) defined several levels of selection; selection level 2 considers composition of home range within the landscape and selection level 3 considers composition of habitats within the home range. Using these 2 levels of selection for analysis leads to analyzing home range composition in comparison to the entire study area (level 2) and radio locations within the home range in comparison to the composition of the home range (level 3). The latter may be accomplished by determining the composition of habitats associated with activity centers or by looking at the habitats associated with individual radio locations (Porter and Church 1987). A complete census of the availability of habitat descriptors within a study area may be accomplished through GIS analyses for categories used in the land cover map and other GIS coverages (e.g., topography).

Home Range

Home range is the area in which an animal interacts with its environment (Burt 1943) and is a convenient area with a biological basis to describe habitat use patterns. Many statistical techniques have been proposed for defining home range; some have been evaluated (Boulanger and White 1990, Worton 1995). The simplest and most commonly used method for describing home ranges is the minimum convex polygon (Mohr and Stumpf 1966). The polygon is easy to calculate and encompasses the area used by the animal. Despite its wide use this technique has received criticisms. The most significant of these is that the minimum area polygon is a function of sample size. The estimated home range increases as the number of relocations increases. The harmonic mean estimator has also been often used to estimate home ranges (Dixon and Chapman 1980) and to describe the ecological aspects of habitat use patterns. Comparison of home range estimators found harmonic mean to most closely approximate the true home range (least biased) but also found harmonic mean to be least able to closely repeat estimates (least precise) (Boulanger and White 1990). It was judged to show the best performance of five techniques evaluated. However, this method may provide poor estimates of home range for animals with linear use patterns or traditional travel corridors (Samuel and Fuller 1994). Harmonic mean also tends to include areas without sample points (Naef-Daenzer 1993, Worton 1995). Kernel density estimators compared well with other methods available (Worton 1995). Kernel methods currently appear to be preferred over the harmonic mean estimator (and other methods) because kernel methods are less biased.

Selection of a technique for estimation of home range should be related to the objectives and analysis requirements of the study. It may be desirable to use 2 or more methods to provide information needed for analysis at different levels of habitat selection. Kernel techniques (Worton 1989) may be appropriate for defining habitats actually used by the study animals as estimated by radio locations. That information may be compared with habitats available in the study area to perform level 2 analysis. Level 3 analysis may be conducted by comparing habitats used as described by kernel techniques with habitats encompassed in a 95% minimum convex polygon (i.e., the habitats available for use at the home range level).

Proportional Use of Habitats

An animal's proportional use of a habitat is associated with use or avoidance of other available habitats (Aebischer et al. 1993). Therefore avoidance of one habitat will lead to the conclusion of preference for other habitats. An analysis technique would preferably determine initially if habitat use is nonrandom. If nonrandom use is indicated, it should determine which habitats are used more or less than expected while taking into account the use of other habitats. Aebischer's et al. (1993) assessment is that the preference/avoidance technique of Neu et al. (1974, Byers et al. 1984) is "fraught with difficulty" in this regard. Although Alldredge and Ratti (1986, 1992) did not make any strong recommendations concerning their evaluation of assessment techniques, Samuel and Fuller (1994) indicated the Neu et al. method "performed well in comparison to other methods."

Several models exist for modeling the relative probability of habitat use from a sample of used and available habitat units when used habitats are only classifies as being used without reference to the amount of use. Manly et al. (1993) suggest the use of a log-linear model where the resource selection probability function is in the form:

$$w(x) = \exp(\beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p)$$

where x_i are the proportions or functions of the proportions of the land cover classes considered. One of the advantages of using a log-linear model to determine probability of use is that resource selection probability functions may be estimated using readily available computer software (e.g., PROC LOGISTIC in SAS (SAS Institute 1989)).

It may also be advisable to explore analysis of habitat selection using the log-ratio difference test developed by Aebischer et al. (1993) which was based on the compositional analyses of Aitchison (1986). This method takes advantage of using each animal as the sampling unit, minimizes the problems of non-independence or proportions, scales the test for selection by the use-availability difference between each animal separately, and tests for between group (e.g., sex, age, season, study location) differences. Compositional analysis programs for SAS are also currently available.

The compositional analysis method of Aebischer et al. (1993) uses the log-ratios of the composition of used habitats paired with the corresponding log-ratios of the composition of available habitats. Titus (1995) followed use of this technique with a linear MANOVA model to test the overall null hypothesis that use and availability did not differ among all habitat categories. If differences were noted based on Wilks' lambda (Λ), he performed a series of *t*-tests and Wilcoxon rank tests measuring the difference between random use among all pairs of habitat categories. Habitat categories may then be ranked following Aebischer et al. (1993) and Johnson's (1980) methods.

Survival Estimation

The process of Schwartz and Franzmann (1991) will be used to examine survival rates of black bears. Survival and cause-specific mortality will be calculated for cubs, yearlings, and subadult and adult females and males using the Kaplan-Meier procedure (Pollock et al, 1989). Survival functions for different age, sex, habitat composition, and/or degree of human activity will be compared with the log-rank and an approximate chi-square test statistic. A Z statistic will be used to compare annual survival rates (Pollock et al. 1989).

Spatially Explicit Population Models

Development of a spatially explicit population model offers the opportunity to greatly expand the usefulness of the resource selection functions in evaluating landscape level effects of management options on black bears. Spatially explicit models provide an opportunity to estimate the response of organisms to landscape-level ecological processes and a method to examine the response of organisms to changes in management practices (Dunning et al. 1995). These models require habitat-specific information about demography, dispersal behavior, and habitat selection of the animal of interest. Spatially explicit models incorporate the movement of individual animals between specific patches across the landscape and quantify how movement may affect population dynamics. Movement rules may allow temporary movement associated with food searches and dispersal movements. Rules may specify mortality, use of corridors, and other landscape features.

The most common use of these models to date has been to evaluate the response of individuals and populations to landscape change. They are also useful as links between studies of habitat selection and population regulation. Insights may be provided into the development of conservation strategies and design of reserves with these techniques.

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Table 1. Description of variables available in the land covers map, Kenai Peninsula, Alaska (Talbot et al. 1984).

Cover class	Description
Forest	Conifer forest
	Conifer woodland
	Mixed forest
Shrub	Deciduous scrub (subalpine)
	Deciduous scrub (lowland and montane)
	Dwarf shrub peatland
	Dwarf shrub tundra
	Dwarf shrub and lichen tundra
Herb./forb	Graminoid and disturbed areas
	Lichen tundra
	String bog-wetlands
Water	Water-high sediment load
	Water-medium sediment load
	Water-low sediment load
Barren	Soil, sediment, bare rock
Other	Snow, ice, and glaciers
	Shadow

Table 2. Human activity groups and zones of human activity for cover and non-cover situations on the Kenai Peninsula, Alaska that may be useful for evaluating survival of black bears.

	Cover		Noncover	
	Zone of Influence		Zone of Influence	
Activity Group	0-1.6 km	1.6-3.2 km	0-3.2 km	3.2-6.4 km
Urban areas, towns	X	X	X	X
Motorized				
Linear high use	X	X	X	X
Linear low use	X	X	X	X
Point	X	X	X	X
Nonmotorized				
Linear high use	X	X	X	X
Linear low use	X	X	X	X
Point	X	X	X	X

Lowell H. Suring

25 November 1997

APPENDIX I. 1997 Russian River Camping-Bear Study.

The Alaska Department of Fish and Game is conducting a survey of campers at the Russian River. We are interested in learning more about how campers feel about brown bears at the Russian River area, and their willingness to accept changes that will make camping and fishing more compatible with brown bear conservation. Would you be willing to take about 15 minutes to assist me?

Thank You!

Please fill in today's date______________________________

Q1 Is this your first camping trip to the Russian River?

( ) YES

( ) NO

IF NO: How many years have you camped here?_________

How many times per year do you camp here?_______

Q2 Which of the following best describes your camping setup?

( ) CAMPER ON PICKUP

( ) SELF CONTAINED CAMPING UNIT (E.G. WINNEBEGO)

( ) HARD SIDED TRAILER PULLED BY VEHICLE (E.G. AIR STREAM)

( ) SOFT SIDED TRAILER PULLED BY VEHICLE (E.G. POP-UP TENT UNIT)

( ) TENT CAMPING

( ) OTHER, please describe it ____

Q3 Have you ever seen a brown bear while camping at the Russian River?

( ) YES

( ) NO

Q4 Have you ever had a brown bear problem while camping at the Russian River?

( ) YES

( ) NO

Q5 What sort of precautions do you take to help prevent an encounter while camping? ***(Check all that apply to you)***

( ) DO NOTHING

( ) STORE FOOD IN CAMPER

( ) DON'T STORE FOOD IN TENT

( ) BEAR SPRAY

( ) KEEP FIREARM HANDY

( ) OTHER, PLEASE

DESCRIBE____

The Kenai Peninsula brown bear population is currently estimated at somewhere between 250-300 bears. Biologists believe that increasing human activity in the form of road building, agriculture, housing development, and recreation could jeopardize this population. Fishing activities here on the Russian River have created additional problems for bears. Each year anglers harvest around 45,000 red salmon. Many return the carcasses to the river. These help the stream by providing food for young salmon and trout, but they also attract brown bears. Some of these bears are also attracted to the camping area by human food, dog food, and fish. Each year there are several dangerous encounters between brown bear and campers or anglers here on the Russian River. And, over the past several years, some bears have been transplanted or destroyed.

Q6 Do you think steps should be taken to try to reduce encounters that may be dangerous to bears or people?

( ) YES
( ) NO

Q7 Given the following choices, which would you find acceptable and which would be unacceptable? ***(Circle number of response)***	UNACCEPTABLE			ACCEPTABLE	
	HIGHLY	MODERATELY	NEUTRAL	MODERATELY	HIGHLY
Require storage of all food, fish, and other items inside hard-sided vehicles or special storage containers.....................	1	2	3	4	5
Allow food to be present in picnic areas/campsites only during meals. Food must be stored at all other times......	1	2	3	4	5
Installation of bear proof garbage containers................	1	2	3	4	5
Prohibit fish waste disposal in garbage containers.........	1	2	3	4	5
Require fish waste disposal in the river.........................	1	2	3	4	5
Enforce regulations and fines related to bear-safe camping and fishing	1	2	3	4	5
Designated camping areas for soft-sided units (e.g. tents) that are fenced and bear proof......................	1	2	3	4	5

The next few questions are related to your willingness to pay a special fee to provide services that would help decrease the number of bear encounters in camp grounds around the Russian and Kenai Rivers.

Each year there are several encounters between brown bears and campers or anglers in this area. These encounters have the potential to lead to serious injuries or death among the campers and anglers. Such encounters are also dangerous for the bears, and over the years, a number of brown bears in the Russian River area have been moved or destroyed. These encounters are in part occurring because brown bears are attracted to camping areas by human or pet food and fish that have been caught by anglers staying in the campgrounds.

Four specific actions have been identified to try to decrease the number of bear encounters:

- **Providing bear-proof garbage containers at campgrounds.**

- **Providing bear-proof food containers to be used by tent campers.**
- **Fencing and bear-proofing a designated tent camping area in an acceptable and aesthetically pleasing manner.**
- **Providing an onsite ranger to patrol the campground, enforce regulations, and ward off bears.**

First, we would like to know how effective you think each of these actions would be at decreasing bear encounters with humans in this campground.

Q8 Do you agree or disagree that each of the following actions would decrease bear encounters in the campground.... ***(Circle the number of your response)***	**Strongly Disagree**	**Moderately Disagree**	**Neither Agree nor Disagree**	**Moderately Agree**	**Strongl Agree**
Providing bear-proof garbage containers at campgrounds........................	1	2	3	4	5
Providing bear-proof food containers to tent campers..............................	1	2	3	4	5
Fencing and bear-proofing a designated tent camping area......................	1	2	3	4	5
Providing an onsite ranger for bear patrol..	1	2	3	4	5

Each of these four actions would require the expenditure of additional funds by the resource management agencies. One way of raising the necessary funds would be to institute a special fee at this location. We are interested in knowing how much more you would be willing to pay if additional money was used to take one or more of these actions. Currently camping fees are $11 per night for a single parking campsite and $18 per night for a double parking campsite. (USFS). OR Currently parking fees on the Kenai NWR at this site are $5 for vehicles < 20 ft. and $6 for vehicles > 20 ft.

Q9 How much more per night would you be willing to pay **if the additional money were only used to provide bear-proof garbage containers?** What amount below, or any amount in between, is the most you would be willing to pay above current camping fees? ***(Circle or write in response)***

$0 $1 $3 $5 $7 $10 $15 $20

Q10 How much more per night would you be willing to pay **if the additional money were only used to provide bear-proof food containers for tent campers?** What amount below, or any amount in between, is the most you would be willing to pay above current camping fees? ***(Circle or write in response)***

$0 $1 $3 $5 $7 $10 $15 $20

Q11 How much more per night would you be willing to pay **if the additional money were only used to fence and bear-proof a designated tent camping area?** What amount below, or any amount in between, is the most you would be willing to pay above current camping fees? ***(Circle or write in response)***

$0 $1 $3 $5 $7 $10 $15 $20

Q12 How much more per night would you be willing to pay **if the additional money were only used to provide an onsite ranger for bear patrol?** What amount below, or any amount in between, is the most you would be willing to pay above current camping fees? ***(Circle or write in response)***

$0 $1 $3 $5 $7 $10 $15 $20

Q13 How much more per night would you be willing to pay **if the additional money were used to fund a combination of each of the four actions described above?** What amount below, or any amount in between, is the most you would be willing to pay above current camping fees? ***(Circle or write in response)***

$0 $1 $3 $5 $7 $10 $15 $20

Q14 For every $100 that is generated with an increased fee, how much should be spent on each of the 4 proposed actions?

$_______ **Providing bear-proof garbage containers at campgrounds.**

$_______ **Providing bear-proof food containers to be used by tent campers.**

$_______ **Fencing and bear-proofing a designated tent camping area.**

$_______ **Providing an onsite ranger to patrol the campground specifically to ward off bears.**

Total = $ 100.00

Q15 The following few questions pertain to tent camping at the campground. If you are currently staying in a tent (or other soft-sided shelter) or if you have ever stayed in a tent at this campground please answer the following questions. **IF YOU HAVE NEVER STAYED IN A TENT AT THIS CAMPGROUND PLEASE SKIP TO QUESTION Q16.**

Do you agree or disagree with the following statements? (Circle your response)	**Strongly Disagree**	**Moderatel y Disagree**	**Neither**	**Moderatel y Agree**	**Strongly Agree**
If a fenced area for tent camping were developed at this campground, you would be likely to use it.	1	2	3	4	5
A fenced area would detract from your camping experience.	1	2	3	4	5
Camping in a fenced area would make you feel more secure when camping in this area.	1	2	3	4	5
Requiring tent campers to stay in a fenced area is unnecessary.	1	2	3	4	5

Q16 Next there are a few questions about the importance of protecting brown bears on the Kenai Peninsula.

Would you say... (Circle the number of your response)	*much less important*	*somewhat less important*	*equally as important*	*somewhat more important*	*much more important*	*...to you than protecting brown bear population o Kenai.*
Increasing camping opportunities is............................	1	2	3	4	5	"
Being able to leave food unattended at my camp site.	1	2	3	4	5	"
Camping in a tent with no fence for protection is.......	1	2	3	4	5	"
Being able to conveniently clean fish is......................	1	2	3	4	5	"
The quality of camping opportunities is......................	1	2	3	4	5	"
Not giving up any camping opportunities is................	1	2	3	4	5	"

Q17 In general, would you say you like or dislike brown bears? *(Circle Response)*

1	2	3	4	5
STRONGLY DISLIKE	**MODERATELY DISLIKE**	**NEITHER LIKE NOR DISLIKE**	**MODERATELY LIKE**	**STRONGLY LIKE**

Q18 In general, would you say brown bears are harmful or beneficial? *(Circle Response)*

1	2	3	4	5
VERY HARMFUL	**MODERATELY HARMFUL**	**NEITHER**	**MODERATELY BENEFICIAL**	**STRONGLY BENEFICIAL**

Q19 In general, do you think protecting brown bears on the Kenai is good or bad? *(Circle Response)*

1	2	3	4	5
VERY BAD	**MODERATELY BAD**	**NEITHER GOOD NOR BAD**	**MODERATELY GOOD**	**STRONGLY GOOD**

Q20 In general, how important would you rate protecting brown bears on the Kenai on a scale of 1 to 7? ***(Circle number of response)***

(Where 1 = NOT AT ALL IMPORTANT , 7 = EXTREMELY IMPORTANT & 4 = NEUTRAL)

1 2 3 4 5 6 7

21 Your gender

( ) MALE

( ) FEMALE

Q22 Your age __________.

Q23 Are you an Alaska Resident?

( ) YES

IF YES: Do you live on the Kenai Peninsula? ( ) YES

( ) NO, where in Alaska:

____

( ) NO

Q24 Do you have any other suggestions that might help us make Russian River camping more compatible with brown bears?

In the future we may complete a more extensive study of the brown bear issue in area campgrounds. Would you be willing to participate in this future study? If so, please provide your name, address, and telephone number below. We assure you this information will not be released or used for any other purpose than to contact you regarding a future study.

Name: ____(LAST)

____(FIRST)

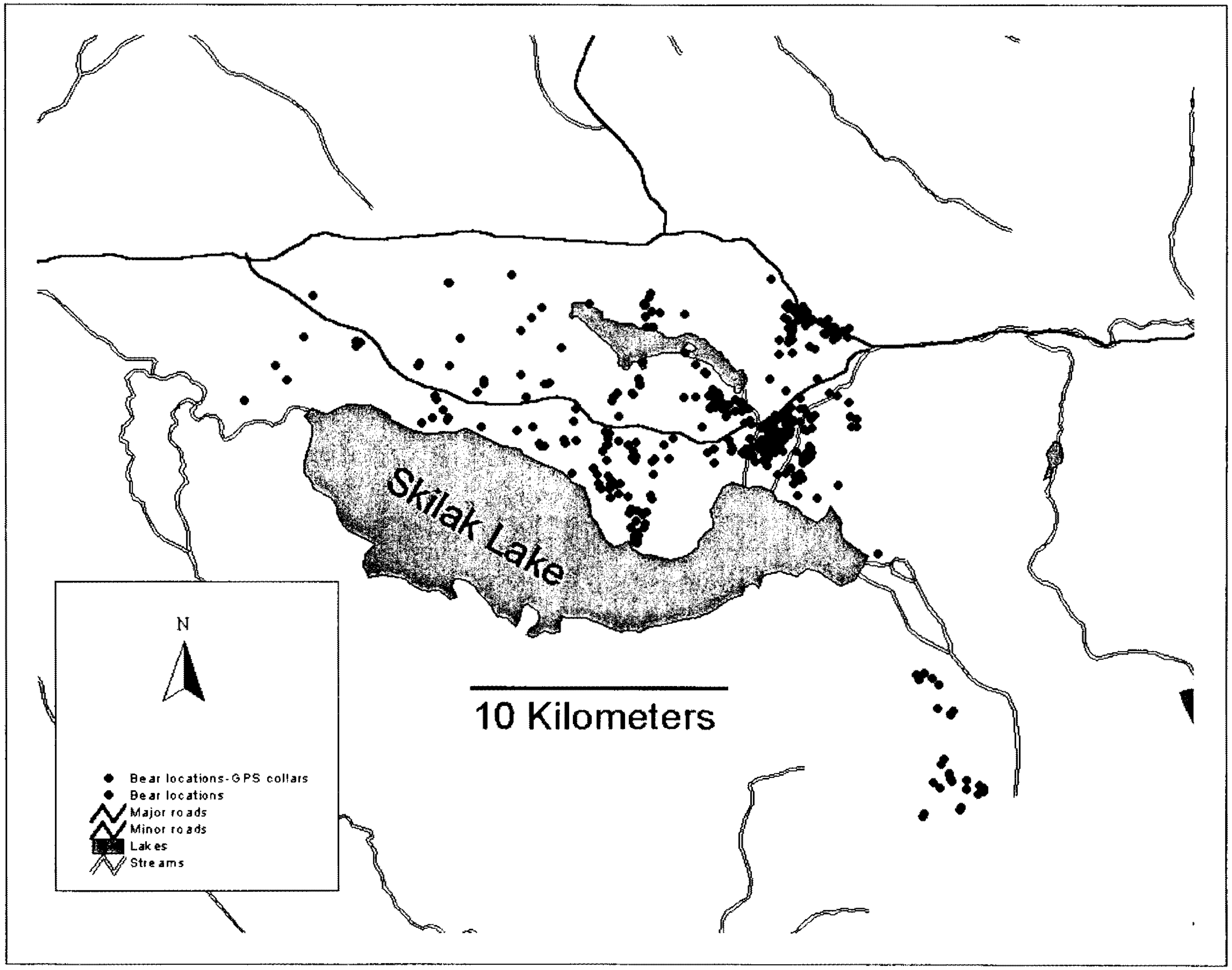
Address:____

street town/city

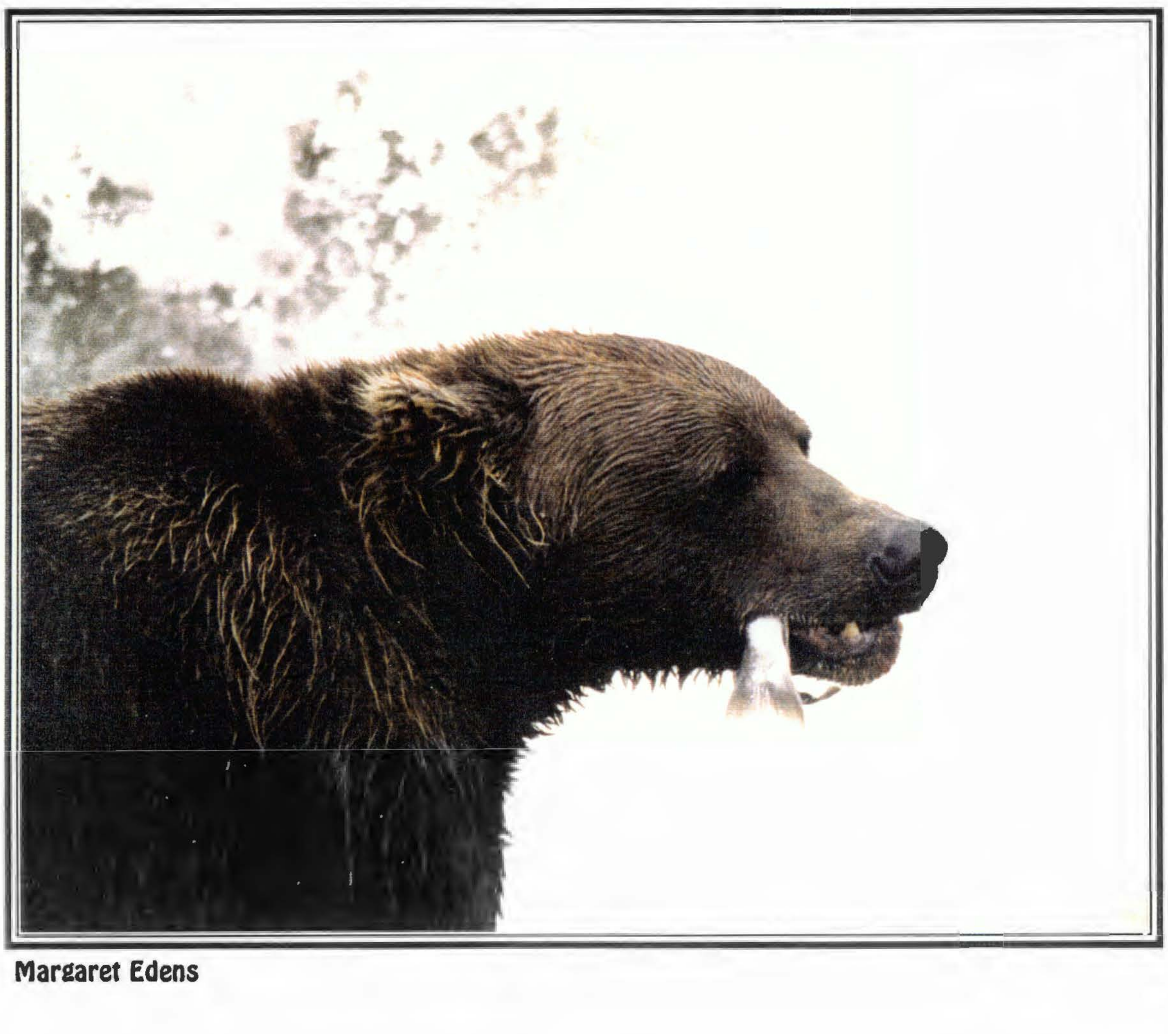
____

state zipcode

Phone: ____


Skilak Lake
10 Kilometers
N
Bear locations-GPS collars
Bear locations
Major roads
Minor roads
Lakes
Streams

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



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