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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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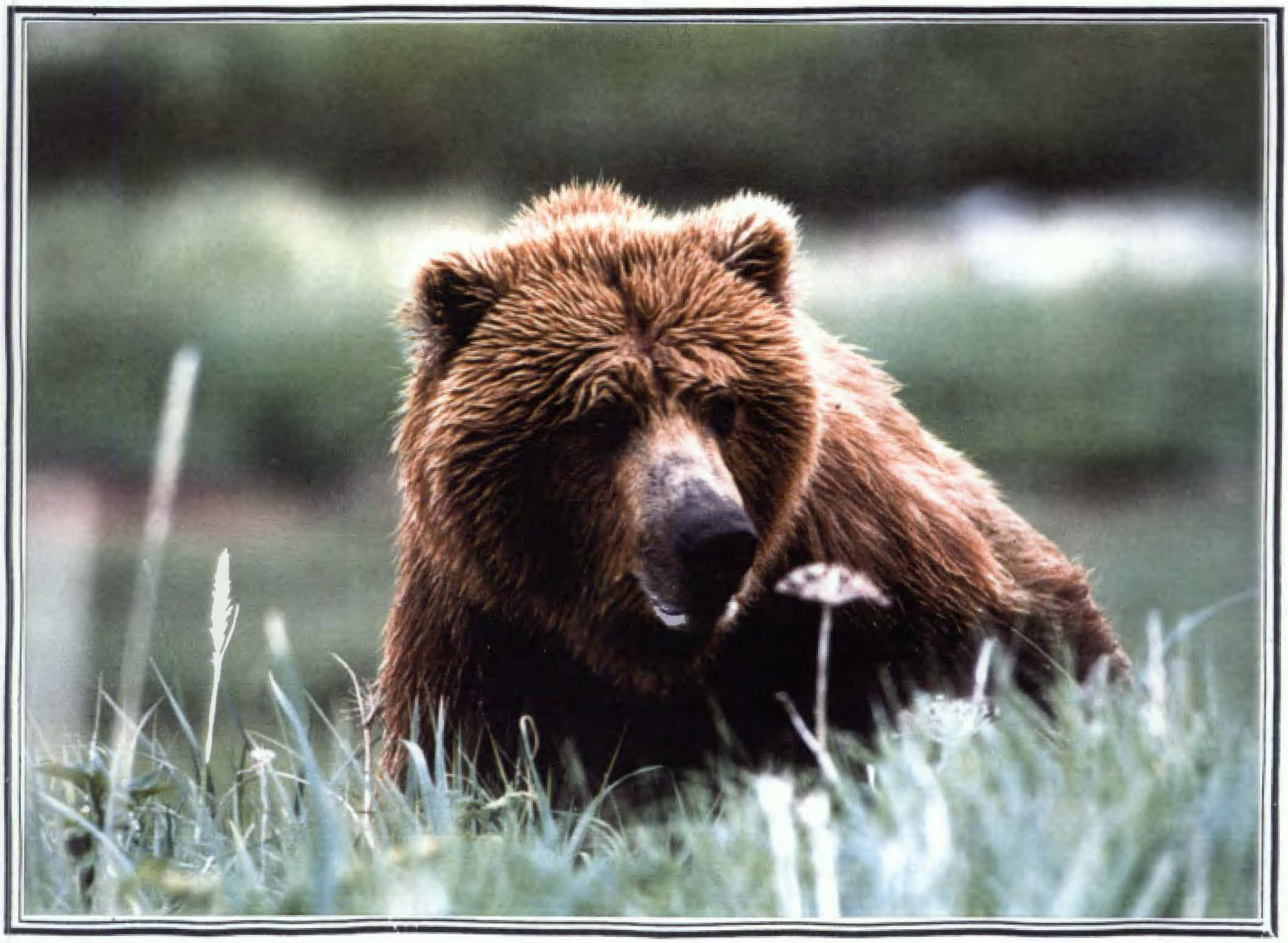

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RESEARCH PROGRESS REPORT

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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 1996-30 June 1997

SUMMARY

We monitored 31 adult females captured in 1995 and 1996 for movements and habitat use information. We deployed 12 Global Positioning System (GPS) transmitters, 10 of which had ARGOS uplinks. The GPS transmitters provided data fixes successfully 12-65% of the time. Fix rate success varied seasonally among bears and was probably affected by location, terrain, vegetative cover, and bear behavior. Based upon movements of GPS bears and with conventional fixes from aircraft (n = 460), we were able to identify several important movement corridors on the Peninsula. Large lakes are a geographic barrier to bear movements; consequently, bears move around the lakes' ends. We verified movements through the Skilak Loop travel corridor. The ends of Tustumena Lake and Kenai Lake may also represent important travel corridors; study is necessary for verification. Kaplin-Meyer survival coefficients for the summer period (May-Oct) was 0.88 (95%CI = 0.78-0.97). We documented only 1 human-caused mortality during this report period. Habitat use information and reproductive histories were catalogued for further analysis. Attempts to obtain a vegetation data layer for the Kenai Peninsula were unsuccessful. Without this GIS layer, we cannot evaluate the cumulative effects model.

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

TABLE OF CONTENTS

SUMMARY i
BACKGROUND..1
OBJECTIVES 3
METHODS 4
RESULTS AND DISCUSSION..5
RECOMMENDATION 11
LITERATURE CITED 11
FIGURES...14
TABLES 20
APPENDIX Body Composition of Brown Bears on the Kenai Peninsula 25

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 from feeding areas, resulting from increasing recreational pressures (salmon fishing). In light of this, we must determine sustained yield for the population, evaluate a cumulative effects model that will allow predictions relative to habitat effects, and develop a long-term management strategy for brown bears on the KP.

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. 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 at 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 the best professional judgment and extrapolation from other areas with known bear density, ADF&G and USFWS biologists estimate the KP population between 150-250 (Jacobs 1989). This estimate was based on the assumption that only 8,800 km^2 of the 23,310 km^2 area on the KP was regularly used as brown bear habitat. More recently, Del Frate (1994) 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 harvest (allowable human kill) of brown bears is 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.

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

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 3-km-long 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), indicating that movements of brown bears onto and off of the KP are minimal.

The KP has received some of the most significant human impacts in Alaska (southcentral Alaska ecosystem) 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, mineral, 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 the state of Alaska. Each year an estimated 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 and the Chugach National Forest are developing, or proposing to develop, campgrounds, hiking trails, and backcountry hostels to accommodate users. Much of this activity is directly associated with 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 harvest program. 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 relative to brown bears are unknown.

The Interagency Brown Bear Study Team (IBBST) was formed by the USFWS, USDA Forest Service, and ADF&G 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 in the face of 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 habitat. The IBBST took the next logical step and designed a cumulative effects model to assess the effects of management practices on habitats to sustain brown bears (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 Model the brown bear population to establish sustainable yield and assess population viability with the ultimate goal of developing a brown bear management plan.

5 Prepare a final report.

METHODS

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

Adult female bears were fitted with both conventional or GPS radiocollars (Telonics Inc., Mesa Ariz.). Using fixed-wing aircraft, we initially located bears by air 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 or Hughes 500 helicopter, using a Cap-Chur® gun (Palmer Chemical and Equipment Co., Douglasville, Ga.).

Captured bears were examined for injuries, ear tagged, lip tattooed, measured for total length, skull width and length, and chest girth. Blood and hair samples were collected to help determine nutritional and health status. A premolar was extracted for age determination. Teeth were decalcified and stained using the 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. Yearlings were aged 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 $\geq$1 and <2, 2-year-olds were $\geq$2 and $\leq$3. We assumed that parturition occurred in the den sometime in late January or early February, and therefore we set birth dates at 1 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, locations of bears indicated by the GPS data were visited on the ground, and evidence of bear activity and habitat conditions was noted. All locations of bears were entered into a GIS, and areas of intense activity and movement corridors were identified.

The cumulative effects model was used to predict seasonal locations of brown bears. Bears with conventional collars were tracked at approximately weekly intervals, whereas GPS transmitted bears were located via fixed wing aircraft less frequently. At each telemetry fix, we noted the bears activity, the vegetation type, terrain, took aerial color photographs of the site, and a GPS fix. Data will be analyzed following recommendations of Manly et al. (1993). If the model deviates from actual results, adjustments will be made based upon the new database. Additional information will then 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 identified critical components of habitat, it failed to identify important travel corridors between these components. The locations from GPS transmitters provided these data.

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 was 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 approximately 25 bears. If mortality is high (i.e., >15%), we will mark additional individuals.

Job. 4. Model the brown bear population to establish sustainable yield 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 which 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 1996, 29 bears were captured 44 times (Table 1). Of these, 21 were adult females, 2 of which were previously collared in 1995. Twelve of the females were collared with GPS transmitters, 10 of which relayed the data via satellite (ARGOS uplink) and 2 stored the data onboard. The other 9 female bears were equipped with conventional VHF collars. Of the 8 males, 4 were fitted with ear-tag transmitters in hopes they would lead us to other females. Two of these were still transmitting when they entered their dens.

GPS collars with the ARGOS uplink were set to take one GPS fix per day with an uplink schedule to the satellite at intervals alternating between 53 (1:00-5:00 GMT) or 58 hours (15:00-19:00 GMT). These uplink times were set to accommodate the best satellite overpasses with the greatest elevation above the horizon and the most consistent (daily) overpasses. The first GPS fix after initializing the collar (turning it on) occurred at 23:00 GMT and the schedule advanced 1:00 hr each day thereafter. Hence, the collar cycled through a 24 hour clock every 24 days. The collar attempted to take a GPS fix over a period of 3 minutes. The ARGOS uplink transmitter attempted to send messages over a 4-hour period. With this frequency of fix/uplink transmissions, the collars were designed to deplete the power supply in approximately 6 months. The GPS store-onboard collars attempted 5 GPS 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 6 months.

During 1996 we monitored 13 bears collared in 1995, a bear transplanted from Anchorage to the Kenai Peninsula in summer 1995, and the 23 bears marked in 1996, for a total of 37. However, of the bears collared in 1995, 1 died and another shed its collar soon after leaving the den in April. Radiocollared bears were located 460 times by air at approximately weekly intervals from March-October, or until they entered dens. In addition, the 10 satellite-linked GPS collars obtained 504 location fixes. Performance of the GPS collars was extremely variable. Success rates for obtaining a GPS fix by individual collars ranged from 12-65%. Success rates were greatest during May and June, and declined during July and August, indicating habitat changes, geographic features, or bear behavior reduced performance when bears moved to salmon streams. The 2 GPS collars with onboard data storage achieved at least 1 fix on 93% and 98% of the days they were deployed. Most likely, this was because the collars attempted to fix position 5 times per day. Fix success rates by these collars were 44% and 55% over all fix attempts, similar to the satellite-linked collars. We are currently analyzing the data and plan to prepare a manuscript for publication.

Aerial location data have been entered into a database for future analysis. Photographs of each location were used to classify vegetation type and the percentage of beetle-killed spruce. Additionally, we obtained a land ownership coverage from the Kenai Peninsula Borough and converted it to an ARC INFO format. We are currently using this database to evaluate bear movements relative to human developments.

We have been unsuccessful to date in obtaining a Peninsula wide GIS data layer of vegetation type. We have investigated several options and have requested special funding to help with this portion of the project. Originally this layer was going to be developed by the Habitat section of the Department of Fish and Game. We are actively pursuing alternatives. Without a habitat data layer for our GIS, we cannot evaluate habitat selection relative to the cumulative effects model. Consequently, no progress was made toward this objective.

Several of the females were captured 2 or 3 times; once each during May, July-August, and October. During each capture, body condition was assessed and blood and hair samples were obtained as part of a graduate study by Grant Hilderbrand of Washington State University (Appendix). This study will examine the effects of different foods on body composition of bears.

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

Each time bears were located from the air, we classified habitat type present at the site 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/ARGOS transmitters to aid in the identification of critical travel corridors near the Skilak Lake area. The Interagency Brown Bear Study Team identified the area west of Skilak lake on the Kenai National Wildlife Refuge as a potentially important travel corridor for brown bears. This area (West Skilak corridor) 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, rapidly being developed (Fig. 1). Movements of 2 GPS/ARGOS collared bears (females 24 and 42) and 1 GPS store-onboard collar (female 37) clearly demonstrate how brown bears avoid developed lands and use the corridor.

Female 24 was first collared on 30 April of 1996 north of the Sterling Highway near Spirit Lake. At the time of collaring, she had 3 cubs of the year (COY). She was sighted with her cubs several times subsequent to tagging, but lost them during the summer, possibly to brown bear predation. Her movements were generally east and west along the north side of developed areas on Robinson Loop and the town of Sterling (Fig. 1). She also used the identified travel corridor, moving north and south across the Kenai River and the Killey River at least 3 times during late summer. Her movements and GPS locations indicated she avoided human development. We visited several of her GPS locations on foot to verify habitat usage and activity. We were successful in locating numerous day beds, 1 adult moose carcass, and feeding sign. We were reasonably sure the sign we encountered at the GPS sites was in fact made by female 24 because we could easily identify adult brown bear tracks in freshly dug day beds and at some sites we also found COY tracks. We found numerous locations where she had stripped the bark from pole-sized aspen trees to feed on cambium. Female 24 was also seen feeding on a yearling moose in the spring shortly after she was collared north of Spirit Lake.

Female 42 was first collared on 16 July, 1996 on Slikok Lake, south of the Kenai National Wildlife Refuge headquarters building. At the time of tagging she was accompanied by 2 COY. Her movements were generally south and east of the developed areas around Soldotna. She crossed the Funny River Road and traveled along the south side of the Kenai River near river mile 28. Although we could not confirm it, GPS location data indicated she visited the Borough Landfill refuse container along the Funny River Road. She traveled as far east as the Funny River and approached, but did not enter, the West Skilak travel corridor. Her movements also indicate avoidance of human development.

Female bear 37 was first located with male 36 on 28 May 1996. Both bears were in the West Skilak travel corridor just north of the Kenai River. When collared, female 37 was not accompanied by offspring and was likely in estrous. She used the West Skilak corridor several times during the summer and traveled north and south through the area across the Kenai River.

The center of her activity was along the Killey River south of the Kenai River. We lost contact with male 36, but he was known to be within the corridor for at least 1 week.

Movements of other radiocollared bears during late August-September also support our contention this area is important to brown bears. In 1996 there were a large number of spawning red and pink salmon just below Skilak Lake in the Kenai River (Fig. 2). This area was very important to brown bears for feeding, particularly female bears with offspring. On one day, we located 12 radiocollared adult females and 20 offspring: a total of 32 different bears in an area of about 10 square miles. This area was intensively used by females with cubs during September and October, and several females were still active in the area during early November. Our October telemetry data and aerial flights indicate these bears stayed within 3 miles of the river during the day, sleeping and resting, and probably fed on fish during the night. Several river guides also reported seeing bears feeding along the Kenai River in this area during early morning hours.

Two fishermen narrowly escaped serious injury after encountering a lone bear on the north side of the river. The fishermen were hiking from the Kenai River toward the Kenai Keys Road on a trail that passes near Torpedo Lake when they encountered a bear on the trial. They tried to leave the area but the bear followed them. They eventually had to use pepper spray (Frontiersman™, Sabre Security Equipment Corp., Fenton, MO) when the bear knocked one individual down and stood over him. After the bear was sprayed in the mouth, it left the area. The fishermen ran to a nearby cabin where they spent the night. The next morning, they ran to the river bank and flagged down a passing boat for a ride back to the Kenai Keys area. They abandoned their gear and never returned.

Fishing activity along the riverbanks in this area should be evaluated and possibly prohibited during fall, when brown bears feed on fish. Our data indicate this area is especially important as a late fall feeding area for females with cubs. These females have the greatest energetic demands during summer due to lactation and require additional calories to prepare for hibernation. This area, with abundant fish runs, represents a ready source of food. Bears feeding in this area scavenge spawned fish that wash up on the banks or are stranded as the high water of summer recedes and exposes the gravel bars. Examination of the site in October revealed that brown bears fed upon nearly all the fish carcasses on the banks.

Although our data on use of the West Skilak corridor represent movements of only 13 bears during 1 year, the patterns are clear. First, both GPS/ARGOS females with home ranges bordering the developed areas between the towns of Soldotna and Sterling avoided these heavily populated areas. This indicates bears will use undeveloped landscapes when available. Second, bears captured as far away as Mystery Creek and the east end of Tustumena Lake used the West Skilak Lake corridor. These two points support the notions of the IBBST that the corridor should not be developed. Additionally, overnight camping and bank fishing should be prohibited in this area during fall when the red and pink salmon carcasses become available. This action will prevent displacement of bears and reduce the potential for human-bear encounters that could result in either a human or bear mortality.

Bear locations also indicate the Killey River represents a significant food source and travel route 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. One platted subdivision of 160 acres straddles the Killey River near its junction with the Kenai River. If this subdivision is developed with recreational or residential housing, it will surely become a bear sink. Bears traveling down the Killey to the Kenai will travel through the development and encounter people, which will increase DLP mortalities. Consequently, we strongly recommend these parcels be purchased and protected from development.

We did not record bears moving regularly along the north shore of Skilak Lake between the inlet and outlet; however, we did have at least 2 bears that used both the inlet and outlet of the lake. We did not obtain enough locations to document the exact path of their movements between these 2 areas. Our radio location data also indicate the inlet of the lake and the area around Hidden Lake are important feeding areas for brown bears (Fig. 2). Recreational development within the Skilak Loop area on the Refuge has probably affected bear movements. We recommend further development be halted until we complete our studies. With a better understanding of travel corridors within the Loop, we will be able to recommend orderly development that will minimize effects on brown bears and reduce potential bear-human conflicts.

Additional movements of marked bears indicated that large lakes on the Kenai Peninsula represent geographic barriers to movement (Fig. 3). Areas near the ends of these lakes are used as travel corridors by bears. In addition to the West Skilak corridor, travel corridors were apparent at the east end of Skilak Lake near Hidden Lake (Hidden Lake corridor), the southeast end of Tustumena Lake (East Tustumena corridor), and the west end of Kenai Lake (Cooper Landing corridor), the area with most of our radiocollared bears (Fig. 4). Based upon these movements, we suspect that the east end of Kenai Lake (Ptarmigan and Primrose corridors) and ends of other large lakes (i.e., Trail Lake, Grant Lake, Upper Russian Lake, Caribou Lake) also are important travel corridors. We intend to radiocollar bears in 1997 in the Trail and Grant Lake areas to help document these areas as key corridors. This is especially important in light of proposed timber sales in this area by the US Forest Service.

For the past several years ADF&G has responded to a number of brown bear problems along the Bean Creek Road near Cooper Landing and the west end of Kenai Lake. Developments in the area include a subdivision and a major tourist lodge. Our data on brown bear movements indicate this area is prone to bear problems because it is a travel corridor (Cooper Landing corridor, Fig. 4). Topography to the north naturally funnels bears through either the Resurrection Valley via Juneau Creek or over Slaughter Creek through the area known as Russian Gap. Russian Gap was historically known for the deeply worn brown bear trail traditionally used by bears traveling from the Kenai Mountains north of the highway to the Kenai River and areas to the south (Red Smith, pers. commun.). Three of our radiomarked bears in this area showed similar travel patterns. Based upon our findings, we suggest that public lands in this area be retained in an undeveloped state to connect Forest Service and Refuge lands to the north with similar lands south of the highway (Fig. 5). The proposed highway reroute in this area will increase habitat fragmentation in this corridor. Consequently, any additional development should be discouraged or planned to maintain a travel corridor for brown bears. Otherwise, we can expect additional bear-human conflicts and the area to develop into a bear sink with high bear mortality.

We have recorded similar bear-human conflicts on the southeast end of Kenai Lake (Primrose corridor, Fig. 4). We strongly suspect this area also is an important travel corridor for brown bears traveling from the mountainous areas east of the Seward highway around Kenai Lake. Land in the valley paralleling the Seward highway is mostly privately owned (Fig. 6). There is one small piece of Forest Service land which spans the valley east to west that connects the mountainous areas at the south end of Kenai Lake. This habitat and the area bordering the east shore of Kenai Lake south of Ptarmigan Creek (Ptarmigan corridor) should be protected from development, maintained in a roadless state, and recognized as critical travel corridors for brown bears. Continued development of the private lands north and south of this area will ultimately restrict or prevent safe travel by bears east to west except through these corridors.

The first bears entered dens during mid-September, and the last entered dens 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.

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

We had 3 mortalities in 1996. One young male bear drowned due to capture-related complications. An adult female (female 22) died due to unknown natural causes some time in early spring shortly after emerging from her den, and another (female 30) was found dead of a gunshot wound on 8 October. During summer, female 30 moved only short distances between Bear and Moose creeks on the north side of Tustumena Lake, where she was probably feeding on salmon. During late September, the bear moved extensively back and forth along the entire north shore of Tustumena Lake. On 7 October she moved approximately 5 miles northeast of the western end of the lake and stopped moving. On 11 October we found the bear dead at this location. Female 30 had 2 yearling cubs, which were unlikely to survive after the death of their mother. We did not necropsy the carcass due to time restrictions, but it was in good to excellent condition with heavy accumulations of fat. The only injury was a small (about 1 cm) hole in the abdominal cavity, indicating it was shot. We will attempt to revisit the carcass in 1997 with a metal detector in an attempt to locate a bullet.

We calculated Kaplin-Meyer survival coefficients for adult females during active and denning periods for 1995 and 1996 data (Table 2). A chi-square test ($X^2 = 0.165$, $P = 0.685$) indicated that survival rates did not differ between years, so we pooled data to determine average survival rates for the 2 periods (Table 3). Survival from May through October was 0.88 (95% CI = 0.78-0.97); we did not observe any mortality during the denning period, so survival was 1.0.

Because we only observed 3 deaths, and 1 of these occurred during a month when only 15 bears were marked (May 1996), we may have underestimated survival during the active period. The one death during May caused our survival estimate to drop to 0.93 in that month. It declined further due to deaths in July and October. However, these deaths resulted in only 2-3% reductions in survival because the number of bears at risk was large (37-38). With additional years of data, our estimates of survival will improve.

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

We began to develop a table of reproductive histories (Table 4) for marked bears. Data are inadequate at this time to model the Kenai population, and no work was performed on this job during this report period.

Job. 5. Prepare a final report.

No work was performed on this job during this report period.

RECOMMENDATIONS

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

LITERATURE CITED

BANGS, E. E., T. H. SPRAKER, T. N. BAILEY, AND V. D. BERNS. 1982. Effects of increased human populations on wildlife resources on the Kenai Peninsula, Alaska. Trans. North Am. Wildl. and Nat. Res Conf. 47:605-616.

CHRISTENSEN, A. G. 1985. Cumulative effects analysis: origins, acceptance, and value to grizzly bear management. Pages 213-216 *in* G. P. Contreras and K. E. Evans, eds. Proc. grizzly bear habitat symposium. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. INT-207.

——, AND M. J. MADEL. 1982. Cumulative effects analysis process - grizzly habitat component mapping. U.S. Dep. Agric. For. Serv., Kootenai Natl. For., Libby, Mont. 60pp.

CRAIGHEAD, F. C., AND J. A. MITCHELL. 1982. Grizzly bear. Pages 515-556 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America. Johns Hopkins Univ. Press, Baltimore.

DEL FRATE, G. G. 1994. Brown bear survey-inventory activities, Units 7 and 15 Kenai Peninsula. Alaska Dep. Fish and Game, Fed. Aid. in Wildl. Restor. Proj. W-23-4. (in press).

HALL, J. 1992. Report to the Kenai Peninsula Borough on the impacts of spruce bark beetle infestation. Memo.

HENNON, P., R. MASK, AND E. HOLSTEN. 1994. Forest health management report: forest insect and disease conditions in Alaska - 1993. U.S. Dep. Agric. For. Serv. Gen. Tec. Rep. TP-40. 36pp.

JACOBS, M. J. 1989. An initial population analysis and management strategy of Kenai Peninsula brown bears. M.S. Thesis. W. Va. Univ., Morgantown. 205pp.

LeFranc, M. N. Jr., M. B. Moss, K. A. Patnode, and W. C. Snugg III, editors. 1987. Grizzly bear compendium. Interagency grizzly bear comm., Wash. D.C. 540pp.

Manly, B. F. J., L. L. McDonald, and D. L. Thomas. 1993. Resource selection by animals: statistical design and analysis for field studies. Chapman and Hall, New York, N.Y. 177pp.

Matson, G., L. Van Daele, E. Goodwin, L. Aumiller, H. Reynolds, and H. Hristienko. 1993. A laboratory manual for cementum age determination of Alaskan brown bear first premolar teeth. Alaska Department of Fish and Game special publication. 52 pp.

Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. Nat. Hist. Press, Garden City, N. Y. 384pp.

Miller, S. D. 1993. Brown bears in Alaska: a statewide management overview. Wildl. Tech. Bull. 11, 40pp.

——, and S. M. Miller. 1988. Interpretation of bear harvest data. Alaska Dep. Fish and Game, Fed. Aid in Wildl. Restor. Final Rep. Proj. W-23-1 Job 4.18, 65pp.

Pollock, K. H., S. R. Witerstein, and C. M. Bunck. 1989. Survival analysis in telemetry studies: the staggered entry design. J. Wildl. Manage. 53:7-15.

Rausch, R. L. 1963. Geographic variation in size in North American brown bears, *Ursus arctos* L., as indicated by condylobasal length. Can. J. Zool. 41:33-45.

Rogers, L. L. 1978. Interpertation of cementum annuli in first premolars of bears. Proc. East . Black Bear Workshop. 4:102-112.

Schoen, J. W., R. W. Flynn, L. H. Suring, K. Titus, and L. R. Beier. 1994. Habitat-capability model for brown bear in Southeast Alaska. Int. Conf. Bear Res. and Manage. 9:327-337.

Schwartz, C. C. and A. W. Franzmann. 1991. Interrelationship of black bears to moose and forest succession in the northern coniferous forest. Wildl. Monogr. 113. 58pp.

Servheen, C. 1981. Grizzly bear ecology and management in Mission Mountains, Montana. Ph. D. Thesis. Univ. of Mont., Missoula. 139pp.

Suring, L. H., K. R. Barber, C. C. Schwartz, T. N. Bailey, M. D. Tetreau, and W. C. Shuster. 1994. Cumulative effects model for brown bear on the Kenai Peninsula, Southcentral Alaska. (in press).

USDI Fish and Wildlife Service. 1982. Grizzly bear recovery plan. U.S. Dep. Inter., Fish and Wildl. Serv., Wash D. C.

VIERECK, L. A., C. T. DYRNESS, A. R. BATTEN, AND K. J. WENZLICK. 1992. The Alaskan vegetation classification. USDA Forest Service, Pacific Northwest Research Station. General Technical Report #286, 278pp.

WEAVER, J., R. ESCANO, D. MATTSON, T. PULCHLERZ, AND D. DESPAIN. 1985. A cumulative effects model for grizzly bear management in the Yellowstone ecosystem. Pages 234-246 *in* G. P. Contreras and K. E. Evans, eds. Proc. grizzly bear habitat symposium. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. INT-207.

WILLEY, C. H. 1974. Aging black bears from the first premolar tooth sections. J. Wildl. Manage. 38:97-100.

YOUNG, D. L. 1985. Cumulative effects analysis of grizzly bear habitat on the Lewis and Clark National Forest. Pages 217-221 *in* G. P. Contreras and K. E. Evans, eds. Proc. grizzly bear habitat symposium. U.S.

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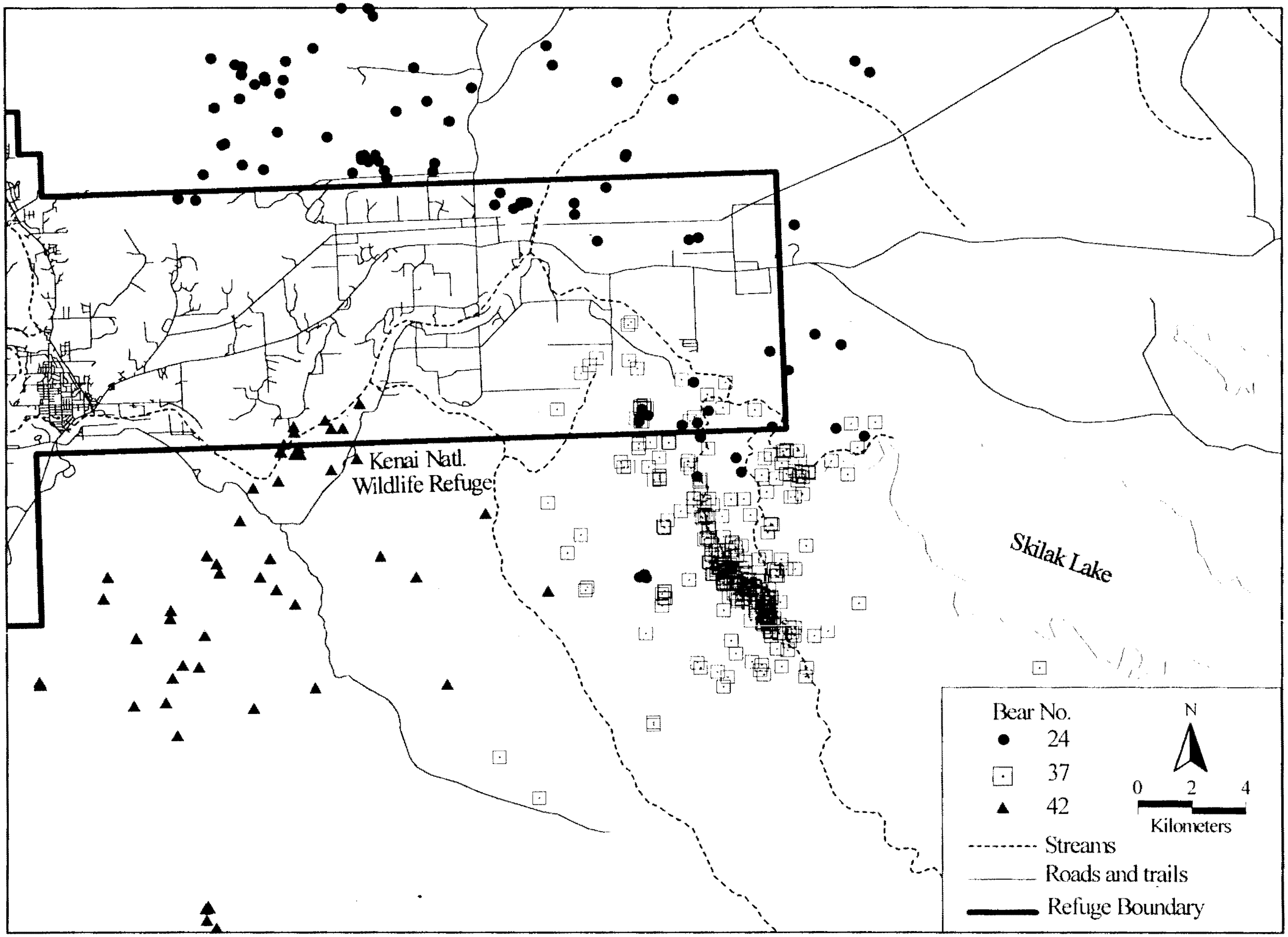

Figure 1. Movements of 3 GPS-collared brown bears around developed areas on the Kenai Peninsula, Alaska, 1996.

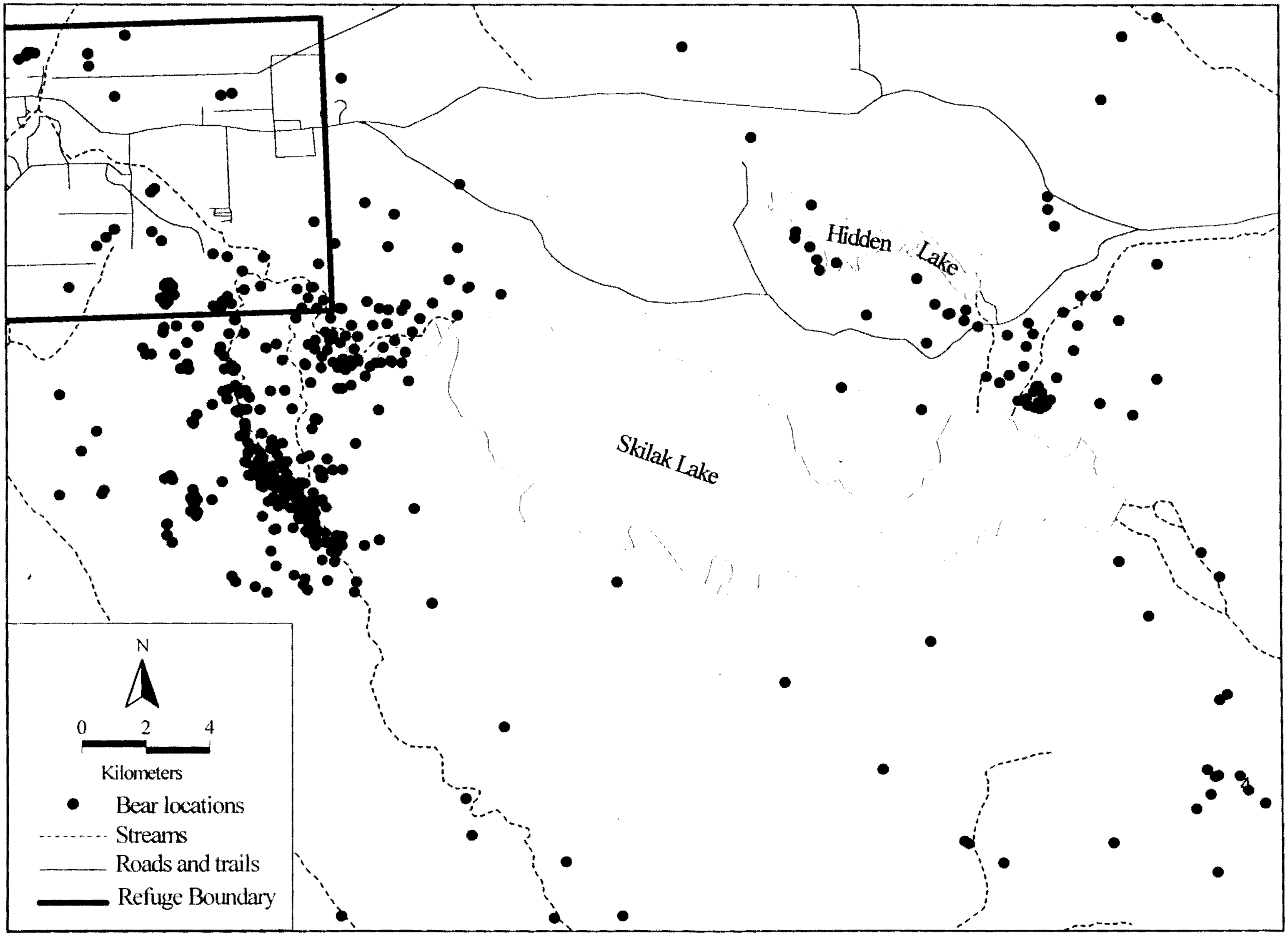

Figure 2. Movements of radio-marked brown bears around Skilak Lake on the Kenai Peninsula, Alaska, 1996.

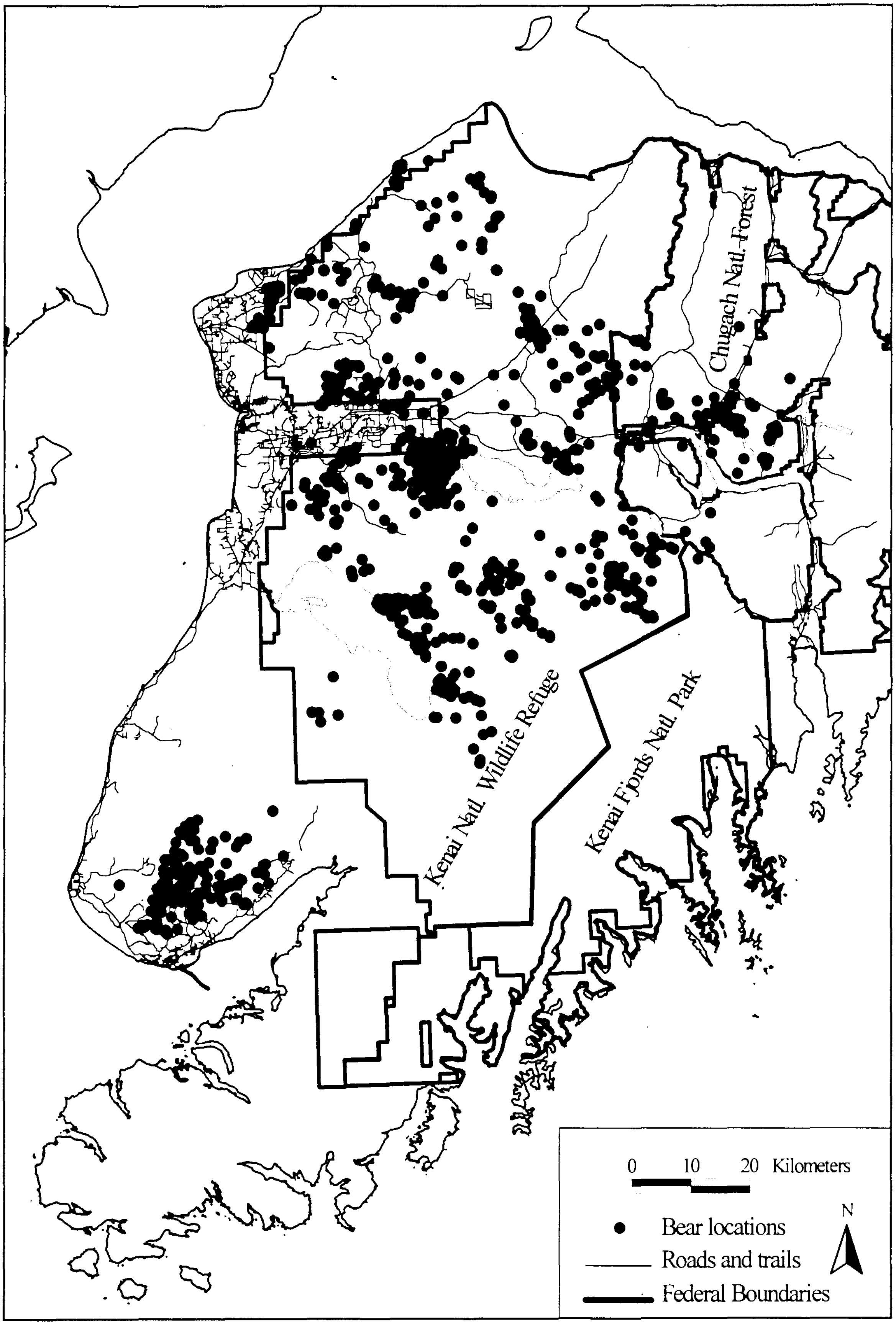

Figure 3. Movements of radio-marked brown bears on the Kenai Peninsula, Alaska, 1995 and 1996.

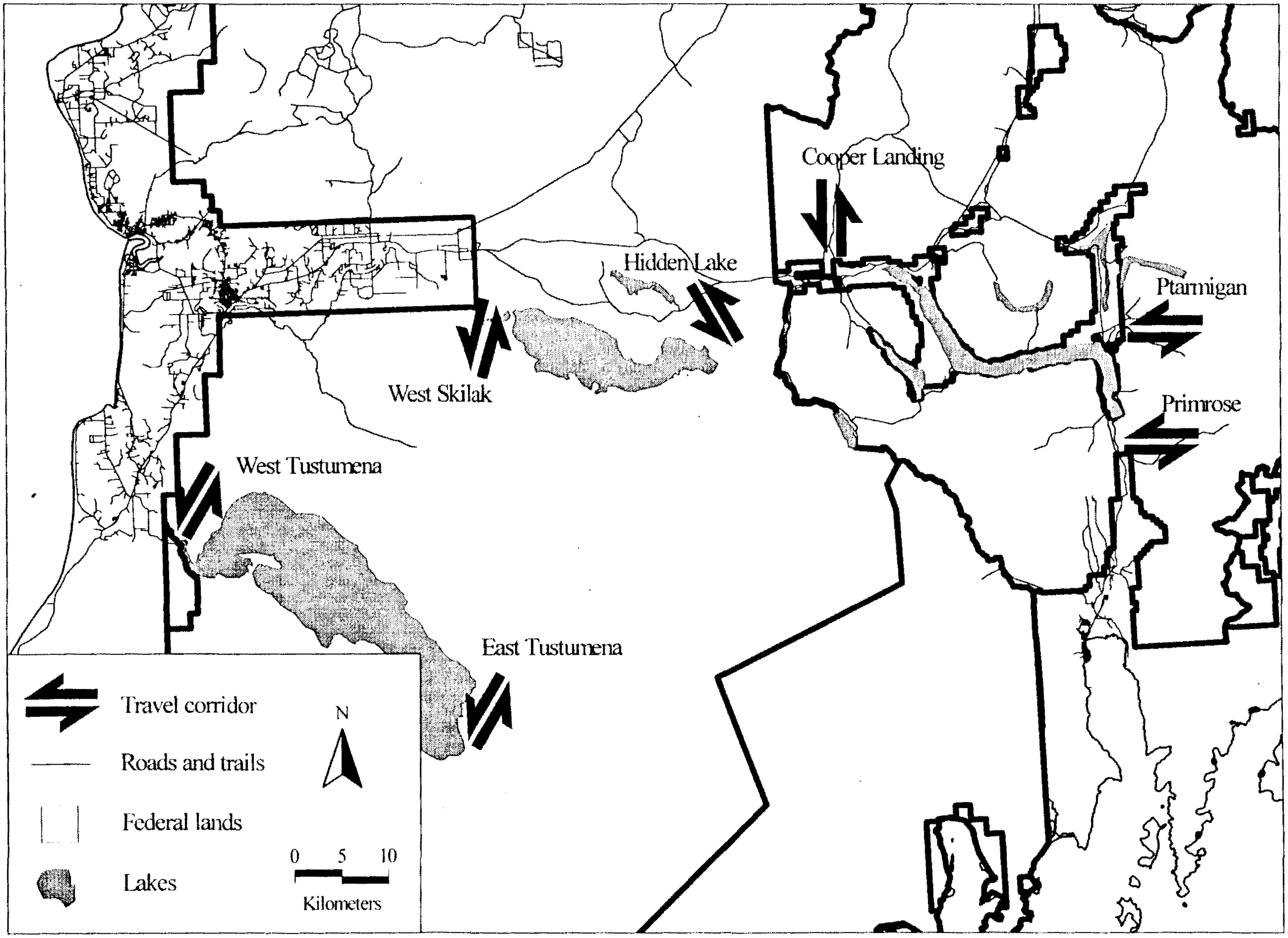

Figure 4. Critical travel corridors for brown bears on the Kenai Peninsula, Alaska.

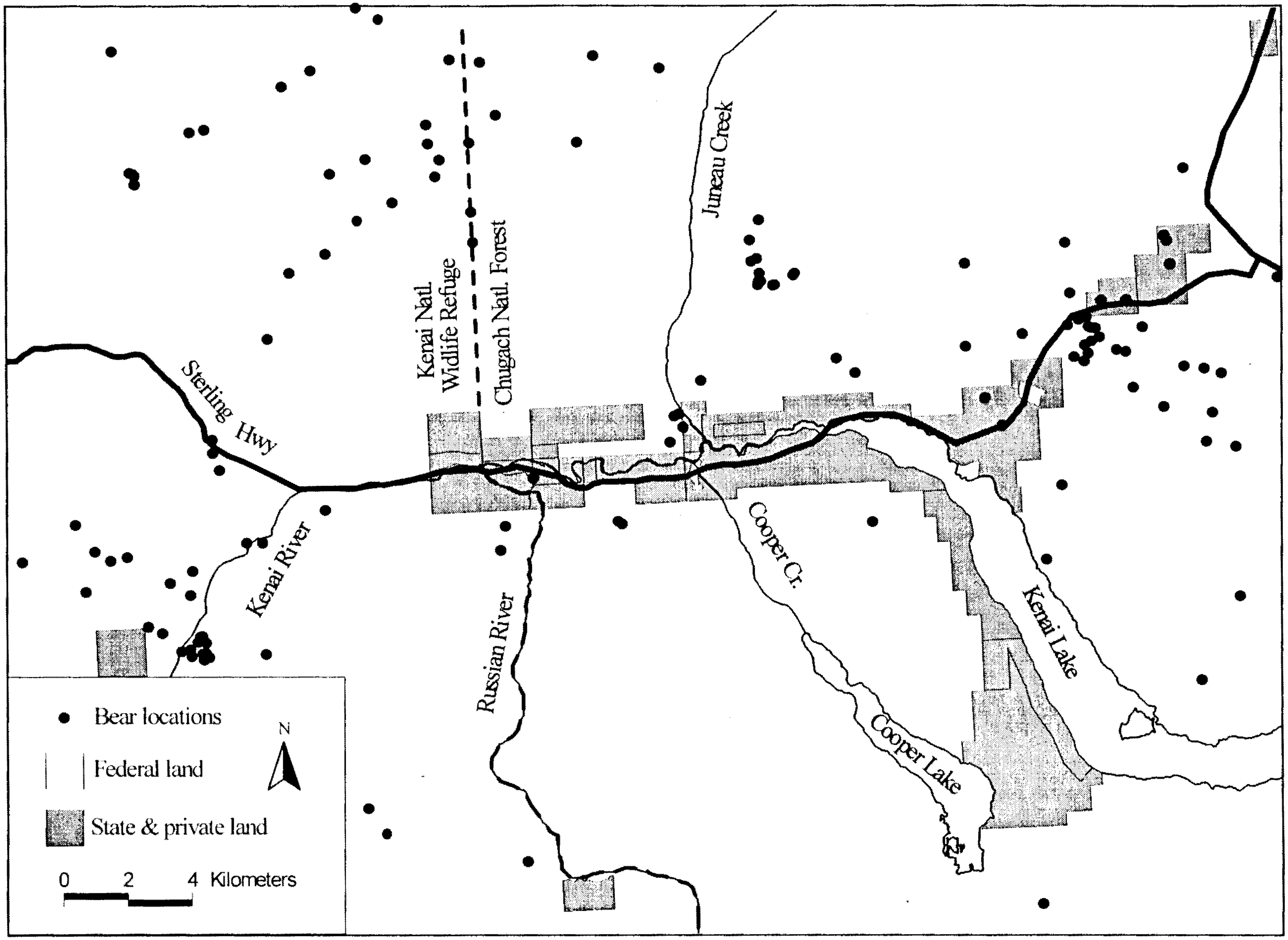

Figure 5. Brown bear movements and land ownership west of Kenai Lake, Kenai Peninsula, Alaska, 1996.

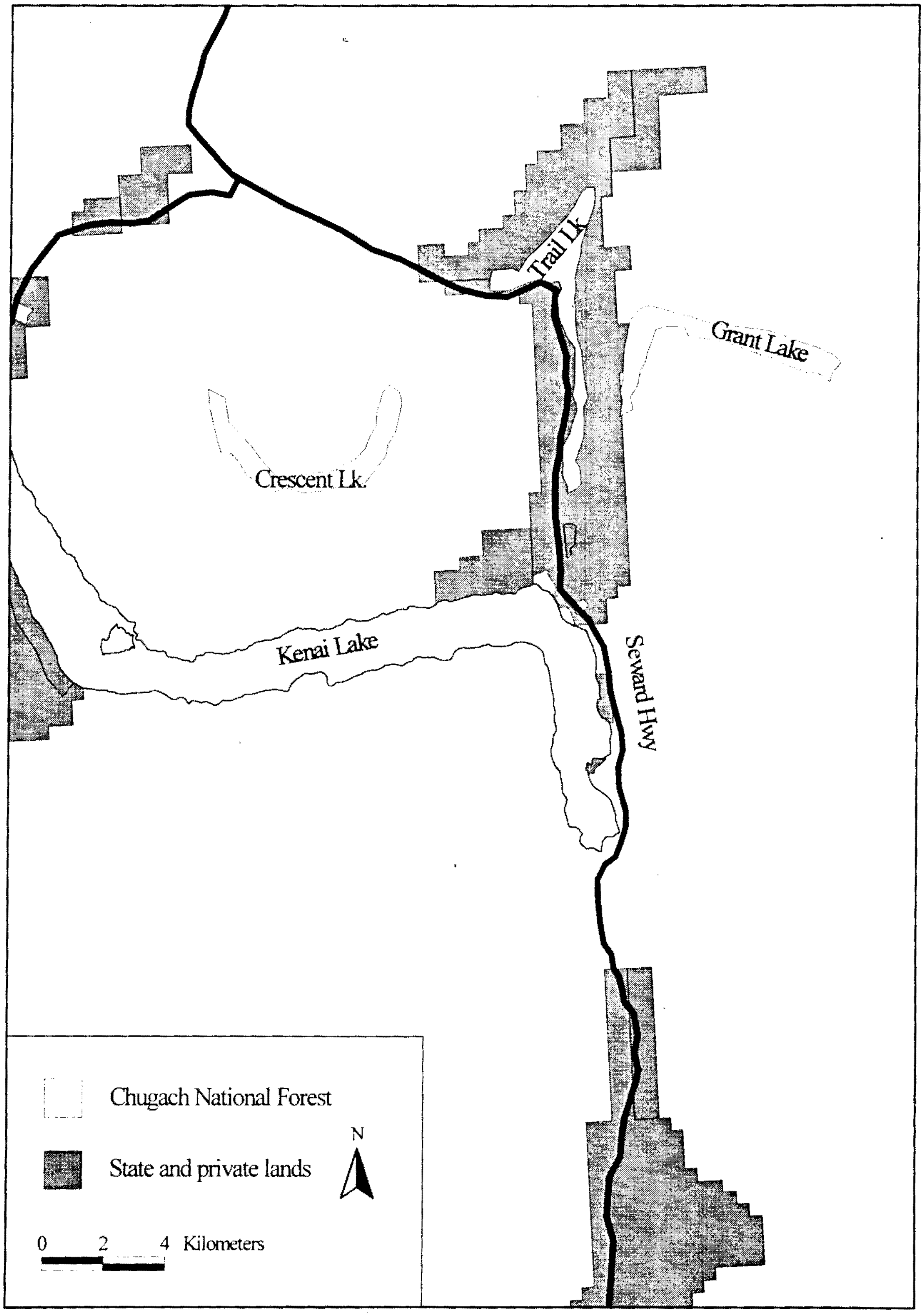

Figure 6. Land ownership near the east end of Kenai Lake, Kenai Peninsula, Alaska, 1996.

Table 1 Brown bear radiocollaring and tagging status by sex and age, Kenai Peninsula 1996.

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, brown bear predation
02	5/19/95	F	4	TIMBERLINE LK	With 03	Conventional	12/5/96	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	Conventional	11/21/96	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	7/11/96	denned
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	2 yearlings	Conventional	12/5/96	denned
11	5/31/95	F	12	W. KILLEY RIVER	alone	Conventional	11/7/96	denned
12	5/31/95	F	16	SKILAK GLACIER	3 cubs	Conventional	11/21/96	denned
13	6/2/95	F	7	HW. COTTONWOOD CR	alone	Conventional	11/21/96	denned
14	6/5/95	F	7	GOAT LAKE	2 yearlings	Conventional	11/1/96	denned
15	6/5/95	F	20	GOAT LAKE	2 2-yr-olds	Conventional	11/1/96	denned
16	6/5/95	F	5	EMMA LAKE	2 yearlings	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	alone	Conventional	11/1/96	denned
20	7/26/95	M	0	PIPELINE		None	7/26/95	unknown
21	8/14/95	F	8	GLACIER CREEK	2 yearlings	Conventional	11/7/96	denned
22	10/4/95	F	3	GLACIER FLATS	alone	Conventional	5/7/96	dead
23	4/30/96	M	3	CHICKALOON FLATS	alone	None	4/30/96	capture mortality
24	4/30/96	F	7	ELEPHANT LAKE	3 cubs	GPS-PTT[a]	11/21/96	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

Table 1 Continued

Bear No.	Capture Date	Sex	Age	Tagging Location	Accompanying Bears	Transmitter Type	Last Date Located	Current Status
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[a]	10/10/96	shed collar
29	5/17/96	F	6	ANCHOR RIVER	1 yearling	GPS-PTT[a]	11/21/96	denned
30	5/19/96	F	9	TRUULI CANYON	2 yearlings	GPS-PTT[a]	10/8/96	dead - shot?
31	5/20/96	F	10	MYSTERY CREEK	3 yearlings	GPS-PTT[a]	11/7/96	denned
32	5/21/96	F	8	FALLS CREEK	alone	GPS-PTT	11/1/96	denned
33	5/22/96	F	7	THURMAN CREEK	2 cubs	Conventional	11/1/96	denned
34	5/22/96	F	2	DIKE CREEK	alone	Conventional	11/1/96	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	with #36	GPS-stored[a]	11/21/96	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	2 yearlings	GPS-PTT[a]	11/7/96	denned
40	7/15/96	F	13	MYSTERY CREEK	2 cubs	GPS-stored[a]	12/5/96	denned
41	7/16/96	F	9	MOOSE CREEK	2 cubs	Conventional	11/7/96	denned
42	7/16/96	F	10	SLIKOK LAKE	2 cubs	GPS-PTT[a]	11/21/96	denned
44	10/17/96	F	15	SKILAK OUTLET	near #45	Conventional	11/7/96	denned
45	10/17/96	F	10	SKILAK OUTLET	3 cubs	Conventional	11/21/96	denned
46	10/17/96	F	10	SKILAK OUTLET	2 cubs	Conventional	11/21/96	denned
47	10/22/96	F	8	SKILAK OUTLET	2 cubs	Conventional	11/7/96	denned
48	10/22/96	F	10	SKILAK OUTLET	2 cubs	Conventional	11/21/96	denned
49	10/22/96	F	8	SKILAK OUTLET	1 cub	Conventional	12/5/96	denned
50	10/22/96	M	1	SKILAK OUTLET	with adult	Ear tag	11/21/96	denned

[a]GPS-PTT collars contain satellite transmitters; GPS-stored collars stored location data onboard. GPS collars were replaced with conventional collars during October 1996, except for bear #32, who was already in a den.

Table 2. Kaplin-Meyer survival estimates for female brown bears on the Kenai Peninsula from May 1995 through December, 1996.

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

Table 3. Nondenning period Kaplin-Meyer survival estimates for female brown bears on the Kenai Peninsula from May through October. Years 1995 and 1996 are combined.

Month	At Risk	Deaths	Survival	Lower	Upper
5	15	1	0.93333	0.81138	1.00000
6	29	0	0.93333	0.84562	1.00000
7	34	1	0.90588	0.81247	0.99930
8	37	0	0.90588	0.81633	0.99543
9	38	0	0.90588	0.81752	0.99425
10	38	1	0.88204	0.78572	0.97836

Table 4. Reproductive status of radiocollared brown bears on the Kenai Peninsula Alaska, 1993-1996. 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	Comments
01	1992			0	DEAD	
02	1988	COY(?)	1YR(?)	2YR(1)	COY(2)	
03	1990			0	LOST	
04	1982		COY(?)	1YR(2)	COY(2)	NOTE 1
06	1992			0	0	
09	1987		COY(?)	1YR(2)	COY(3)	NOTE 1
11	1983			0	COY(3)	
12	1984			COY(3)	1YR(3)	
13	1988			0	COY(2)	
14	1988		COY(?)	1YR(2)	2YR(2)	
15	1975	COY(?)	1YR(?)	2YR(2)	0	
16	1990		COY(?)	1YR(2)	2YR(2)	
18	1988	COY(?)	1YR(?)	2YR(2)	COY(2)	
19	1990			0	COY(2)	
21	1987		COY(?)	1YR(2)	0	NOTE 2
22	1992			0	DEAD	
24	1989				COY(3)	NOTE 3
28	1988				COY(3)	
29	1990			COY(?)	1YR(1)	
30	1987			COY(?)	1YR(2)	
31	1986			COY(?)	1YR(3)	
32	1988				0	
33	1989				COY(2)	
34	1994				0	
37	1988				0	
39	1990			COY(?)	1YR(2)	
40	1983				COY(2)	
41	1987				COY(2)	
42	1987				COY(2)	
44	1981				0	
45	1986				COY(3)	
46	1986				COY(2)	
47	1988				COY(2)	
48	1986				COY(2)	
49	1988				COY(1)	
ANC	?				0	

NOTES:

1. 1995 yearlings were never seen after the mother was captured.
2. 1995 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.

APPENDIX Body Composition of Brown Bears on the Kenai Peninsula.

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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 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 KP black bears (U. americanus) will be assessed to determine if resource partitioning occurs between the peninsula's brown and black bear populations.

METHODS

BEAR CAPTURES

To assess seasonal changes in body mass and composition and determine the importance of available food resources, adult female brown bears were captured during 3 time periods: 1) early spring, after emergence from the den, 2) mid-summer, concurrent with the return of salmon, and 3) late fall, prior to denning. 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.

BODY COMPOSITION

The body composition of captured bears was determined by bioelectrical impedance analysis (BIA) and/or isotopic 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 review).

STABLE ISOTOPIC ANALYSES

The contribution of salmon, terrestrial meat, and vegetation to the diet of KP's brown bears will be 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, Canada, and the lower 48 states and black bear hair samples from KP have been collected and will also be analyzed for their isotopic content.

RESULTS AND DISCUSSION

BODY COMPOSITION

Adult female body mass did not change significantly between spring and summer (spring = 155.028.0 kg, summer = 179.119.6 kg, $p = 0.0677$), but did increase between summer and fall (fall = 263.835.6 kg, $p<0.0001$). The increase in body mass between the summer and fall consisted entirely of fat as lean body mass did not change during this interval (summer =

145.819.6 kg, fall = 157.925.1 kg, p = 0.2528). Fat content increased between summer and fall on both a mass (summer = 33.49.2 kg, fall = 105.913.7 kg, p <0.0001) and proportional (summer = 18.74.8%, fall = 40.23.0 %, p <0.0001) basis.

Stable Isotopic Analyses

Stable isotopic analyses of hair, blood, and food samples are currently under way.

Conclusions

The period between the summer and fall captures is important for bears to attain fat stores which are necessary to support cub production and lactation (Farley and Robbins 1995). Stable isotopic analyses coupled with observational data and scat analyses with provide insight into the relative importance of nutritional resources available to bears during this time interval.

LITERATURE CITED

FARLEY, S.D., AND C.T. ROBBINS. 1994. Development of two methods to estimate body composition of bears. Can. J. Zool. 72:220-226.

FARLEY, S.D., AND C.T. ROBBINS. 1995. Lactation, hibernation, andmass dynamics of American black and grizzly bears. Can. J. Zool. 73:2216-2222.

HILDERBRAND, G.V., S.D. FARLEY, AND C.T. ROBBINS. Predicting body composition of bears using two field methods. J. Wildl. Manage (in review).

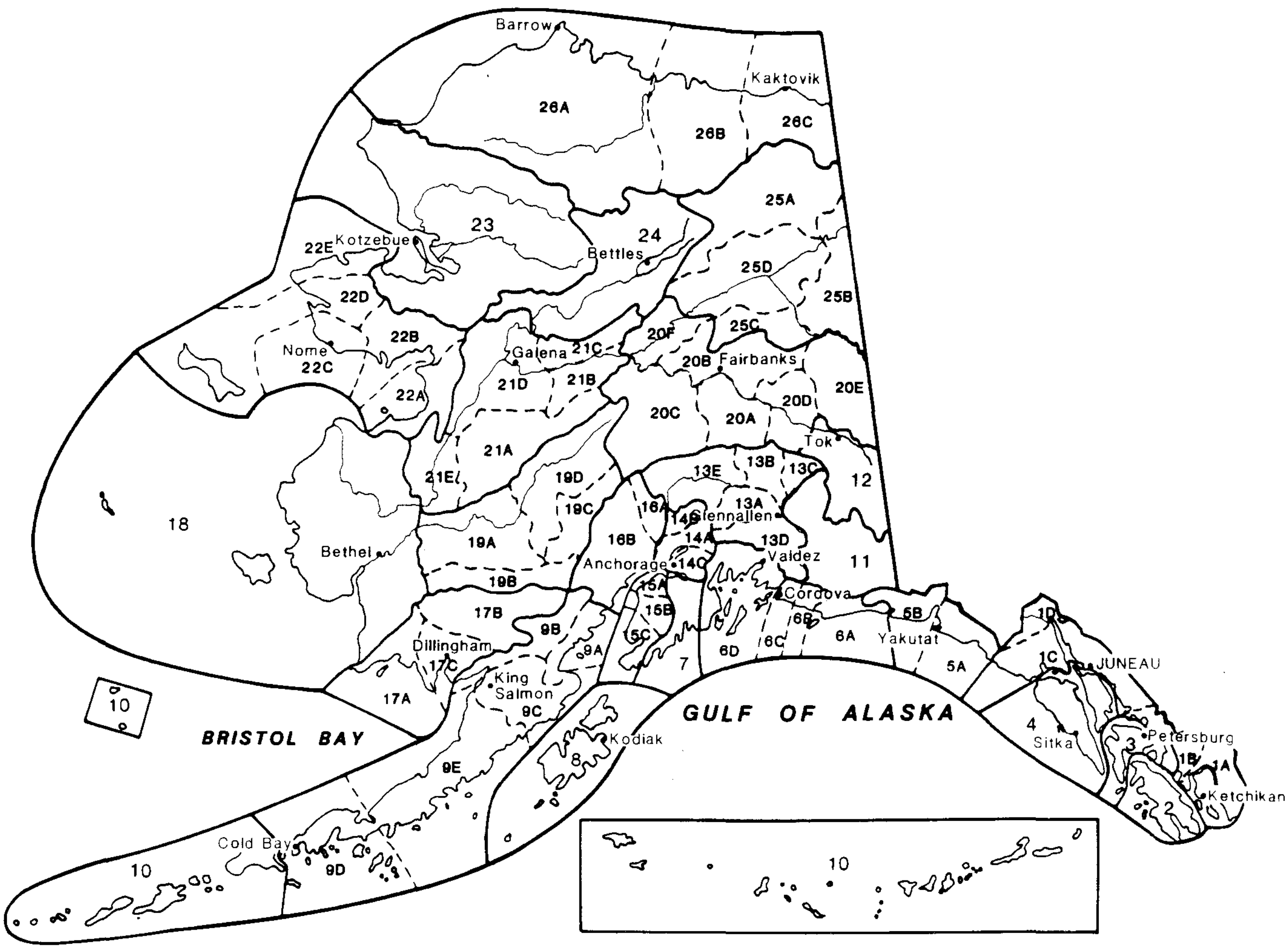
HILDERBRAND, G.V., S.D. FARLEY, C.T. ROBBINS, T.A. HANLEY, K. TITUS, AND C. SERVHEEN. 1996. Use of stable isotopic analyses to determine diets of living and extinct bears. Can. J. Zool. 74:(in press).

Table 1. Seasonal body composition of adult female brown bears.

Bear ID	Date	Mass(kg)	Fat(%)	Fat(kg)	LBM(kg)
Spring					
24*	120	146.9	19.5	28.6	118.4
28*	137	169.4	22.0	37.6	132.1
29*	137	121.9	13.8	16.8	105.1
30*	139	143.0	15.4	22.0	121.0
31*	140	145.3	12.8	18.6	126.7
32*	141	198.0	23.2	45.8	152.2
33*	142	130.0	25.3	32.8	97.2
37*	148	192.8	19.7	37.9	154.9
Summer					
15*	182	154.0	15.3	23.5	130.5
39*	182	148.2	20.3	30.1	118.1
06*	183	169.0	16.0	27.0	142.0
40	196	204.7	11.0	22.6	182.1
30*	197	195.5	18.0	35.2	160.3
41	197	167.0	21.0	35.1	131.9
42*	197	196.2	13.1	25.7	170.5
31*	202	176.0	17.3	30.4	145.6
28	202	206.7	24.0	49.6	157.1
24*	218	174.5	23.6	41.1	133.4
29*	219	178.5	26.2	46.8	131.7
Fall					
39	287	252.2	43.7	110.2	142.0
6	287	267.3	41.3	110.4	156.9
15	293	251.4	42.3	106.3	145.1
29	293	223.4	40.9	91.4	132.0
40	294	268.5	37.9	101.8	166.7
24*	294	243.3	40.5	98.5	144.8
31	294	255.4	42.9	109.6	145.8
37*	300	261.4	34.7	88.9	172.5
44	300	351.4	38.6	135.6	215.8

* - body composition determined by BIA and isotopic dilution

Alaska's Game Management Units



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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