FEDERAL AID
FINAL RESEARCH REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

PROJECT TITLE: Ecological studies of the Kenai Peninsula brown bear

PRINCIPAL INVESTIGATOR: Sean Farley

COOPERATORS: U.S. Fish and Wildlife Service (FWS), Kenai National Wildlife Refuge
U.S. Forest Service (USFS), Chugach National Forest
National Park Service (NPS), Kenai Fjords National Park

FEDERAL AID GRANT PROGRAM: Wildlife Restoration

GRANT AND SEGMENT NR: Initiated under W-27-3, completed under W-33-3

PROJECT NR: 4.29

WORK LOCATION: Kenai Peninsula

STATE: Alaska

PERIOD: 1 July 2004–30 June 2005

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The population viability of Kenai Peninsula brown bears (*Ursus arctos*) may be at risk from the cumulative impacts of sport harvest, illegal harvest, defense of life or property (DLP) killing, loss of habitat from development and logging, and displacement of bears from salmon streams by recreational sport fishing. Long-term conservation of Kenai Peninsula brown bears will depend on flexible wildlife management that balances conflicting demands for finite peninsula resources. We do not fully understand all the biological needs of a viable brown bear population on the Kenai Peninsula; thus, development, administration, and refinement of this plan will not be a static process and shall require considerable input from sound research for at least the next 5 years. If the Alaska Department of Fish and Game (ADF&G) is expected to maintain a viable Kenai Peninsula brown bear population through management actions, biologists will require critical information on bear population parameters, genetic isolation, and the effects of human pressure on habitat and nutritional constraints.

<u>Background</u>

1. Population parameters

Alaskan brown bears range over much of the state and number approximately 31,700 animals (24,990–39,136) (Miller 1993). However, bear populations are declining in some areas due to human-related activities and habitat alteration. There is concern the Kenai Peninsula brown bears may be such a population at risk. There is no statistically reliable estimate of the Kenai Peninsula population, and we can only extrapolate from other regions with assumed similar bear densities.

Jacobs (1989) provided an initial estimate of 150–250 bears, which was later increased by ADF&G management biologists to 277 (Del Frate 1993). Both estimates are derived from a habitat capability model, but differ over the amount of available brown bear habitat on the Kenai Peninsula (8800 vs. 23,310 km^2). It has been estimated (Jacobs 1989) that if the annual harvest of brown bears exceeds 7% of the population, the Kenai brown bears will not be self-sustaining (estimated from reproductive and population parameters and an assumed natural mortality rate of 5%). Therefore, the allowable annual harvest should not exceed 14–21 bears, if the population is estimated to contain 200–300 bears.

Between 1985 and 1997 the estimated yearly kill of Kenai Peninsula brown bears was 18, 18, 12, 13, 7, 14, 15, 27, 23, 20, 15, 11, and 17 individuals (X = 16; s.d = 5.5). Though the overall mean is within model limits, the years 1992–1994 were cause for alarm as the kill rate climbed to high levels. Further, the method(s) used to determine bear deaths resulting from DLP and the natural mortality rate (est. at 5%) have been questioned. If incorrect, either could drastically change the calculated allowable yearly kill of brown bears.

The harvest of brown bears has recently exceeded estimates of sustained yield, forcing management personnel to shorten the hunting season length twice. Though the season was reduced in 1990, nevertheless the total annual kill climbed to 27 bears in 1992 and DLP-related bear deaths also increased. The fall bear season was closed by emergency order in 1995, 1996, 1997, and 1998, and the Board of Game shortened the fall 1994 hunting season. More recently the Board of Game voted to move the fall season to 15–31 October in order to provide more protection to female bears (Hicks 1998). In 1999 the spring hunt was closed by emergency order. Obviously, the hunting regulations are in a state of flux because of perceived changes in the bear population.

2. Genetic isolation

The Kenai Peninsula brown bear population may be further at risk of rapid decline if it is truly isolated from mainland brown bear populations. The Kenai Peninsula 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. Approximately 250 gray wolves (*Canis lupus*) have been marked on the Kenai Peninsula over the past 20 years, and only 5 have been documented to move off the peninsula. Further, marked wolves from elsewhere in Alaska have never been documented to move onto the Kenai Peninsula (T. Bailey, pers. commun., USFWS). Gray wolves tend to disperse greater distances than brown bears (Mech 1970; Craighead and Mitchell 1992); thus, brown bear immigration/emigration on the Kenai Peninsula is likely minimal, and we cannot view mainland bears as a natural source of recruitment into the Kenai population. This isolation places the Kenai population at risk of extirpation.

3. Pressure on habitat and nutritional constraints of Kenai brown bears

The Kenai Peninsula has seen intensive human impacts on its wildlife habitat and populations. 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 resident human population increased from 24,600 to 43,600 in only 10 years (1977 to 1987)

(Bangs et al. 1982) and is now estimated to be 44,019 (Kenai Peninsula Borough records). Logging, mining, and development of human habitation on the peninsula has led to modifications or destruction of brown bear habitat.

The Kenai Peninsula is a very popular recreation region in Alaska and is the most easily accessible. Each year people spend approximately 1,000,000 visitor days on the Kenai Peninsula camping, fishing, hiking, hunting, and participating in other outdoor-related activities. The Kenai National Wildlife Refuge, the Chugach National Forest, and Alaska State Parks have responded to this pressure by proposing a multitude of campgrounds, hiking trails, and backcountry developments. Much of this activity is centered on the Kenai River watershed and its associated salmon runs, which are heavily used by the bears.

Timber on the Kenai Peninsula is experiencing a widespread die-off from infestation of spruce bark beetle (*Dendroctonus rufipennis* Kirby). Over 1.2 million of the 2.2 million acres of peninsula forest (primarily white spruce [*Picea glauca*]) have been infected by the bark beetle (Hall 1992). Foresters estimate that 397,771 acres are actively infested (Hennon et al. 1994), which has prompted calls for a vigorous timber harvest program. The proposed logging sales include approximately 37,600 acres of identified brown bear habitat (Jacobs 1989), and to date 85,000 acres of peninsula land have been cut and 275–300 miles of unregulated logging roads constructed (Steve Albert, ADF&G-Habitat Division, pers. comm.). Clearly, the massive beetle infestation and its concomitant logging pressure will cause landscape scale changes across the Kenai Peninsula forest ecosystem for many years. Unfortunately, we do not have enough information on brown bear habitat requirements to predict the effect(s) of such landscape scale changes on the brown bear population. This concern for the bear population has been identified by other management agencies. The Chugach National Forest and the Kenai National Wildlife Refuge have identified the brown bear as a management indicator species and ADF&G has formally identified the Kenai Peninsula brown bear population as a "Population of Special Concern." The latter designation indicates the population is recognized to be at risk of extirpation.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

In 1984 an Interagency Brown Bear Study Team (IBBST) was formed to collect information crucial to management of Kenai Peninsula brown bears and to function as a clearinghouse for research on the Kenai bears. Founding members included the ADF&G, FWS, and the USFS. The NPS joined in 1990. The IBBST initiated its first research in 1984 and produced a draft management plan 5 years later (Jacobs 1989). Recently the IBBST designed a cumulative effects model to assess the effects of management practices on brown bears (Suring et al. 1994), in hopes of providing an analytical tool to evaluate the impact to bears from human activity on all state, federal, and private lands. Habitat capability/cumulative effects models for brown bears have been created for other populations and have been used by land and wildlife management agencies (Christensen and Madel 1982; Christensen 1985; Weaver et al. 1985; Young 1985; Schoen et al. 1994). Currently the IBBST is awaiting the development of a peninsula-wide vegetation map in order to validate assumptions used in the cumulative effects model.

The IBBST has also collected data on brown bear habitat use, identified some bear travel corridors in high use salmon areas, begun preliminary collection of population demographics, and funded research detailing nutritional resources used by bears (Hilderbrand et al. 2000a; Hilderbrand et al. 2000b; Hilderbrand et al. 2000c; Hilderbrand et al. 2000d; Jacoby et al. 1999).

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVES 1 AND 2: Assess survivorship and recruitment to evaluate perceived population trends seen in recapture data. Determine if Kenai brown bears represent a population exhibiting large litter sizes and early weaning.

From 1995 through 2004 a total of 89 bears were collared on the Kenai Peninsula. Adult female survivorship for this period was 0.919 (0.952–0.86 upper and lower 95% CL). Mean inter-birth interval was 3.23 years (s.d. = 0.44) and annual birth rate was 0.342 female cubs per female. Litter size was 2.21 for cubs of the year (COY) and 2.11 for litters of yearlings and 2-year olds. Survivorship for cubs of the year was 0.683 (0.75–0.62 upper and lower 95% CL). Yearling survivorship was 0.587 (.0673–.501 upper and lower CL). Lambda (finite rate of population increase) was 1.018 (1.104–.9508 95% CL). Annual yield was calculated to be 2.49 for the period of 1995–2004.

The Kenai brown bear population has not been censused; however, a habitat-based estimate of 277 animals is used for management purposes. Assuming a 50:50 sex ratio provides a breeding population of 138 females.

OBJECTIVE 3: Measure the degree of heterozygosity seen in the Kenai brown bears, and calculate an “effective population size” (N_e).

We collected data from 20 bi-parentally inherited microsatellite loci, and nucleotide sequence from the maternally inherited mitochondrial DNA (mtDNA) control region to determine levels of genetic variation of the brown bears of the Kenai Peninsula. Nuclear genetic variation was similar to that observed in other Alaskan peninsular populations. We detected no significant inbreeding, no genetic signature of a recent bottleneck, and found no evidence of population substructuring on the Kenai Peninsula. Kenai brown bears have lower levels of mtDNA haplotypic diversity relative to other brown bear populations.

Rather than calculate effective population size, we calculated critical *M* values (M_C), using a prebottlenecked effective population size (N_e) of between the one quarter (Allendorf et al. 1991) the estimated range of the population size (Jacobs 1989; Miller 1993; Del Frate 1993). Critical M values can be used to detect reductions within populations that have occurred historically (approximately over 100 generations). There is no evidence of a recent severe bottleneck on the Kenai Peninsula based on heterozygosity excess; however, a significantly low *M* suggests the Kenai population may have been reduced during more historical times (up to and over 100 generations ago), perhaps coupled with a long recovery in a small post-reduction population.

A manuscript reporting this work has been submitted for publication.

OBJECTIVE 4: Assess habitat use, identify key travel corridors, and quantify the nutritional resource needs of adult male brown bears.

We used global positioning system (GPS) locations from brown bears (*Ursus arctos*) on the Kenai Peninsula of Southcentral Alaska to illustrate a technique that identifies functional corridors from animal movement characteristics across a landscape. We derive density, speed, and the angular deviation of movement from paths drawn between locations. We use a cluster analysis to classify the landscape into non-habitat, primary habitat, and corridors. We identify areas with high amounts of sinuous movement as primary habitat patches and areas with high amounts of very directional, fast movement as highly functional bear corridors. We examine differences among landscape functions with a classification tree. Primary habitat was associated with fishable reaches of salmon streams. Bear corridor locations were characterized by a combination of factors constraining movement, such as large lakes and land cover types and most-efficient paths between fishable reaches of salmon streams. The time between bear locations and scale of analysis influenced the number and size of corridors identified. Bear locations should be collected at intervals ≤ 6 hours to correctly identify travel corridors. Our corridor identification technique will help managers move beyond the theoretical discussion of corridors and linkage zones to active management of landscape features that will preserve connectivity. A manuscript reporting this work has been submitted.

Highway construction and expansion through bear habitat can negatively affect brown bear, *Ursus arctos*, populations. We examined the spatial and temporal distribution of brown bear crossings of the Sterling and Seward Highways on the Kenai Peninsula. Four of 13 bears crossed the highway less frequently than expected. While locations where bears crossed the highway were clustered, none of the spatial models strongly explained the observed clustering. Bears were more likely to cross the highway during nighttime. Bear movements were faster and more perpendicular to the highway as bears approached and crossed the highway. Further study is needed to determine the appropriate number and location for placement of highway crossing structures in this region. A manuscript reporting this work has been submitted.

We used bear locations obtained with GPS collars and digital elevation models (DEMs) to examine whether cost of locomotion (COL) correlates with reproductive status and reproductive success in brown bears on the Kenai Peninsula. Estimates of mean hourly distance moved increased slightly when elevation was incorporated into distance estimates, but decreased when locations were sampled at less frequent time intervals. No statistically significant differences were detected among bears of different reproductive status, reproductive success, or landscape inhabited. Our estimates of COL (1656 kcal/ day) are around 10% of the energy costs to bears while they are active. Thus, the influence of COL relative to overall metabolic costs may still be important. Knowledge of how COL is affected by topography is necessary. An abstract reporting these results has been submitted for presentation at the next international conference on Bear Research and Management.

It was determined that the technology needed to safely collar large Kenai Peninsula brown bear males did not exist during this study period. A few (3–5) males were collared, but all shed their collars within a week of collaring.

OBJECTIVES 5 AND 6: Experimentally evaluate if the management concept of "buffers" has biological relevance to Kenai brown bears, and continue to evaluate and refine the cumulative effects model.

We describe landscape use of female brown bears (*Ursus arctos*) on the Kenai Peninsula to aid in the development of management strategies. VHF and GPS radio collars, fitted to 43 adult female brown bears, provided >28,000 radio relocations, which were used to describe habitat use patterns by season and reproductive condition (with or without cubs) at landscape and use-area scales. Resource selection functions indicated that in the spring, female brown bears without cubs were associated with areas with low densities of human developments and roads, as well as with riparian areas that would receive summer salmon (*Oncorhynchus* spp.) runs. In contrast, during the spring, female brown bears with cubs associated with upland habitats, which could indicate an avoidance of other brown bears and people. Streams with a high potential for containing spawning salmon positively influenced summertime distribution of female bears without cubs. Female brown bears with cubs used similar streams; however, these female brown bears also frequented streams with lower potential for containing spawning salmon, apparently in an effort to avoid concentrations of brown bears. Female brown bears with cubs also selected habitats that were close to cover and avoided areas that were accessible to humans via roads. Resource managers may use this information to help conserve the brown bear population on the Kenai Peninsula.

OBJECTIVE 7: Develop and apply new technologies (e.g., video collars, triaxial accelerometers) to ecological studies of bears. No work was accomplished on this objective.

IV. MANAGEMENT IMPLICATIONS

While large litters have been observed for some Kenai brown bears, the mean litter size for COY is in agreement with sizes recorded for other brown/grizzly populations (Wielgus et al. 1994; McLellan 1988). The litter size of 2.21 for COY is slightly larger than the mean value of 2.1 calculated from Table 4 in McLellan (1994). The Kenai brown bear population has an inter-birth interval of 3.23, which is slightly less than the mean interval of 3.6 in McLellan (1994). Thus, the Kenai population appears to possess a slightly, but not significantly, larger litter size. There are no indications that the Kenai brown bears exhibit early weaning, as the measured inter-birth interval is similar to that found in other bear populations that wean their young at 2 years of age.

The combination of population parameters derived from radiocollaring work and data from the genetics analysis lead to the conclusion the Kenai brown bear population has been stable in the past, and under static environmental conditions, should remain stable. However, the low haplotypic diversity may indicate an extreme amount of differential productivity in the population, which in turn would make the population susceptible to changes in habitat and food resources. Given the continual increase of human development on the Kenai Peninsula, and the increasing recreational uses of the Kenai by people, it is very likely that the Kenai Peninsula brown bear population could be at risk of depletion. The last extant refuge for the bears is on the lands of the Kenai National Wildlife Refuge and portions of the Chugach National Forest. The remaining areas of the peninsula are either unsuited for bears by virtue of geology or by virtue of increasing road development and use by people.

Kenai Peninsula brown bears travel across the landscape along both stream/river courses, in primary habitat, and through corridors. Highway crossings by bears will continue to be problematic and highly dependent on traffic density and timing. The bears are motivated to travel in large part for breeding opportunities and for access to salmon streams. As highway development continues on the Kenai, the density of traffic will continue to bisect some travel corridors now used by bears. Other corridors, such as along the east and west lake edges of Skilak Lake and the east edge of Tustumena Lake, are clearly preferential routes for the bears.

Access to fishable reaches of salmon streams will remain a critical survival component for Kenai brown bears. The animals need sufficient streamside cover to ensure safety of family groups during and after fishing, and current management prescriptions for riparian buffers are inadequate. The bears need sufficient access to fishable stream segments that have low-risk of human-bear interactions and are large enough to allow bear-bear interactions. The Russian River recreational fishery is a prime example of good intentions creating a critically dangerous setting for people and bears on salmon streams. Recreational fisheries need to be managed with the recognition that brown bears will be attracted to some types of fisheries, and the management of those fisheries must be accomplished with consultation of wildlife conservation staff recommendations. It is clear that to do otherwise will create discrete locations that will become population sinks for brown bears through killings by DLP and/or management actions for public safety.

V. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN FOR LAST SEGMENT PERIOD ONLY

Job 1. Radiocollaring, tracking and population assessment.

In fall of 2004 handled 5 females for re-collaring. In spring 2005, two bears were re-collared, and 2 new bears were collared. There were no capture-related mortalities. Population assessment done. (See Section III.)

Job 9. Publication/report writing.

Co-author of four reports listed under Section VII.

VI. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THE LAST SEGMENT PERIOD, IF NOT REPORTED PREVIOUSLY

None

VII. PUBLICATIONS

Graves, T. A., S. D. Farley, and C. Servheen. Frequency and distribution of highway crossings by Kenai Peninsula brown bears. Accepted for publication by Wild. Bulletin.

Graves, T. A. , S. D. Farley, and M. I. Goldstein. Cost of locomotion by Kenai brown bears: application of GPS collected location data and digital elevation models. (to be presented at International Bear Association conference, submitted to Ursus).

Graves, T. A., S. D. Farley, M. I. Goldstein, and C. Servheen. Identification of functional corridors with movement characteristics of brown bears on the Kenai Peninsula, Alaska. Submitted to Landscape Ecology.

Suring, L. H., S. D. Farley, G. V. Hilderbrand, S. Howlin, W. E. Erickson, M. I. Goldstein. (In review, Journal of Wildlife Management). Patterns of landscape use by female brown bears on the Kenai Peninsula, Alaska.

VIII. RESEARCH EVALUATION AND RECOMMENDATIONS

In order to adequately assess the population dynamics of Kenai brown bears an additional 10–15 females need to be collared and included in the sample pool. The current sample of collared animals (16) is not adequate to provide reasonable statistical precision for population dynamic estimates.

Effort needs to be put into developing a population dynamic model that incorporates both telemetry data and genetics-based variables of heritability. The intent of this model should be to determine the extent, geographic location, and matrilines with differential productivity in the Kenai population. This information will be critical to establishing a sound management plan for ensuring the continued viability of the Kenai brown bear.

Considerable additional effort needs to be put into utilizing information gathered from genetics-based research. These will prove to be powerful tools for wildlife managers, and depending upon the question, can be less expensive and quicker to implement than classical techniques. For example, a 2-year study completed as a master's thesis was instrumental in addressing the critical question of the degree of genetic isolation experienced by the Kenai brown bear population. It may not have been possible to even address that question by only applying classical radiocollaring techniques. We will improve our understanding of the true population dynamics of the Kenai brown bear population by extending our sample collection to the closest regions near the Kenai Peninsula, and by ensuring their timely analysis.

IX. PROJECT COSTS FROM LAST SEGMENT PERIOD ONLY

Stewardship Investment items purchased: None

Total Costs

FEDERAL AID SHARE $85,126 STATE SHARE $28,375 = TOTAL $113,501

X. APPENDIX

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XI. PREPARED BY:

Sean Farley
Wildlife Biologist III

SUBMITTED BY:

Earl Becker
Research Coordinator

APPROVED BY:

____
Tom Paul
Federal Aid Coordinator
Division of Wildlife Conservation

____
Matt Robus, Director
Division of Wildlife Conservation

APPROVAL DATE: _________________