

HABITAT CAPABILITY MODEL FOR BROWN BEAR ON THE KENAI PENINSULA, SOUTHCENTRAL ALASKA

INTRODUCTION

A habitat capability model for brown bear (*Ursus arctos*) on the Kenai Peninsula will provide an analytical tool to evaluate the effects of human actions on brown bear habitat and their population. Habitat capability/cumulative effects models for brown bears have been created and are being used more frequently by land and wildlife management agencies (Christensen and Madel 1982, Christensen 1985, Weaver et al. 1985, Young 1985, Schoen et al. 1990, USDA Forest Service et al. 1990). As a management indicator species (MIS) on the Chugach National Forest, the brown bear represents other animals that require large expanses of land relatively undisturbed by humans and represents the quality of riparian areas.

The brown/grizzly bear once ranged from Mexico to the Arctic Ocean and from the Mississippi River to the Pacific Ocean. Bear populations south of the Canadian border now exist in only 6 ecosystems, totalling 600-800 individuals, and were listed as threatened under the Endangered Species Act in 1975 (USFWS 1982, LeFranc et al. 1987). In Alaska, brown/grizzly bears roam over most of the state and were estimated to number 32,000-43,000 (ADF&G 1978). In localized areas bear populations and their habitat are declining due to direct human-caused mortality and human encroachment. South of the Canadian border the brown/grizzly bear was listed as threatened because it met the following criteria: 1) both present and threatened future destruction and/or modification of its habitat; 2) a present loss or potential loss of bears by illegal killing and control actions involving grizzly bears threatening humans or killing livestock; 3) critical data are lacking on grizzly habitat conditions, carrying capacity, population estimates, annual reproduction, mortality, and population trends; and 4) some existing populations appear to be isolated from each other and cannot be reinforced by movements from other areas (Servheen 1982, cited in LeFranc 1987:1). The Kenai Peninsula brown bear population meets these criteria with the exception of being totally isolated from other populations in Alaska; the Peninsula is connected to the "mainland" by a 15 km wide strip of land between Cook Inlet and Prince William Sound, most of which is restrictive to bear movement (2 communities, 2 airstrips, 13 km of road, 2 campgrounds, railroad tracks, a 3 km long lake, several glaciers, and is the most visited place in Alaska). Based on best professional judgment of ADF&G and USFWS biologists the brown bear population on the Kenai was estimated to be 150-250 (Jacobs 1989). The Kenai Peninsula is 23,310 km² in size, but only approximately 8,800 km² was regularly used by brown bears (Jacobs 1989).

The Kenai Peninsula has received some of the highest human impacts in Alaska to the detriment of some wildlife populations and habitat. Wolves and Caribou were extirpated by market hunting and poison by 1915 and salmon populations were depressed into the 1950's (Bangs et al. 1982). The human population increased from 24,600 to 43,600 from 1977 to 1987 (Bangs et al. 1990). Logging, mineral and energy development, water impoundments, and livestock grazing all occur on the Kenai and lead to modification or destruction of habitat. Subdivision development, livestock grazing, recreational development, and sport hunting all occur on the Kenai and lead to an increased likelihood of human/bear conflicts and may lead to bear mortality (Craighead et al. 1982, USFWS 1982).

An interagency brown bear study team (IBBST) was formed by the U.S. Fish and Wildlife Service, U.S. Forest Service, and Alaska Department of Fish and Game in 1984 to gather information on Kenai Peninsula brown bears. The National Park Service joined the effort in 1990. The goal of the IBBST was to maintain a viable population of brown bears on the Kenai Peninsula. Research was initiated in 1984 and a draft management plan was written in 1989 (Jacobs 1989), but it did not include a habitat capability model. Much of the information used in this model was gathered during this research (Risdaahl 1984, Bevins et al. 1985, Risdaahl et al. 1986, Schloeder et al. 1987, Jacobs et al. 1988, Jacobs 1989) or adapted from more intensive research and model construction for Southeast Alaska (Schoen et al. 1990).

HABITAT USE

A home range contains everything a bear needs to survive; its size depends on habitat quality, bear density, and sex and age of the individual. On the Kenai Peninsula, annual home ranges averaged 620 km^2 ($n=10$, $SE=146$) (Jacobs 1989). Similar to findings in other studies, the home range of adult males was larger (950 km^2 , $n=4$, $SE=119$) than the home range of adult females (401 km^2 , $n=6$, $SE=185$). Brown/grizzly bear home ranges from other areas for adult male and female, respectively, include: 874 and 281 km^2 in Yellowstone (Blanchard and Knight 1991), 850 and 415 km^2 on the Nelchina and Upper Susitna Basins (Miller and Ballard 1980), 295 and 174 km^2 on the Copper River Delta (Campbell 1985), and 22 and 39 km^2 on Admiralty Island (Schoen and Beier 1987). Based on home range size alone, habitat quality on the Kenai Peninsula appears to be similar to Yellowstone and interior Alaska but not as high as more coastal areas.

Food habits of bears varied seasonally on the Kenai Peninsula (Jacobs 1989). Horsetail (Equisetum spp.), grasses, and sedges were primary foods in the spring and were widely distributed across the Peninsula, but first became available in avalanche chutes and wetlands (Risdaahl 1984, Bevins et al. 1985, Risdaahl et al. 1987, Schloeder et al. 1988). Carrion of ungulates (moose, caribou, Dall sheep, and mountain goat) was sought out and consumed. These food habits have been documented in most studies of food habits of bears (Mace 1987). As salmon (Onchorhynchus spp.) spawning began in mid-June on the Kenai, the fish became a very important food source. July through October, 73% of radio-tagged bear relocations occurred near salmon streams (Jacobs 1989). Similarly, July through September 66% of relocations on Admiralty Island occurred within 160 m of salmon streams (Schoen et al. 1990). Salmon continued to be consumed into the fall on the Kenai Peninsula but were augmented by many species of berries: devil's club (Oplopanax horridus), crowberry (Empetrum nigrum), salmonberry (Rubus spectabilis), highbush cranberry (Viburnum edule), blueberries and lowbush cranberries (Vaccinium spp.). Bears were also attracted to remains of animals killed by hunters during the fall. Brown bears caused the annual mortality of 1% of the adult female moose on the Kenai Peninsula (Bangs et al. 1989) and killed 79% of radio-tagged moose calves in a study in the Nelchina and Susitna basins (Ballard et al. 1981).

Bears range widely and it is useful to view them as creatures of landscapes rather than habitats (Schoen 1990). Habitat use by brown bears varied seasonally in response to food availability (Schoen et al. 1990). After den emergence on the Kenai, bears ranged widely, but remained near salmon streams

later in the season. Staple spring foods of grasses, sedges and horsetail were present on all 12 habitat surveys conducted on the Kenai, possibly explaining movements at this time (Risdaal 1984, Jacobs 1989). On Admiralty Island, bears move to low elevation sites that green up early, old-growth forests, coastal sedge meadows, and south-facing avalanche slopes (McCarthy 1989, Schoen and Bier 1990, Schoen et al. 1990). Forested alpine meadows were used next until salmon moved into streams in mid-summer. Some bears foraged in interior regions of the Island, away from salmon streams, all season on vegetation and berries in subalpine areas and avalanche chutes. Most bears moved to higher elevations in the fall and fed on berries.

Brown bears enter dens in October and November and emerge in April and May in most ecosystems in Alaska studied; females enter earlier and emerge later than males (Patnode 1987). On the Kenai Peninsula, males entered dens late October through November and emerged in late March and early April; females entered in October and emerged in mid-April (Jacobs 1989).

In many ecosystems, dens are clustered in areas that apparently possess favorable environmental characteristics (Craighead and Craighead 1972). Dens are typically in steep terrain that holds snow well (Craighead and Craighead 1972, Vroom et al. 1980, Servheen and Klaver 1983). Den site fidelity has been reported from many areas (Valkenburg 1986, Miller 1990, Van Daele et al. 1990) and Smith and Van Daele (1988) report denning bears at a density of $2/\text{km}^2$, yet reuse of a den is uncommon (Servheen 1981, Schoen and Beier 1986). On the Kenai Peninsula, 10 den sites were located, 7 on steep slopes adjacent to glaciers of the Harding Ice Field (Jacobs 1989). These sites were located at an average elevation of 546 m ($n=10$, $SE=105$) and had an average slope of 20° ($n=10$, $SE=1.5$). *

Brown bears are solitary most of the year. They stay together for 1 day to several weeks to mate, usually during May and June (reviewed in LeFranc et al. 1987). Several may congregate along salmon streams when the fish are spawning. Cubs typically remain with their mother 2.5 or 3.5 years, being weaned mid-May to late June, then the adult female mates shortly afterward. The cubs sometimes remain together for several months after being weaned. Humans and other brown bears are the only predators brown bears have. Highest natural mortality occurs during the first year and has been estimated at 30-40% (Bunnell and Tait 1985). Bears live an average of 21 years.

Human induced impacts on bear populations can be indirect through habitat modification and disturbance, or direct through mortality. Brown bears utilize vast areas in search of the necessities of life, increasing the chance of conflict with humans. Logging, mining, dams, recreational activities and expansion of communities and road systems usually reduce brown bear habitat and brown bear populations (LeFranc et al. 1987).

Many researchers report decreased use of timber harvest areas by brown bears (see Moss and LeFranc 1987:137, Archibald et al. 1987, Schoen and Beier 1990) while others report no change in use (Zager 1980). Bear food production increased on 30 of 70 timber units after harvest in the Cabinet Mountains of Montana where bear habitat was not considered during the planning process (Bratkovich 1986); no data was collected on bear use of these sites though. On Admiralty Island, brown bears seemed to avoid clearcuts and used adjacent sites with higher quality forage and better cover (Schoen and Beier 1990), but trends

were not statistically significant. In British Columbia, bears avoided logging roads while there was vehicle traffic, thus decreasing the habitat available to them (Archibald et al. 1987). Several silvicultural techniques are thought to minimize adverse impacts or enhance brown bear habitat and studies have been initiated to test these hypotheses, but little data exists. Closing of logging roads, selective cutting, timing of the cut, prescribed fire, seeding of bear foods, and planting of berry-producing shrubs are being investigated (Garcia 1986, Hillis 1986, Holland 1986). Permanent closure of logging roads and maintaining cover around food sources, especially salmon streams, seems to be most critical to minimizing influences of timber harvest on the Kenai Peninsula.

Mining and dam building activities may also affect bears by displacing them, altering their behavior and habitat, and increasing mortality rates, especially if road access is improved for the general public. Preliminary analysis of data for a study of Greens Creek mine on Admiralty Island indicate habitat use has not changed significantly, though den sites locations have moved significantly away from the active mine (Schoen and Beier 1990). Most bears stayed in the area of Greens Creek mine during road and mine construction, but shifted areas used away from most intense activity, then moved back later. Sufficient forest cover in the area and rigid camp and garbage guidelines may have contributed to minimal influences on the bears. Another study of a mine project in British Columbia (McLellan 1989b, 1989c, 1990) and of a hydroelectric project on Kodiak Island (Smith and Van Daele 1990) produced similar results. Both studies concluded that dense cover in the area helped minimize the influence of increased human activity, and on Kodiak Island, bears were shown to avoid open areas during construction activities. Proper location of camps, garbage sanitation, restriction of firearm use, and especially restriction of access to roads minimize adverse impacts on bear populations in relation to resource extraction activities (McLellan 1989b, 1990; Kasworm and Manley 1990; Schoen and Beier 1990; Smith and Van Daele 1990). All these researchers indicated that long-term impacts on bear populations could be much different (again, because of easier access by hunters, poachers and recreationists).

People recreating in the backcountry displaced brown bears on trails and at campsites (Mattson et al. 1987, Nadeau 1989, Gunther 1990, Kasworm and Manley 1990, Mattson 1990). Displaced bears often abandon high energy food sources (Gilbert 1989). Bears tended to habituate to people using their habitat, and become less wary, thus increasing the chance of bear/human encounters (Gilbert 1989, Leonard et al. 1990). As recreational uses increased, bear/human interactions increased in many areas. The number of brown bears killed in the "defense of life and property" (DLP) is increasing on Kodiak Island (Smith et al. 1989) and on the Kenai Peninsula (Jacobs 1989); 53% of the bears killed on Kodiak were taken by deer hunters. Many areas are developing programs of active management to preserve bears and provide for human safety (McCory et al. 1989, Smith et al. 1989).

In addition to impacting habitat, these activities often increase human/bear interactions, often leading to bear mortality. Any activity that increases human accessibility to bear habitat, especially road-building, is likely to be detrimental to bears (Elgmork 1978; Zager 1980; Peek et al. 1987; McLellan and Shackleton 1988; McLellan 1989b, 1989c, 1990). On the Kenai Peninsula 4 radio-tagged bears were harvested by hunters; all were originally captured in remote locations, but harvested in easily accessible areas, 3 near roads

(Jacobs 1989). Knight (1987) called areas within a bears home range "population sinks" if they were easily accessible to humans because bears were much more likely to die in these areas.

GENETIC CONSIDERATIONS

The loss of genetic variation should be considered when making management decisions based on output of the HCM. Genetic variation can be lost in small populations through the founder effect, genetic drift, and/or inbreeding (Frankel and Soule 1981, Schonewald-Cox et al. 1983, Shaffer 1986). Reduced genetic variation in animal populations can lead to decreases in survival, disease resistance, growth rates and developmental stability (Frankel and Soule 1981). Larger populations and gene flow from adjacent populations help maintain genetic variation and negate these effects. It is very important on the Kenai Peninsula to provide travel corridors in suitable brown bear habitat to the west coast of Prince William Sound and to the "mainland".

Effective population size (N_e) can be used to assess species- or population-specific loss of genetic variability based partly on a populations mating structure (Samson 1983, Schonewald-Cox et al. 1983). N_e can be thought of as an "ideal" population in which mating is random, sex ratio is equal, and genetic material from each individual is passed on to subsequent generations. Generally, an N_e of approximately 50 is required to avoid deleterious inbreeding effects and an N_e of approximately 500 is required for natural mutation rates to counteract genetic drift (Shaffer 1986), thus providing for the gene frequency of a population to evolve to changing conditions in the environment. Based on preliminary analysis, N_e of grizzly bear populations range from 0.2N to 0.4N (Harris 1986). Applying this to the Kenai Peninsula population estimated at 150-250, an N_e of 30-100 is obtained. A stochastic computer simulation model based on initial N_e of 50 for the Yellowstone grizzly bear population led to an N_e of 0 after 50 years (Samson et al. 1985). However, an N_e necessary to maintain genetic variability was reduced to negligible levels if 1 individual enters the population every 5 years. This underscores the importance of maintaining a travel corridor for exchange of genetic material between the Kenai and mainland brown bear populations.

HABITAT MODEL

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