SEASONAL MOVEMENTS OF AN ALASKA PENINSULA BROWN BEAR POPULATION

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Abstract: On the central Alaska Peninsula, 344 different coastal brown bears (*Ursus arctos* L.) were immobilized and marked during 5 spring seasons. Between 1970 and 1976, the observed locations of 123 marked bears were determined 354 times, and the locations of 139 marked bears killed by hunters during spring and fall hunting seasons were recorded. Bears moved greater distances per unit of time during spring than during other seasons of the year. Summer movements were restricted as bears concentrated along streams to feed on salmon. Dispersal away from streams began in late summer. Denning usually began by mid-November, but some bears remained out of hibernation through mid-December. The seasonal ranges of 30 adult females averaged 293 km^2 and those of 4 adult males averaged 262 km^2. Limited movement data for adult males suggested that males spent more time than females in or near escape cover. The mobility and spring distribution of adult females were related to changes in their reproductive status. Single adult females moved further than females accompanied by young. Females with 1- to 3-year-old young utilized open lowland areas during the spring and tended to be in mountainous terrain when breeding and when accompanied by young through age 6 months. Subadult males were more transient than females, tending to move out of their maternal seasonal range after family separation; subadult females tended to remain. The seasonal range of 5 subadult males and of 6 subadult females averaged 740 km^2 and 224 km^2, respectively.

This paper describes seasonal distribution and movements of brown bears on a 8,547 km^2 study area located on the central Alaska Peninsula. The Alaska Peninsula extends 680 km southwest from mainland Alaska into the Pacific Ocean. It contains probably the largest remaining parcel of prime brown bear habitat yet unaltered by man. The region supports a large population of bears and annually contributes about 25 percent of the total statewide harvest (average, 200 of 800). About 50 of the 200 bears are taken on the study area. Increased hunting pressure has required increasingly restrictive and complex hunting regulations to stabilize bear population levels. In recent years, there has been a marked increase in mineral exploration and other related industrial activities, all of which may ultimately prove detrimental to this bear population. Also, land ownership patterns are changing as provisions of the Alaska Native Claims Settlement Act of 1971 are implemented. Administering bear management programs on federal, state, Alaska Native, and private lands will be difficult.

Information on movements of coastal brown bear populations is limited, especially for populations that receive heavy hunting pressure and for bears that depend on salmon (*Oncorhynchus* spp.) for food. Craighead (1976) reported the strong influence of earth-filled garbage dumps on grizzly bear density and movements within and beyond Yellowstone National Park. Berns and Hensel (1972) described summer and fall activities of 14 brown bears on Kodiak National Wildlife Refuge and discussed the size of activity areas in connection with food-gathering and denning. Glenn et al. (1976) noted that bears were strongly attracted to salmon in Alaska's McNeil River State Game Sanctuary during July and August. The purpose of this study is to provide resource managers with information on the general pattern of movements of a coastal brown bear population.

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STUDY AREA

The study area (Fig. 1) is approximately 110 km long and 65 km wide and lies between two semi-active volcanoes: Mount Aniakchak (1,021 m) on the northeast and Mount Veniaminof (2,226 m) on the southwest. These mountains are dominant features of the portion of the Aleutian Range that extends through the study area. A broad, flat coastal plain with many small lakes and meandering streams lies between the mountains and the coast of Bristol Bay. Lowlands of the coastal plain are poorly drained and remain flooded until streams subside, usually in the third week of June. Mountains of the Aleutian Range gradually ascend from the coastal plain, with peaks averaging 850-975 m above sea level. On the Pacific side of the mountains, habitat is characterized by steep slopes with alder (*Alnus* sp.) covered foothills. The broad valley of the Meshik River and Black and Chignik lakes bisect the Alaska Peninsula. Dominant vegetation is sedge (*Carex* spp.) and willow (*Salix* spp.) in tundra areas and dense alders, willows, crowberry

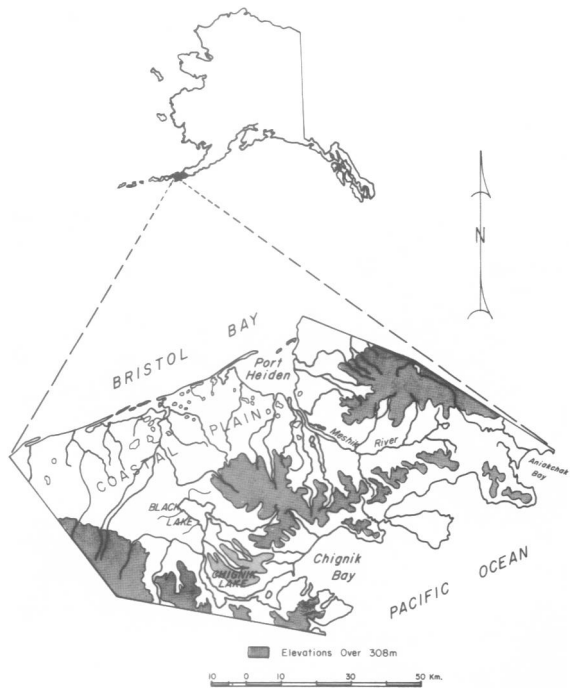

Fig. 1. Map of study area and Alaska location map.

(*Empetrum nigrum*), blueberry (*Vaccinium* spp.), lowbush cranberry (*V. vitis-idaea*), and grasses in mountainous areas. Weather is characterized by high winds, overcast skies, fog, and rain showers in the summer, and by snow showers and cloud cover in the winter. The resident human population is sparse. Access to the area is by aircraft or boat.

METHODS

Bears were captured and marked in spring only, beginning in 1970 and continuing through 1975, excluding 1973. Three hundred forty-four different bears were marked; about 46 percent of these bears were recaptured 1 or more times. Sixty-two marked adults were relocated by individually identifiable markings 188 times, and 61 subadults were relocated 123 times. The locations of 139 marked bears that were killed during spring and fall hunting seasons were recorded.

Bears were located and captured with the aid of a Bell 206A Turbo helicopter and a fixed-wing Piper PA-18 aircraft. The fixed-wing aircraft was used as a spotter plane. Radio communication between the two aircraft directed the helicopter pilot to the located bear. Bears were located by random excursions over the study area.

Bears were immobilized from the helicopter by injecting Etorphine (M-99) or phencyclidine hydrochloride (Sernylan) into the rump muscles with Palmer Cap-Chur darts. When a female with young was located, the adult always received the first drug injection. The pilot then moved the helicopter a short distance away and herded the family group to keep them together and away from thick escape cover and wet areas where they might drown. After the female was immobilized, the same procedure was used to capture the young (except cubs-of-the-year). Cubs-of-the-year were captured by hand.

Most bears (451 of 502) were captured in valleys and foothills below the alder zone or on the coastal plain, where the helicopter could be safely maneuvered; the other bears were captured in the mountains. One upper first premolar tooth and one lower first premolar tooth were removed from each captured bear older than cubs-of-the-year. The teeth were sectioned to determine age from cemental layers (Mundy and Fuller 1964, Craighead et al. 1970, Willey 1974). All captured bears were marked with ear tags and were tattooed on the groin and on the inside of the upper lip. A numbered nylon-and-fiberglass identification collar designed to permit visual identification by observers in fixed-wing aircraft was developed, tested and used to mark 38 adult bears. Fifteen adult bears were collared with radio transmitters manufactured by AVM Instrument Company, Champaign, Illinois.

The movements of collared bears were monitored by periodic aerial surveys. Each survey aircraft was equipped with a portable receiver and a 3-element yagi antenna attached to the wing strut. The position and direction of movement of marked bears were plotted on 1:250,000 U.S. Geological Survey topographic maps.

A state regulation requires that successful bear hunters present their bear skulls and hides to Department of Fish and Game personnel for recording of kill data. This regulation allows department personnel to interview successful bear hunters or their guides in order to establish precise locations of bear kills. This system was used to determine kill locations of tagged bears. Marked bears were detected in the harvest by the presence of fiberglass collars or radiocollars, ear tags or holes in the ears, lip and groin tattooes, and missing upper and lower first premolars.

Because this investigation was concerned with bear movements that may bias population censusing, emphasis was placed on spring distribution. Mean airline distances traveled by bears away from their original spring capture sites were determined in order to show the extent of movement. The term *subadult* refers to a single bear 2-4 years of age. A *seasonal range* is an area used during spring, summer, or fall but excludes the denning

area (Craighead 1976), and is determined by marking the location sightings on a map and connecting the peripheral points.

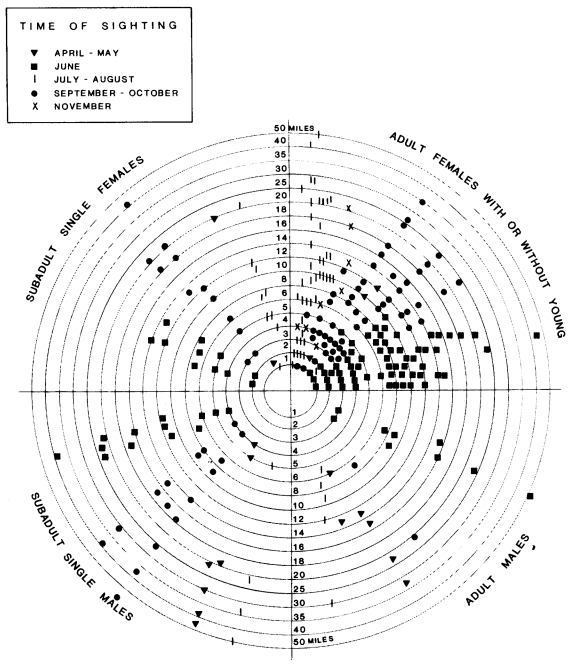

Fig. 2. Dispersal in miles (1.61 km), by season, from spring capture sites for adult male and female brown bears and young (both sexes) captured as subadults and relocated in subsequent years at any age.

RESULTS AND DISCUSSION

Fig. 2 summarizes the seasonal dispersal of marked bears away from original spring capture sites. The 1:1 ratio of marked to unmarked bears captured during June 1975 and the locations of marked bears killed by hunters support the conclusion that tagged bears were distributed throughout the population.

Spring Movements

Lentfer et al. (1972) reported that the greatest proportion of Alaska Peninsula brown bear dens was located in the Aleutian Range at an elevation of about 396 m. In our study, most brown bears had moved away from den sites to lower elevations by 25 May. Emergence from dens usually began in early April and continued to the end of May. The high proportion of adult males killed during the early part of spring bear hunting seasons (average, 89 percent before 20 April and 72 percent after 10 May) indicates that males emerged from dens earlier than females. Females with cubs-of-the-year were observed near den sites as late as 6 June; females with older young were not observed near den sites after 25 May. Craighead and Craighead (1972) reported that some females with cubs-of-the-year remained in the vicinity of their dens until the snow had disappeared.

Bear movements during June were complex. Except for females with cubs-of-the-year, bears moved greater distances per unit of time than during other periods of the year. Bears descended from mountainous subalpine areas onto the coastal plain. Time spent on the plain varied with the individual; most bears were observed only once, but some remained longer than 16 days. The rates of capture success in lowland areas provided indices of changes in bear density. Between 28 May and 10 June, an average of 0.6 bear was captured per hour of aerial search; between 15 and 30 June, the capture rate increased to 1.3 bears per hour. Bears were attracted to Bristol Bay to feed on dead gray whales (*Eschrichtius robustus*), walruses (*Odobenus rosmarus*), harbor seals (*Phoca vitulina*), and other marine mammals that washed ashore. Although caribou (*Rangifer tarandus*) calving areas did not appear to attract bears, they were observed preying on caribou calves. Bears were observed catching moose (*Alces alces*) calves and feeding on adult caribou and moose. The coastal plain provided a source of protein food that was especially attractive to females with young older than cubs-of-the-year. The observed density of bears on the plain reached a peak in mid-June, remained high until about 30 June, and then declined rapidly as bears moved to salmon spawning streams, located primarily in the foothills of the Aleutian Range.

Summer Movements

The arrival of salmon in streams was responsible for the most dramatic seasonal shift in bear distribution and density. By 15 July, the previously dispersed bear population had concentrated near salmon spawning streams, remaining there during the peak of spawning in August. Brown bears began feeding on salmon in early July and some bears were observed eating salmon in late November.

There are approximately 75 streams within the study area that provide habitat for spawning salmon. Because bears are strongly attracted to the salmon food source, the chronology of salmon migration into 2 major freshwater spawning systems is briefly described here. The Black Lake-Chignik River watershed supported the largest salmon-rearing area on the lower Alaska Peninsula and attracted the largest summer bear population. For example, on salmon spawning tributaries near Black lake in early August, it was common to count more than 100 different bears during a 3-hour aerial bear survey. Bears began feeding on red salmon (*Oncorhynchus*

nerka) about 7 July as the fish began moving into 11 salmon spawning tributaries that comprise the Black Lake-Chignik River system. Red salmon spawning terminated in 10 of these tributaries about 1 September. Silver salmon (*O. kisutch*) spawned in the remaining streams into October. The Port Heiden Bay-Meshik River watershed supported the second largest salmon-rearing area in the study area. Red, chum (*O. keta*), and king (*O. tschawytscha*) salmon entered Port Heiden Bay and Meshik River tributaries on 1 July. The peak of spawning occurred here between 1 and 15 August when it was common to count more than 35 different bears during bear surveys flown along these tributaries. Silver salmon arrived in late August and spawned in some of these streams into December. (Salmon chronology is provided by A. Shaul, Area Fisheries Biologist, Alaska Department of Fish and Game, personal communication.)

Fall Movements

At the end of August, bears began moving away from streams and supplemented their fish diet by feeding on berries. Although berries were available near spawning streams, some bears traveled to higher elevations to feed. The bear population continued their dispersal through September. During October, the numbers of bears using the coastal plain increased noticeably, although numbers recorded in spring were much greater. By mid-November, some bears presumably had denned, since fewer were observed during aerial reconnaissance. Some bears remained out of hibernation through mid-December. Further study is required to determine conditions that influence predenning movements and time of denning. Most bears observed during fall were in the subalpine alder zone and alpine areas.

Movements of Adults

The seasonal ranges of 30 adult females average 293 km^2 (range, 26-1,098 km^2), and those of 4 adult males averaged 262 km^2 (range, 62-749 km^2). The small size of the male sample restricted comparison of adult male and female ranges. Radiocollars attached to adult males provided little movement information because they were easily shed; the average neck diameter for 9 males (30 cm) was similar to their average zygomatic width (27 cm). Limited straight-line distance data for 2 adult males suggest that range size is larger than that previously reported: The first male was captured 28 June 1970 near the beach on the south side of Port Heiden Bay and was recaptured 28 June 1972 on the Aniakchak River, 8 km from the Pacific Ocean. Between age 6.5 and 8.5 years, this male traveled the entire width of the Alaska Peninsula (82.0 km). The second male, 8.5 years old, was captured 7 July 1972 near the beach on the Pacific Ocean side of the Aleutian Range and was killed by a hunter near Chignik Lake on 14 May 1976, having traveled 98.0 km within the Aleutian mountains. The capture locations of 7 males 8-14 years old indicated that these males remained in the mountains until late June and then moved to streams to feed on salmon.

There was considerable variation in the seasonal ranges of female bears. Craighead (1976) stated that home range size was influenced by availability and distribution of food, proximity of mates, den site requirements, habitat preference, foraging habits, age, sex, condition of the animal, and other factors. Results of this study support conclusions by Craighead (1976) and demonstrate the complexities involved in providing a detailed description of population movements. Three examples illustrate variations in movements of adult females: (1) Female No. 19 (seasonal range, 26 km^2) was never observed on the coastal plain. She apparently used the mountains and lowland areas adjacent to the mouth of West Fork River. (2) Females No. 728 and 731 (combined seasonal ranges, 345 km^2) usually traveled half the width of the Alaska Peninsula as they moved from mountains located near the center of the peninsula to salmon spawning tributaries east of Black Lake. These females were never observed far out on the coastal plain but were observed within 10 km of the foothills during spring and fall. Females No. 747 and 773 (combined seasonal ranges, 614 km^2) usually traveled three-quarters of the width of the peninsula as they moved from the mountains east of Black Lake to the beach on the coastal plain and back. They were never observed on the coastal plain in fall.

Females with 1- to 3-year-old young tended to be recaptured each spring in open lowland area; females with cubs-of-the-year were seldom captured because they were generally observed in mountainous terrain. Only 1 of 12 females with 6-month-old cubs was captured before 19 June, and most (9) were captured after 24 June. Three of 12 females with cubs-of-the-year were captured on the coastal plain, and 9 were captured in valleys and foothills of the Aleutian Range. Observations before 15 June indicated the locations of 14 females with cubs-of-the-year. Ten of these family groups were located in rugged alpine areas and 4 were located in dense alder thickets in the foothills. Aerial surveys conducted during August, when bears were easily observed along salmon spawning streams, showed that about 50 percent of the young in family

groups were cubs-of-the-year. Eighty-three percent of the captured young (N = 153) in family groups were older than cubs-of-the-year. These data reflect the reluctance of females with 6-month-old cubs to move away from protective cover before 20 June.

The observed distribution of apparently estrous females supports capture findings that most breeding females remained in or near the mountains. Thirty estrous females over 5 years of age were captured in open lowland areas during June. Of these females, 8 were in the company of young males (5-7 years old); 12 were single and may have already bred, and 10 were single and lactating, indicating that family separation had recently occurred. During the same month, we captured and frequently observed mated bears in mountainous terrain. The higher density of males over 7 years of age in the mountains as opposed to the coastal plain appeared to influence the spring distribution of estrous females. Whether the distribution of adult males is natural or is influenced by bear hunting is unknown. Hunting is focused on single bears because females with young are protected. Since young usually remain with adult females for 2.5-3.5 years, greater hunting pressure is exerted on adult males. Adult males whose seasonal ranges include exposed lowland areas run a greater risk of being shot. This hunting pressure may explain why few males over the age of 6 years were captured on the coastal plain and why most breeding females were observed or captured in the mountains.

The mean seasonal distances traveled by adult male and female bears away from their original spring capture sites are shown in Table 1. The cumulative 6-year movements of 13 adult males were greater than those of 49 adult females. During a single annual cycle, females with cubs 6-11 months old traveled a mean distance of 13.5 km; females with older young traveled a mean distance of 17.5 km. Single adult females traveled farther than all other females, 20.8 km. These movements support the conclusion that annual mobility of adult females is associated with changes in their reproductive status.

Table 1. Distance (km) moved from original capture sites by adult female brown bears with different-aged young during a single annual cycle and by adult and subadult male and female bears on the central Alaska Peninsula, 1970-76.

Sex and age	Number of bears	Number of observations	Distance (km) Mean	Range
Female				
Subadult single[a]	26	88	21.8	2-82
Adult single	10	20	20.8	2-45
Adult with cubs	7	14	13.5	2-34
Adult with yearlings	18	37	17.5	2-81
Adult with young aged 2+ years	14	27	17.4	3-66
All adult females	49	165	16.6	2-81
Male				
Subadult single[a]	35	79	48.5	6-134
Adult	13	23	31.5	5-98

[a] Captured as subadults and relocated in subsequent years at any age.

Females normally separate from their young within their home ranges. One female (No. 433) 19 years old, however, traveled 64 km southwest of the center of her home range before separating from her 2 young, aged 3.5 years (Nos. 434 and 435). When captured with her young on 15 June 1974, the adult female's vulva was swollen, indicating her estrus cycle had begun. Fifteen days later, she returned alone (56 km to the northeast) and was captured while breeding with a male 5.5 years old. Female offspring No. 434 was killed 29 km southwest of her 15 June capture site during the October bear hunting season. Female No. 433 was located alone on 24 October 1974 and 7 October 1975 within 6.4 km of her original capture site.

The speed of travel of male No. 714, aged 6.5 years, provides evidence of the potential rate of mobility. While on the coastal plain, this male moved 25.8 km between 19 and 22 June and 72.5 km between 22 and 26 June.

Homing movements were also recorded and provide information on the speed of movement through mountainous terrain. Female No. 89, 3.5 years old, was captured on 24 June in the village of Chignik Lagoon, located on the Pacific side of the Aleutian Range. This bear was transported by helicopter to the northwest side of Black Lake and released. After recovering from the effects of the immobilizing drug, she returned to the village of Chignik Lagoon, an airline distance of 40.2 km, within 24 hours. Excluding travel in deep snow during periods of warm weather, there appeared to be few geographical barriers that restrict bear movements.

Movements of Subadults

The seasonal ranges of 5 males bears between mean ages of 3.3 and 5.5 years averaged 749 km^2 (range, 111-2,109 km^2). The ranges of 6 females between mean ages of 3.3 and 5.9 years averaged 244 km^2 (104-420 km^2). Males tended to move out of their maternal seasonal range; females tended to remain. This characteristic was emphasized by computing the mean distance traveled by male and female bears captured as single subadults and observed at any age thereafter (Table 1). The mean age of 35 subadult males at first capture was

3.3 years and of 26 subadult females was 3.5 years. In subsequent years, these bears were relocated 167 times. The mean airline distance traveled by males was 48.5 km, or about twice that of females, 21.8 km. When these bears were last observed, the mean age of males was 5.2 years (range, 2.5-9.5); that of females was 5.3 years (range, 2.5-10.5). The distance moved by young females was similar to that of single adult females, 20.8 km. Since distances moved between time of family separation and first capture were unknown, these averages were considered minimum.

We also computed the difference in distance traveled by 14 subadult males and 9 subadult females before and after family separation. Movements by these bears provided further evidence that males were more transient than females. The average age of males when first captured with their mothers was 2.2 years; the average age for females was 1.8 years. When last sighted, these 23 bears were alone; the average age of males was 5.3 years, that of females 5.9 years. After family separation, males were relocated a mean distance of 83 km and females a mean distance of 27 km from their original capture sites. When these young were with their mothers, the family groups moved a mean distance of 16.4 km from their capture sites. When the movements of these males captured with their mothers were compared with those of males captured as single subadults and relocated at any age thereafter, the data indicated that males travel long distances during the first few months after family separation.

The longest recorded distances were made by 5 young males (mean distance, 126 km) that were killed outside the study area: (1) Yearling male No. 80 was captured with his mother near the beach on the south side of Port Heiden Bay. When he was 4.8 years old, he was killed by a hunter, 166 km southwest of his original capture site. (2) Male No. 799 was 2.5 years old when captured alone near Black Lake. He was reported killed at age 6.8 years, 134 km to the northeast. (3) Male No. 865 and sibling male No. 866 were captured with their mother near the Meshik River when 2.5 years of age. Male No. 865 was killed at age 4.8 years, 107 km to the southwest. (4) Male No. 866 was killed when he was 6.8 years old, 95 km to the southwest of his original capture site. (5) Male No. 142 was captured alone near the mouth of Ocean Creek when he was 3.5 years old. The next spring he was killed 129 km to the southwest. About 50 percent (N = 66) of young males captured in family groups when 1.5-3.5 years of age have not been relocated. On the basis of kill locations of marked males, it appears that many of these bears have moved outside the study area.

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