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REVIEW OF ALASKA PENINSULA BROWN BEAR INVESTIGATIONS

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SUMMARY

Aspects of life history, movement, and dynamics for a relatively dense and intensively hunted population of brown bears on the Alaska Peninsula were studied from 1963-1978. Data available on management of brown bears in that area, as well as on sex, age, and location of bears killed by hunters or in defense of life or property on the Alaska Peninsula are presented. Data on reproductive biology of living bears captured in the Black Lake area are analyzed. Aspects of sampling that provided live-captured and hunter-killed samples of bears are discussed in relation to potential biases.

Regulations governing hunting of bears changed greatly during the study period. Open season lengths were drastically shortened, and seasonal timing was altered to reduce the harvest and direct it at particular sex and age classes of bears. Guided hunters were probably more selective than nonguided hunters and killed larger and older bears. Differences between behavior of various sex and age classes of bears probably affected their vulnerability to hunters.

Bears at Black Lake were observed breeding in early May. Males spent little time with individual females and were observed in association with several females at the same time. Females did not appear to be promiscuous.

No sows 3.5 years old or less were observed with young, though some 3.5-year-old individuals were determined to be in estrus. One female observed with 0.5-year-old young was determined to be 4.5 years old. Females appeared to be most productive between 9 and 16 years and remained productive throughout their lives.

Frequently observed in association with estrus females were 3.5-year-old males, and one was observed copulating with a 9.5-year-old female. Breeding success of males under 6 years old is probably lower than for older, larger, and more dominant males which have larger territories.

Differential behavior was detected between sows with 0.5-year-old young and sows with 1.5-year-old young. This behavior apparently affected observability of litters. Litters of more than 3 young were observed. Apparent high productivity was attributed to a high plane of nutrition and adoption of cubs.

Mortality rates were greater for young attended by females less than 9 years old than by older dams. Mortality for young in family groups may have been affected by differential behavior of family groups and age of attendant dam; this rate was calculated at 34 and 21% for young from 0.4 to 1.5 years old and 1.5 to 2.5 years old, respectively.

Though family bonds are generally believed to dissolve when young are between 2.5 and 3.5 years old, solitary 1.5-year-old young were encountered on the study area. The later observations may have been the result of premature and abnormal occurrences.

Neither lactation nor association with young appeared to preclude female bears from coming into estrus. Closed hunting seasons on females accompanied by young may select for highly productive females.

Data indicated that young males may become self-sufficient before young females and that the former are better able to survive after becoming self-sufficient.

Rigorous statistical treatment of hunter kill data was recommended prior to using that source of data to model population characteristics.

Key words: Alaska Peninsula, brown bear, life history, movements, Ursus arctos.

CONTENTS

BACKGROUND

The Alaska Department of Fish and Game initiated formal research on brown/grizzly bears (Ursus arctos) at McNeil River in 1963. These investigations were designed to obtain information on basic life history for this unhunted population, and resulted in several publications (Erickson, 1963, 1964; Erickson et al. 1968; Lentfer et al. 1972). Continued intensive studies of marked bears at McNeil River State Game Sanctuary formed the basis of a publication on brown bear reproductive biology (Glenn et al. 1976).

In 1970, a brown bear research project was initiated in the Black Lake area of the Alaska Peninsula. Research at Black Lake emphasized life history, movements, and dynamics for this relatively dense and intensively hunted population of brown bears. These investigations provided data for publications on morphometry and movements of brown/grizzly bears (Glenn 1980, Glenn and Miller 1980).

Although data on sex, age, and location from nearly 3,500 bears killed by hunters on the Alaska Peninsula from 1962 through 1978, as well as data on sex, age, movements, and productivity from nearly 350 bears live-captured in the Black Lake study are available, they have yet to be subjected to rigorous statistical analyses and simulation modeling to assess their significance and utility in management of the species.

Biometrical analyses of these data to produce a scientific publication (monograph) on population ecology and management of brown bears on the Alaska Peninsula (Modafferi 1980) has been delayed by continued unavailability of biometrical counseling and technical assistance. Rather than present these data in monograph form, future efforts will be directed at presenting portions of the data, originally intended to form chapters in the monograph, as complete units or component reports in themselves (Modafferi 1981).

OBJECTIVES

Summarize pertinent information on the environment and history of brown bear hunting and management on the Alaska Peninsula.

Summarize mechanics involved in capturing living bears and in obtaining data from bears killed by hunters or in defense of life or property. Discuss potential causes for biases in the collection of raw data.

Summarize data gathered on reproductive biology of brown bears on the Alaska Peninsula, assess their biological significance, and compare them with data collected in other studies.

Summarize data on the age structure and sex ratio of live-captured and hunter-killed bears from the Alaska Peninsula.

PROCEDURES

Review literature on climatic, physical, and biological environments of the McNeil River and Black Lake areas of Alaska Peninsula.

Review general information available on history of hunting and management of brown bears on the Alaska Peninsula.

Review specific procedures involved in obtaining hunter-killed mortality and live-capture samples of bears. Locate and describe procedures that may have biased sampling and affected "representativeness" of the samples.

Review procedures and accuracy with which data were gathered.

Review data collected on reproductive biology of brown bears in the Black Lake research area for comparison with those data published from other studies of brown bears on the Alaska Peninsula, in Alaska, and in other parts of North America. Address the following topics: breeding season length and pair formation; reproductive maturity and longevity; and litter size and sex ratio from conception to family breakup. Attempt to attribute observed similarities and differences within and/or between various populations or studies to sampling procedures, life history phenomena, and "evolutionary strategies" of the species.

Communicate with J. Faro and C. Smith, area game management biologists for the Alaska Peninsula; L. Glenn and L. Miller, principal field researchers in the Black Lake study; and others familiar with bears and bear hunting on the Alaska Peninsula, for more detailed and additional input and personal perspectives.

Review, edit, and summarize (in tabular form) by area, year, and season, where appropriate, data currently available on the age structure and sex ratio of the live-captured bears and the dead bears (from hunter harvest and defense of life or property) from the Alaska Peninsula, Alaska Game Management Unit 9.

STUDY AREA

The study area is a long (900 km) and narrow (200 km, at widest point), 117,900 km^2 parcel of land located in southwestern Alaska and designated a part of Game Management Unit (GMU) 9 (Fig. 1). The southern two-thirds of the area, the Alaska Peninsula, is bounded on the northwest by the Bering Sea and on the southeast by the Pacific Ocean. The northern one-third of the area, although bordered on the east by Cook Inlet, is within the mainland portion of the State.

The Aleutian Mountain Range, usually varies from 370 to 1,800 m in elevation but includes several volcanoes rising to 3,100 m. These mountains extend along the entire Pacific coast side of the area ending rather abruptly at the Pacific Ocean, leaving steep alder (Alnus spp.) covered slopes, short rivers, and a rugged coastline. On the northwest side, the mountains slope gradually to broad, gently rolling and poorly drained plains on the Bering Sea coast.

Vast stretches of the peninsula are covered with volcanic ash or cinder. Lava flows dominate the landscape near active volcanoes, and bare rock is common above 600 m. White and black spruce (Picea spp.) forests intermixed with birch (Betula sp.) are the dominant forest types from the northern portion of the area to the base of the peninsula. These forest types thin and yield to scattered stands of aspen (Populus tremuloides), cottonwood (Populus trichocarpa), and poplar (Populus balsamifera) intermixed with low brush and tundra communities to the southwest. Arboreal species disappear to the south of Port Moller where vegetation is predominantly wind-swept tundra, composed of crowberry (Empetrum nigrum), blueberry (Vaccinium sp.), cranberry (Vaccinium vitis idaea), sedges (Carex spp.) and grasses, with willow (Salix spp.) and alder occurring in riparian habitats and on sheltered hillsides.

The area is rich in wildlife. The world's largest red salmon Oncorhynchus nerka runs as well as large numbers of chum (O. keta), pink (O. gorbuscha), chinook (O. tshawytscha), and silver (O. kitsutch) salmon spawn in many of the streams. Thousands of moose (Alces alces) and tens of thousands of caribou (Rangifer tarandus) are resident to the area. Small numbers of black bears (Ursus americanus) inhabit the forested northern portion of the area. Dall sheep (Ovis dalli) are found at the southern terminus of the Alaska Range in the extreme northern part of the GMU. Whales, sea otters (Enhydra lutris), Pacific walruses (Odobenus rosmarus), seals, and Steller sea lions (Eumetopias jubata) are found in the near- and offshore areas. During the fall, hundreds of thousands of ducks and geese utilize wetland habitats throughout the peninsula.

Weather in the area is harsh. Summers are short, cool, and wet; fog, overcast skies, and high winds are common during this season. Snow showers, cloud cover, and high winds characterize the long winters; severe icing conditions are not uncommon. Average monthly temperature extremes range from about 13 C in July to -11 C in February. Annual precipitation averages about 89 cm a year.

To facilitate management of brown bears in GMU 9, the area is subdivided into 4 geographical areas. These game management subunits are related to differences in habitats, densities of bears and other big game animals, their accessibility to hunters, and vulnerability of bears to hunters.

Subunit I is nearest to the major population centers in the State, has the most forested habitat, and has a relatively limited number of places where light aircraft can land. The area also has the least dense populations of bears, is hunted by the fewest number of nonresident (guided) hunters, and has an earlier freezeup in the fall and a later breakup in the spring (affecting activities of bears and hunters and uses of aircraft). This subunit produces about one-sixth the number of hunter-killed bears per unit area as the other subunits but has twice as many bears killed in defense of life or property as any of the other subunits. Due to the local availability of other big game species (sheep and black bears), many brown/grizzly bears are killed incidentally by those hunting another species.

Subunit I differs from Subunits II, III, or IV in many aspects. The differences between the latter 3 subunits are more subtle.

Densities of bears are reasonably similar between Subunits II, III, and IV. Because of remoteness and lack of facilities (lodging, fuel, etc.), Subunit IV probably receives less hunting pressure than Subunits II and III. The latter 2 subunits have larger populations of other big game animals and attract hunters who are interested in hunting several different species. The precipitous mountains characteristic of the Pacific Ocean side of Subunits II and III are not as prevalent in Subunit IV. Habitat in Subunit IV is more open than that in subunits to the north, as trees and alders are greatly reduced in numbers or entirely absent from the landscape in many locations. Fewer guides and nonresidents hunt in Subunit IV, as compared to Subunits II and III.

For all practical purposes, Subunits II and III are not dissimilar; both have high densities of bears and numerous guides operate in each area out of long-established central camps (cabins/lodges). Hunters are distributed to smaller tent camps with track vehicles or light aircraft equipped with large tires or floats for landing on pumice patches, gravel river bars, intertidal beaches, and abandoned mining strips or lakes.

The resident human population in the area is associated with military reservations or fishing villages; many of the latter people are transitory, coming to fish in the summer, and departing in the fall. During the fall, the area's population is again inflated with the arrival of hunters seeking waterfowl as well as big game. The population level fluctuates from about 3,000 winter residents to about 8,000 during the commercial fishing season to about 3,500 during the fall hunting season. These inhabitants are distributed among about 25 towns or settlements; the largest of which are the King Salmon-Naknek area and King Cove, each with about 600 winter residents. Using these data, the entire area is calculated to have a resident population density of about 1 person/40 km^2.

Transportation to the area is provided by commercial and/or chartered aircraft. The longest road system is in the King Salmon/Naknek area with 43 km of improved driving surface.

At the time of this study, 2 parts of the area were closed to brown bear hunting: Katmai National Monument and McNeil River State Game Sanctuary, encompassing about 13,900 km^2 and 300 km^2, respectively. A 125 km^2 area around the town of Cold Bay was closed to the taking of brown bears for several years, but numerous human/bear conflicts resulted and the closure was lifted to partially solve the problem. In 2 additional areas, Izembek National Wildlife Range (1,700 km^2) and the Alaska Peninsula Management Area (2,000 km^2), methods of transportation are more strictly regulated. On the wildlife range, aircraft may not be employed and all vehicles may not be operated off the road system. In the management area, hunting with the aid of motorized vehicles (except boats and aircraft) is prohibited.

The history of hunting and management of brown bears in GMU 9 can be divided into 4 chronological periods (Table 1). Prior to the early 1960's, trophy hunting for brown bears in GMU 9 was not as popular as on Kodiak Island. But, by the 1960's, more than 200 bears were killed annually, a 30% increase from previous levels. In response to the increase in kill, hunting season lengths were shortened and methods used for transportation became more restricted in an attempt to maintain the harvest at a desirable level. In the early to mid 1970's, harvest rates again appeared to exceed prescribed levels. By the mid to late 1970's, hunting was restricted further. Seasons were shortened more, and their timing and occurrence were varied to reduce the numbers of adult male bears killed. This was an attempt to alter sex ratios to optimize productivity.

FINDINGS

Kill Sample

Pertinent Regulations:

The sample of killed bears was derived from 2 sources: bears killed by hunters and bears killed in defense of life or property. During the sampling period (1961-78), dates and duration of open seasons, methods and means of hunting, and type and accuracy of data collected have varied within and between subunits.

The open hunting seasons in GMU 9 have occurred during spring and fall, separated by a June, July, and August minimum closed period and a December-to-April denning period. Duration of the annual seasons has been reduced from a maximum of 273 days in 1963-64 to a single season of 15 days in more recent years (Fig. 2).

In 1961, the Department of Fish and Game enacted a "sealing" program to gain specific data on hunter-killed bears. This regulation required that hides from all bears killed in GMU 9 be presented to an official of the Department for examination and sealing, within 30 days after the date of kill. The sealing process involved attaching a numbered locking metal tag to the hide of each bear presented, examining the hide for sex determination, and gathering additional information on the bear, the hunter, and the hunt.

Regulations have always prohibited the taking of brown bear cubs (bears in their 1st or 2nd year of life), or sows accompanied by cubs.

Any bear may be killed in defense of life or property. Persons killing brown/grizzly bears in defense of life or property must file an affidavit describing the extenuating circumstances and forfeit the bear's hide and skull to the Department.

In fall 1967, new regulations and statutes were promulgated which affected the hunting and killing of brown bears as follows: nonresidents were required to hunt with a guide; guides could only fly to and from the location of preregistered camps; hunters could not kill a bear the same day they were airborne; and skulls as well as hides had to be presented for "sealing." In the "sealing" process, a metal locking tag was affixed to the skull as well as the hide and information on the hunter, the hunt, and the bear was recorded. In 1968, the aforementioned regulation was amended to allow for collection of a premolar tooth from all bears sealed. In this same year, it became law that a person could only kill 1 bear every 4 regulatory years.

Essentially all of GMU 9 is currently divided among 83 exclusive guiding areas and 182 guides are licensed to operate in that entire GMU. Each guide is allowed to have no more than 3 assistants, but any guide may permit another guide(s) to operate, as an assistant, within his exclusive area and likewise the latter guide ("assistant") is also permitted to have 3 assistants. Considering this procedure, there is no upper limit to the number of guides and/or assistants that may be active in a particular exclusive area at a particular time. All nonresidents are required to be accompanied by a guide when hunting brown bears.

Mechanics of Sampling:

In the past, bears were regularly killed for domestic use throughout the Iliamna watershed and in isolated areas around villages on the lower Alaska Peninsula. Presently, interest in such activities is low and has a negligible impact on the bear populations.

Few bears are killed by local residents for sport. Most bears killed in GMU 9 are killed by nonlocal and nonresident sport hunters who desire a large prime hide and/or a recordbook-sized skull trophy. If the opportunity arises, these hunters will select for bears with those attributes.

Brown bear hunting in GMU 9 has always been divided into 2 distinct seasons: spring and fall. Even in the early 1960's (when the hunting season was only closed during June, July, and August), a minimum 4-month denning period effectively separated the open season into spring and fall components. Recently, each of these components has been abbreviated to 15 days in length and only occur in alternate years.

Characteristics of the hunts, the hunters, and the bears killed differ between spring and fall seasons. During spring seasons, predominantly male bears are killed; whereas, during fall seasons, the sex ratio of the kill is nearly equal.

Hides from bears killed during the early spring are long-haired but lack overall luster. Hair on hides taken during fall is much shorter but is glossy and lustrous. Hides from some bears are "rubbed" as soon as they leave the den in spring. It is not uncommon for bears to have nonprime hides in September, but bears killed during an October fall season are usually prime. The majority of hunters prefer an unrubbed spring hide.

Hunters on guided hunts (which by law, includes all nonresidents) kill larger bears on the average than those hunters which are not accompanied by a guide. This may be due to several reasons. It is very difficult for an inexperienced person to judge the size of a bear. Most guides, who have a great deal of experience with bears, can recognize large bears by their physical appearance and/or behavior and are able to encourage their clients not to shoot a "small" bear, one which may likely have been mistaken to be a "large" bear by an inexperienced, unguided hunter. However, the trend in more recent years (even on guided hunts) has been that any legal bear (often the first one observed) represents a suitable bear.

In addition, guides (and their clients) normally have light aircraft and frequently track vehicles available for transportation. Established cabins allow guided hunters to wait out periods of inclement weather and then continue on with his hunt. This mobility and shelter enables the guide and/or his hunter to preview and select from a large sample of bears before deciding on an individual bear to kill and also provides additional and timely access should it be necessary for a successful hunt. Unguided hunters working out of more primitive facilities are frequently discouraged by weather and utilize the improved weather to return to town rather than continue their hunt. Conversations with a person familiar with guiding activities on the Alaska Peninsula indicated that a guide and hunters could easily locate

and kill a bear every day of the open season in GMU 9, even without the assistance of aircraft; however, some guides and hunters may look over 8-12 bears before selecting the one to be killed. The latter activities, he related, were necessary to maintain an outstanding reputation and to demand high premiums for such a guided hunt.

The predominant means of transporting hunters throughout the area is light aircraft. In the spring, light aircraft with wheeled skis can land in more areas than those normally available in the fall. For example, valleys that are brush-covered in the fall may have areas with adequate snow cover for landings with ski-equipped light aircraft during a spring season. Under certain conditions, snowmachines are used for transportation in the spring. Hunts during a spring season in GMU 9 are exclusively for brown bears. Since no other big game seasons are open in the spring, bear hunts at that time are less attractive to some nonresidents who could hunt at least 2 additional species of big game in the same immediate area during a fall season. In addition, the potential for inclement weather is much greater during a spring rather than a fall season.

A typical nonguided hunt usually entails the following: the hunter decides on an area to hunt; he/she charters an air taxi to the area and schedules a pickup time and place; no facilities are provided; he/she hunts on foot in that area until successful or out of time; nonguided hunters probably shoot the 1st legal bear they encounter; costs of the hunt may be less then $500; and probably less than 40% of unguided hunters kill a bear.

In contrast, a typical guided hunt usually involves the following: the hunter decides on an area to hunt or a guide to hunt with; the hunter is transported to the main hunting camp; the guide uses aircraft to scout for bears before and after the hunter arrives; after seeing a bear(s) in an area, the guide sets the hunter up in a spike camp with himself or an assistant; if unsuccessful or if bears are seen elsewhere, the guide may move the client to another spike camp; the guided hunter may pass up several small bears before selecting one to shoot; costs of the hunt may exceed $7,000; and probably more than 70% of the guided hunters kill a bear.

Though not a common practice, it has been said that guides bait bears to accessible sites; that they harass or herd bears with aircraft to a hunter prepositioned on the ground; or the guide and a client may fly together, spot a bear, land, and kill the bear, all in less than 1 hour. All of these are illegal methods of hunting bears. Demographic characteristics of bears killed in this manner would probably be different from bears killed by legal hunting methods.

Both the accessibility of bears to the hunter, and the mobility of the hunter in relation to the bears, are strongly related to whether or not the hunter is guided. Bears are more accessible to, and less mobile than, the guided hunter. Conversely, bears are less accessible to, and more mobile than, the unguided hunter.

Considering these factors, one would expect differences between samples of bears derived from nonguided hunters, from guided hunters, and from hunters using illegal methods, even though all samples were derived from the same population.

Our kill sample data were derived from bears presented to Department of Fish and Game officials to satisfy the mandatory sealing requirements. Bears killed for domestic use and from which the skull and/or hide are not salvaged need not be presented for sealing. Efforts to ensure that all remaining bear hides and skulls killed are sealed are encouraged through law enforcement activities. In spite of such efforts, there is probably a small percentage of bears killed by hunters in GMU 9 that are illegally transported out of the State without being sealed.

Data Collection:

The type, accuracy, and continuity of data gathered from hunter-killed bears have varied throughout this study. From 1961 to 1967, only hides were required to be presented to a Department official for sealing. This regulation enabled each hunter-killed bear to be quantified by hide size, sex, and location of kill. Regulations promulgated in 1967 required that skulls from all hunter-killed bears must also be sealed and measured; however, it was not until 1968 that regulations required the taking of a premolar tooth for determining the age of each bear.

Initial attempts at preparing premolar teeth for age determination were suitable, but suboptimal. Quality of tooth sections and accuracy of ages determined were greatly perfected by 1970. Though the technique of processing teeth for counting cemental annuli has undergone slight modifications since that time, it probably has had little effect on determinations of age. Age determinations for bears included in this study were all performed by the same biological technician.

The basic technique for enumerating cemental annuli for determining the age of a bear has been substantiated through examination of a large sample of marked known-age bears recaptured during research activities in the Black Lake study area. After initiation of these research activities in subunit III in 1970, the sealing requirement and process became a very effective means of screening all hunter-killed bears for tattoos or tags remaining from a previous live-capture.

Live-capture Sample

Data Collection:

The mechanics of gathering the live-capture sampling data are thoroughly described elsewhere (Glenn and Miller 1980:308) and specifically states that "Bears were located by random excursions over the study area." But, in reality, these excursions were not "random" in the strict sense, i.e., they were not calculated so that each portion of the study area had an equal and independent chance of being sampled. Perhaps the sampling procedure could better be described as an opportunistic searching of the study area. Flight searches were frequently disrupted and altered by daily weather conditions and local physical features.

Few bears were captured in the alder zone or in mountainous valleys. Because old males and sows with cubs of the year are believed to frequently utilize those habitats, live-capture samples may not be representative of the live population.

Reproductive Biology

Data gathered on the reproductive biology of brown bears in this study generally conform to those published in other studies on this species (Mundy 1963, Craighead et al. 1969, Hensel et al. 1969, Craighead et al. 1976, Pearson 1975, Reynolds 1978). In some instances, our data demonstrated additional variation for these characteristics of the species.

Breeding Season Length and Pair Relationships:

The breeding season for the Black Lake population of bears appeared to extend from at least the 1st week of May through early August. However, individual female brown bears may be in estrus for shorter periods of time. Data on initiation of breeding activities appeared to be limited by the timing of our field activities. The earliest we have ever captured an adult female without cubs (potential breeder) was on 6 June and that sow was in estrus and accompanied by an adult male bear. However, observers in aircraft have on several occasions reported seeing bears copulating in the 1st week of May.

These findings lead us to believe that females could be in estrus and able to breed before early May and perhaps even in late April, almost 1 month earlier than reported for brown bears on Kodiak Island (Hensel et al. 1969).

Though bears may have protracted breeding seasons, which permits polygamy, males in some populations spend great lengths of time with an individual female (15 days, Herrero and Hamer 1977; 23 days, Murie 1944; 42 days, Dean 1976) and may only breed with that particular female. Likewise, Craighead et al. (1969) found estrus behavior to span a maximum of 27 days, 18 of which were

spent in a nonestrous condition. Our data indicated that bears on the Alaska Peninsula behaved differently. Males appeared to spend little time with any particular female; we had no resightings of any given male-female pair in the same breeding season. Males presumably bred with more than 1 female in a single breeding season; 1 adult male was observed with a different female on 3 occasions. In this study, males were observed in association with more than 1 female at the same time (possibly a harem association). On 5 occasions, adult male bears were observed in association with 2 other adult bears, in 3 of these instances the other 2 bears were known to be adult females. These data suggested that male bears in the Black Lake population spent little time with any particular female; were promiscuous; and were polygynous.

Our data indicated that adult female brown bears may not be promiscuous. Except for 1 instance, when 2, 3.5-year-old males (non-littermates) were observed near an estrous 5.5-year-old female, adult females were never accompanied by more than 1 adult male at any given time as was observed by Murie (1944) in Mount McKinley National Park. However, an individual female could still mate with more than 1 male during the same day as observed by Craighead et al. (1969). In 2 instances, 3 different adult females were observed in association with a single female during the breeding season; intervals between those observed pairings varied from 5-64 days. Though several males may breed a single female and littermates may have had different sires, it is surprising that more than 2 months could lapse between breedings (i.e., pregnancy was not realized physiologically) unless copulation did not take place in the 1st pairing or it did but fertilization did not occur.

If females were in short supply, relative to males, it would be of value for a male to remain with an individual female through her entire estrous period (Herrero and Hamer 1977). However, if the sex ratio is skewed heavily toward females, a male theoretically would have greater reproductive success by mating with several females. Similar rationale could be used to account for the observations of several adult females with a single adult male. With the population sex ratio skewed toward females, it would behoove females to be accessible to adult males during the breeding season. An extremely imbalanced sex ratio of females over males could eventually affect individual females' opportunity to breed.

Through evolution, such a system would dictate the following 2 conditions: a female could increase her "fitness" by taking up a territory within that of a male, and that territory should specifically be located in a portion of the male's territory that he would most likely visit during the breeding season. Likewise, if it were important whether a female was impregnated in May as opposed to July, then it would matter not only that the 2 bears met, but also at what time period of the breeding season.

Reproductive Maturity and Longevity:

We found brown bears to be capable of breeding at 3 years of age and bearing young at 4 years of age.

At Black Lake, we found that no 2.5-year-old sows ($\underline{N}$ = 9) and 47% of the 3.5-year-old sows ($\underline{N}$ = 32) exhibited signs of estrus (Table 2). Though none of the 41 sows 3.5 years of age or less were observed with cubs, one sow with 3 cubs of the year was subsequently determined to be 4.5 years old and a 5.5-year-old sow was accompanied by a 1.5-year-old cub. The latter 2 observations provide circumstantial evidence that those particular sows were successful in breeding at 3.5 years of age. The presence of placental scars in a 4-year-old bear led Hensel et al. (1969) to believe that it bred successfully in its 3rd year of life.

Observations at McNeil River (Glenn et al. 1976) indicated that 5 of 11 3.5-year-old females captured exhibited signs of estrus at the time of capture. None of those females were subsequently known to be accompanied by cubs the following spring. Only females bred at 4.5 years of age were known to be successful in bearing and raising young to at least 0.5 years of age.

Similar to our observations, Craighead et al. (1969) found that females grizzlies in Yellowstone National Park, Montana may have bred at 3.5 years, but that none were observed with cubs the following spring. Data gathered in the Yukon Territory and northern Alaska revealed that bears did not conceive before they were 6.5 years old (Pearson 1975, Reynolds 1976). Apparently, in most populations, sows can behave as breeders at 3.5 years of age but only in Southcentral Alaska have they been observed with young the following summer. Reproductive maturity of sows in populations in the Yukon of Canada and arctic Alaska is achieved at a much older age.

Our data further suggested that a female brown bear's 1st breeding was less productive than subsequent ones. Eighty-three percent of the 4.5 and 5.5-year-old sows without young ($\underline{N}$ = 35) exhibited signs of estrus, 36% more than for the 3.5-year-old females. Of the 87 sows 6.5 years of age and older that were without young, only 1 individual, a 10-year-old, did not exhibit signs of estrus. These data indicate that the probability of a sow coming into estrus was related to her age, and that essentially all sows (more than 99%) older than 5.5 years of age were either with young or were in estrus. It is possible that most all sows older than 2.5 years of age did come into estrus but that the length of time they remained in estrus was variable and also positively correlated with age. This could account for lower reproductive rates reported for sows less than 5.5 years of age even though they experienced estrus.

Our data suggested that sows were physiologically able to come into estrus and produce young throughout their lives. The 2 oldest female bears captured at Black Lake, a 20 and 21-year-old, were accompanied with 1.5 and 2.5-year-old cubs, respectively. Those observations imply that both individuals successfully bred at 18 years of age. At McNeil River, a 20-year-old bear was observed with 3, 6-month-old cubs. This individual apparently bred at 19 years of age.

Our data indicate that sows may be most productive or in their reproductive prime during their middle years of life (between 9 and 16 years of age). During this time interval, a female may breed and raise about 2 different litters. Three of the 4 oldest bears observed with cubs had only single cubs (Table 3). Likewise, there appeared to be more litters of 1 individual in age classes less than 9 (approximately 25%) than in the 9 to 16-year-old age classes (approximately 8%).

In some studies, it has been demonstrated that productivity was not related to age but the conclusions were based on nonsignificant correlation coefficients. However, it is as absurd to test for a curvilinear biological relationship with linear statistical techniques as to believe that productivity increases throughout life.

In review, our data furnish evidence that brown bears on the Alaska Peninsula were capable of breeding at 3 years and bearing young at 4 years. It appeared likely that most bears were bred before age 6. If these suppositions are correct, on the average bears would be involved with their 1st litter until about 8 years of age. We suggest that a bear's 1st breeding is less productive than subsequent ones, and bears appeared to be in their reproductive prime from 9 to 16 years of age, a time interval during which they can breed and raise about 2 different litters. The size of litters produced during a bear's reproductive prime were larger (and/or survival was better) than those produced before or after this period. We believe that behavioral traits as well as physiological condition may be relevant factors. Brown bears we studied continued to breed and bear cubs throughout their lives, but productivity appeared to decline in individuals older than 16 years. Decreased productivity in old age classes, coupled with open hunting seasons on bears without cubs, was perhaps in part responsible for the scarcity of female bears >20 years old in our sample.

Though determination of the minimum breeding age of males is more difficult than for females, our data indicate 3.5-year-old males, like females, exhibit breeding behavior. In at least 9 instances, 3.5-year-old males were observed in association with estrous females. One of these males was observed copulating with a 9.5-year-old female. It is not unreasonable to believe that the breeding success of 3.5 to 5.5-year-old males is less than for older individuals, as was the case for productivity in females.

If it is fact that older males are more dominant and have larger territories, then these same individuals should also have access to, and possibly breed, more females than younger and less dominant males. It therefore appears probable that not only are older males more successful breeders but also that they may breed with more females than do younger males.

Our data indicated that 1.5-year-old litters were more common in the population than 0.5-year-old litters (Fig. 3). Since differences were apparent for 4 age classes of attendant females and the sample was a composite for all years of the study, potential biases due to age class of attendant female or year class of young probably are not important.

These data also indicate that females over 10 years of age may be more successful in raising litters to 2.5 years of age than females under 10 years of age. Two and a half-year-old litters were observed at similar frequency for females in the 7-10 and 11-16 year classes, but younger age litters were more commonly observed with females in the former age class. It is also possible that older aged females were more secretive and less likely to be observed with litters under 2.5 years of age.

Litter Size and Sex Ratio from Conception to Family Breakup:

Conception to Cubs of Year (July). We found the size of litters for cubs of the year to average 2.2. When stratified by season, it was found to be 2.1 during June and July, and 2.4 for late July and early August surveys along salmon spawning streams. These sample data indicated that production and/or survival to 8 months of young brown bears in the Black Lake area, though less than for McNeil River, was better than the average for all previously cited studies (Table 4).

Noteworthy in our study is that litter size appeared to increase from 2.1 in June-July to 2.4 in the July-August sampling period, a time interval when one would expect mortality in young bear cubs. This apparent increase in litter size within a season and with maturity of the litter can in part be attributed largely to physical size and behavior of the cubs and to behavior of their dams. Increased physical size of older cub bears makes each individual in a litter more visible to observers. Behavior of cubs to seek cover when disturbed is less pronounced as they get older. As cubs get older, females are more likely to utilize open habitats. In each case, entire litters become more readily observed as the cubs get older.

Hensel et al. (1969) found a total of 38 placental scars in a sample of 15 adult female Kodiak Island brown bears (estimated to be at least 4 years of age), a mean of 2.5 scars per individual, where each scar represents 1 fetus. In a sample of 98 litters of cubs of the year, the mean size was 2.2. These data suggest a 10% loss in young from the implantation site (December) to the

cub stage, about 8 months later. Pearson (1975) found an average of 1.9 placental scars in 9 adult sows and 1.7 cubs per litter in 11 litters, suggesting an 8.5% loss of embryos or young. Additional information on embryonic litter size is limited.

Size of litters for brown bear cubs reported in the literature ranges from 1.7 to 2.5 and averages 2.1 (Table 4). Specific studies considered show that litters of cubs of the year contained an average of 2.2 ($\underline{N}$ = 13, Mundy 1963); 2.1 ($\underline{N}$ = 213, Craighead et al. 1976); 1.7 ($\underline{N}$ = 11, Pearson 1975); 2.5 ($\underline{N}$ = 47, Glenn et al. 1976 and this study); 1.8 ($\underline{N}$ = 13, Reynolds 1976); and 2.0 ($\underline{N}$ = 15, Reynolds 1978) young. It is not unreasonable to believe that bears in the Black Lake area of the Alaska Peninsula are similar to the Kodiak Island brown bears in that they experienc a 10% loss of young between the "placental scar stage" and 7 months of age. In addition, we suspect that mean litter size for cubs of the year is much higher than what our field data indicate. Obviously, one must be cautious in interpolating from these data since some of the values represent averages for many years (15 years in Craighead et al. 1974), where the annual variation ranged from 1.7 to 2.5; a single sample; a variety of sampling methods; and a disarray of seasonal sampling periods.

Only in Yellowstone Park and in Alaska on the Alaska Peninsula and Kodiak Island have brown bears been observed to have litters with more than 3 cubs (Table 5). Only in the Alaskan locations are litters of 3 cubs reported as the most common size of litter. Litters of 5 cubs have only been observed in the Black Lake area. Craighead et al. (1976) believed that the availability of garbage as a food source may have elevated the reproductive rates of Yellowstone National Park brown bears and that reproductive rates would have been lower (perhaps no litters of 4 cubs) under more natural conditions and its associated lower plane of nutrition.

Larger litters, as observed in Alaska, may in part be the result of adoptions, as well as a higher reproductive rates. Data from McNeil River (Glenn et al. 1976) indicated that cubs were frequently exchanged between different maternal females. Exchange and adoption of cubs may be more common in dense populations of bears and/or in populations of bears that gather at a common place in late summer, such as a salmon stream. In either case, interactions would be more common and exchanges more probable.

Cubs of the Year to Yearlings. Estimates for survival of young from the cub stage (about 0.5 years of age) to the yearling stage (1.5 years of age) vary greatly depending on the particular study in question. Most of these data are based on comparisons of age class strengths and are not related to the survival or mortality of individuals within a particular cohort. Obviously, losses of entire litters are not detectable in the former method of data gathering.

Data from McNeil River indicated that 15 of 48 cubs (31%) from marked family groups disappeared before they reached the yearling stage (Table 6). These data suggest that 31% of young bears alive at 0.5 years of age do not survive to be 1.5 years of age. At Black Lake ($\bar{N}$ = 14), we found 43% mortality for young during a similar time interval. If data from both our studies are combined, then 21 out of 62 cubs (34%) observed at 0.5 years of age did not accompany their mothers 1 year later.

Our field data revealed that for the 4 litters of yearlings observed at Black Lake, 7 litters present at the cub stage had disappeared. At McNeil River, for 9 litters of yearlings observed, 11 cub litters were observed. If data from McNeil and Black Lake are combined, they indicate that for every 13 litters that survived from 0.5 to 1.5 years of age there were 5 entire litters (38%) that had disappeared. In general terms, we found that for every 2.6 yearling litters observed there was previously another litter of similar size in which all individuals had perished.

Our data suggest that mortality rates based on differential sizes of litters are conservative and inappropriate estimates of juvenile mortality. For these reasons, these contrary findings are not without expectation or explanation. They further suggest that for studies in which juvenile mortality is quantified by comparisons of the average sizes of litters, mortality estimates may be 28% too conservative.

Yearlings to Family Breakup. Knowledge of the timing of family breakup greatly enhances the utility and is essential to correctly interpret mortality rates for young bears. To assess survival of bears from 1.5 years of age to family breakup, one must be cognizant of variation (within and between populations) in the age of young at the time when family bonds dissolve.

A sow that was known to have cubs and was observed a year later without any young could indicate that either the young perished or the family bond dissolved, quite contrary interpretations. Similarly, mortality rates would be expected to differ tremendously before and after families break up.

Hensel (pers. commun. in Glenn et al. 1976) found that few 22-month-old bears were associated with their mothers at the time of denning. Data from McNeil River ($\bar{N}$ = 13), indicated that bonds for most families (69%) had dissolved before young were 2.5 years of age. A few families separated before the young were 1.5 years old (23%) or when the young were between 2.5 and 3.0 years of age (8%). Out of 42 family groups observed at McNeil River, none were composed of young 3.5 years of age.

Four of the 95 family groups (7%) observed at Black Lake involved 3.5-year-old young. Comparisons of the maternal relationships for young in like-age groups that were captured in the Black Lake area indicated that 9% of the 1.5-year-old young, 47% of the 2.5-year-old young, and 10% of the 3.5-year-old young were associated

with their dam (Table 7). Viewed from another spectrum, these data imply that if a cohort of 100 families were followed for 3.5 years, 3, 36, and 61 of the females would have been without young after 1.5, 2.5, and 3.5 years, respectively. All females would have been separated from their young after 4 years. Craighead et al. (1976) found that all young over 3 years of age had ceased to associate with their dam. Martinka (1974) reported that most families broke up before the young were 2 years. But in 1 case out of more than 65, a family of bears remained intact into their 4th summer at which time the young were 3.5 years of age. Similarly, Mundy (1963) found that family bonds dissolved before young were 2.5 years of age. Pearson (1975) never observed young to separate from their mother until after 2.3 years of age and found that 1 family remained together for at least 3.7 years. Reynolds (1978) observed that litters of 3- and 4-year-old young still associated with their mother and that family units did not break up until the young were at least 2.5 years of age.

In summary, our data indicate that brown bears on Kodiak Island and the Alaska Peninsula can become self-sufficient at an earlier age than bears in other populations. Brown bears in arctic Alaska and the Canadian Yukon maintained family associations for the longest period of time.

Since aggressive encounters by male bears are known to temporarily disrupt family units (Herrero and Hamer 1977), it is not unreasonable to believe that in many of these instances families never again unite. If this is the case, premature breakup of families would be related to the probability of an aggressive encounter, which in turn is related to the density of bears in the respective population. Together, these factors may, in part, account for our observations of early family breakup on the Alaska Peninsula. Though under these circumstances, family breakup may be "behaviorally premature;" we have evidence that some Alaskan brown bears are capable of self-sufficiency by 7 months of age (Johnson and LeRoux 1973).

Since specific aspects of mortality will be considered in greater detail in a subsequent report, its inverse, survival of yearlings to 2.5 years of age, will not be treated in detail in this report. Our data indicate that of 43 yearling females alive, 19% were observed at 2.5 years of age. Forty percent ($\underline{N}$ = 34) of those not observed at 2.5 years of age were observed in a subsequent year. These data indicate that at least 63% of the yearling females survived to be 2.5 years of age. Similar calculations for 44 yearling males indicate that 42% were observed 1 year later and 14% of those not observed were in fact alive. These data imply that at least 56% of the yearling males were alive 1 year later. Craighead et al. (1976) found a 68% survivorship rate for each sex during this same interval.

It should be reemphasized that survivorship rates of individual yearling bears would certainly be related to the timing of family breakup. It would be reasonable to assume that survival rates decrease greatly when young first become self-sufficient.

Duration of the Family Bond. One biological phenomenon that has a profound effect on the reproductive potential of a population of brown bears is the breeding interval. A factor that may affect the time period between successive breeding is the duration of the family bond.

If survival of cubs is independent of their age at self-sufficiency, then a sow, whose family bonds dissolve when young are 1.5 years old, could produce twice as many young in her lifetime as a sow that maintains the family unit for 3.5 years.

It has been reported that female bears do not breed when lactating or accompanied by young but that females which lose or are separated from their young before or during a breeding season may come into estrus immediately (Erickson and Nellor 1964). Thus, the salient questions to address are the following: 1) What stimulates or initiates family breakup and thereby triggers estrus and subsequent breeding behavior? 2) Do the young voluntarily leave the sow? 3) Does the sow force away the young? 4) Does the presence of an adult male influence the behavior of young and drive them away from the sow or influence the behavior of the sow to drive them away? and 5) Is there interaction between all four of the former possibilities? Obviously, the tremendous variation in "maternal personalities" of individual female bears must also be considered as an equally important and factor.

Although 1.5, 2.5, and 3.5-year-old bears were commonly observed in association with sows, solitary 1.5-year-old young were encountered in the study area. Whether separation of the 1.5-year-old young from their sows was premature (sows perished or separation happenstance but permanent) or normal was not known. Generally, family bonds are believed to dissolve when young are between 2.5 and 3.5 years old (Glenn and Miller 1980).

Our data suggest that family bonds and lactation alone do not directly control onset of estrus in female brown bears. Most lactating sows we observed were associated with young and were not in estrus. However, we did observe females with and without young to be simultaneously lactating and in estrus. Dams in all the former cases were probably preparing for cessation of milk production and disintegration of family bonds, as their young were 2.5 years old. In the latter case, where the young were 0.5 years old, the dams may have recently lost a litter, came into estrus, and subsequently adopted a new litter. Apparently, spatial separation from young and/or cessation of lactation are not necessary precursors to the onset of estrus (as determined by external examination of the vulva).

A recent study of black bears indicates that sows may breed while accompanied by young and come into estrus and become pregnant while nursing young (Le Count 1983).

Since females with young were protected from hunting by State statute, natural selection processes in our hunted study population would favor females that were most frequently associated with young. Females without young would be vulnerable to hunting mortality, whereas females with young would not. If protracted association with young does not negatively affect a female's productivity in hunted populations, natural selection would favor those females that were usually associated with young even if it overlapped with estrus.

Sex Ratio of Young. The sex ratio of young bears (cubs through 3.5 years of age) in family units at Black Lake was nearly equal (Table 7). However, the sex ratio for 1.5- and 2.5-year-old bears not associated with their dams (self-sufficient) indicates a preponderance of males, 75 and 65%, respectively. This may indicate that males are more likely to become self-sufficient before females or that young males are better able to survive on their own at this young age. The latter explanation more adequately accounts for the even sex ratios of young that remain in family groups.

Demographic Characteristics of Live-Captured and Hunter-Killed Bears:

Data presented in Appendices A-I exemplify the general type of information available from live-captured and hunter-killed bears. Live capture and hunter kill data each represent an independent sample of bears from the resident live population. The hunter kill sample is our best estimate of dominant losses of individuals from that live population over the respective time period. Because these data are the result of interactions between behavior of bears, behavior of hunters, and varying restrictions on the latter, they are extremely complex and require sophisticated statistical analyses. Simple, facile analyses of these data would be inappropriate and could lead to erroneous conclusions.

Preliminary analyses, designed to examine the data for biases inherent from sampling procedures, are necessary to refine data that are to be incorporated in modeling the population and performing simulation analyses.

RECOMMENDATIONS

Efforts should be made in the future to analyze live capture and nunter kill data. Rigorous statistical treatment of data is necessary prior to modeling population characteristics and conducting simulations under restrictions of various management strategies.

Statistical treatment should address the relationships between demographic characteristics of live capture and kill samples and those of the wild population. To evaluate such relationships,

interaction between vulnerability (behavior of bears) and selectivity (behavior of hunters and live capture sampling schemes) will have to be assessed. Subsequently, mortality rates may be approximated and life tables constructed for building a population model. Iterative modeling may lead to estimates of population size or density of bears. Simulation techniques may later be used to assess the end results of alternate-year seasons, alteration of season length, opening of spring vs. fall hunting seasons, trophy hunting, alteration of hunting methods and transportation means, and the control of numbers of guided vs. nonguided hunters as potential management strategies. In total, these analyses should lead to selection of the combination of strategies most useful in producing a desired harvest.

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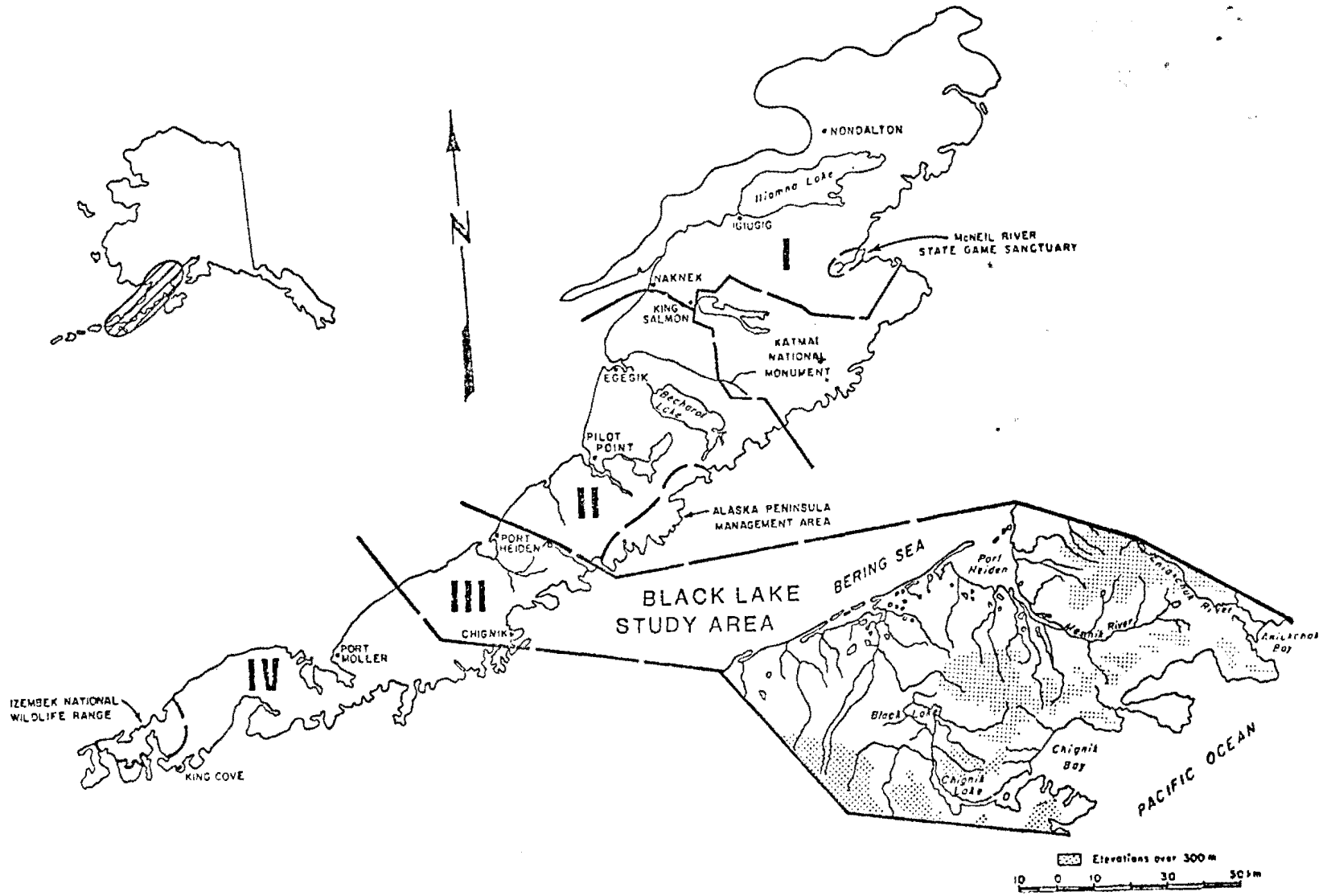

Fig. 1. Location of Game Management Unit 9 in Alaska, showing the 4 management subunits where sampling occurred and the Black Lake field research area.

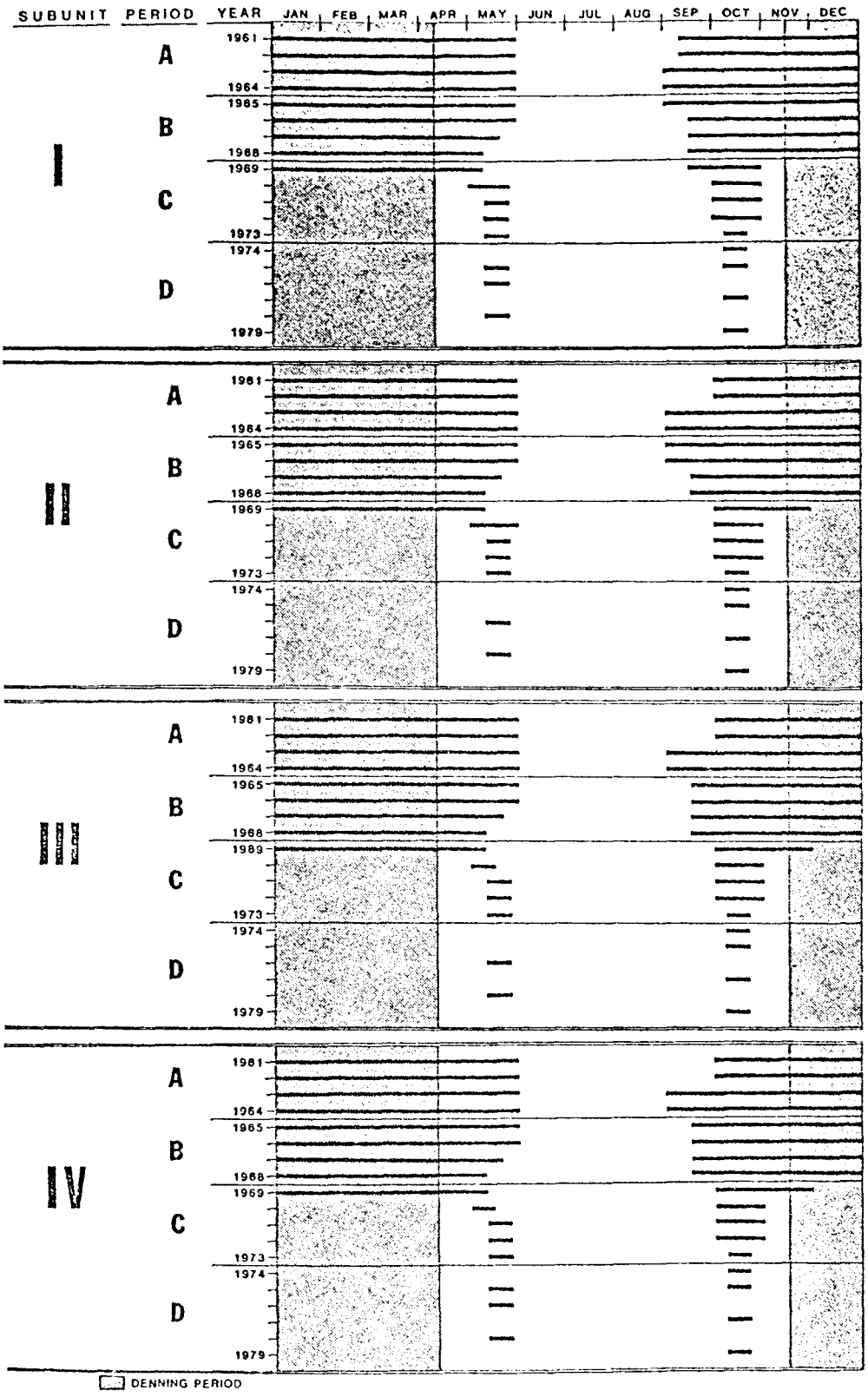

Fig. 2. Variation in length and timing of annual hunting seasons within and between different phases (annual periods) of management stategy for subunits I-IV in Game Management Unit 9, Alaska, 1961-79.

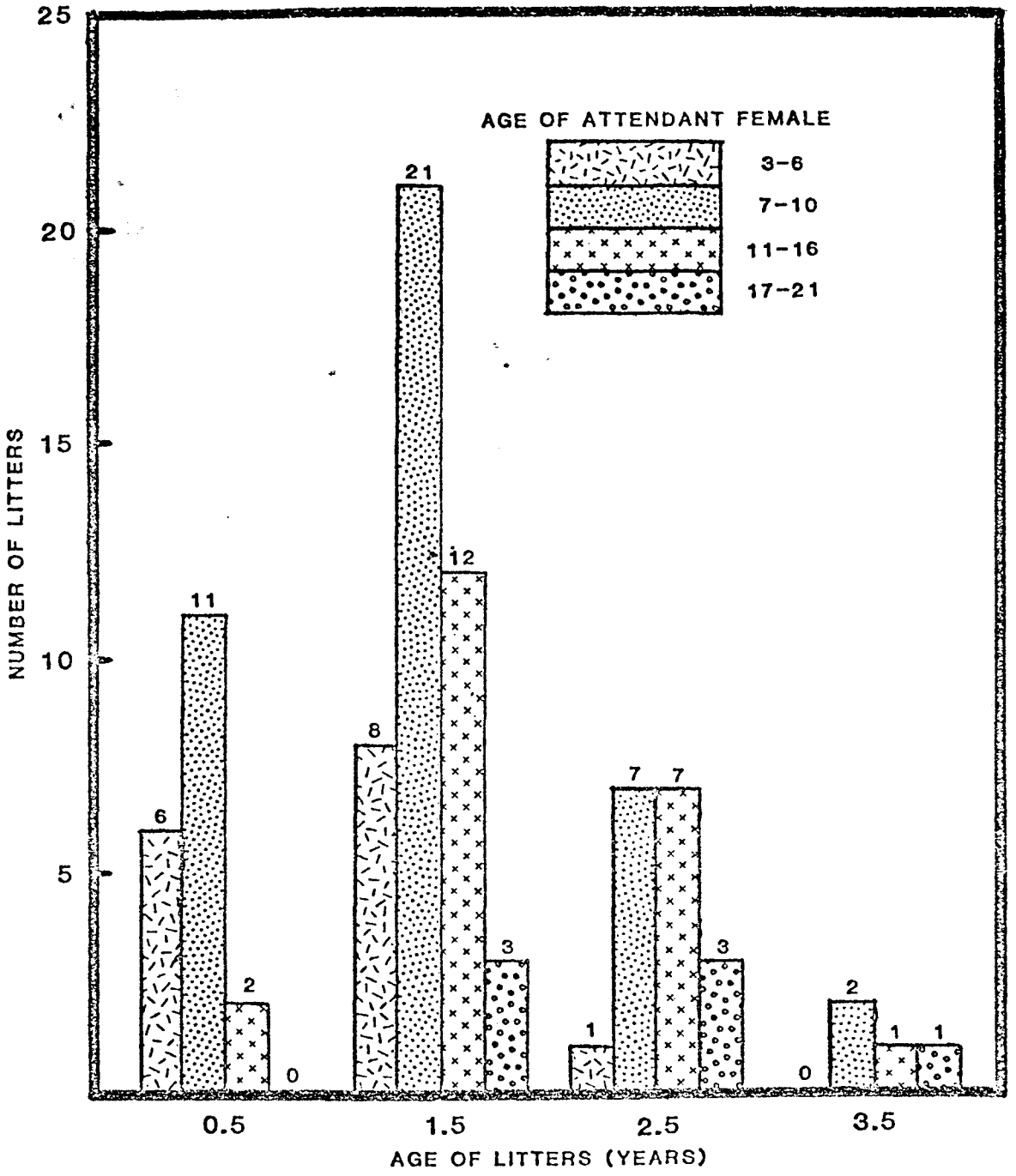

Fig. 3. Number of litters for 4 age classes of young and 3 age groups of attendant brown bear females.

Table 1. Historical summary of hunting intensity and pertinent regulations applying to hunting of brown bears in Game Management Unit 9, 1961-79.

Period	Extent of kill[a]	Regulations[b]
1961-64	Low	Long seasons; no restrictions on mobility (9)
1965-68	Moderate	Shorter seasons; limitations on mobility (8)
1969-73	Excessive	Drastically shortened seasons; more restrictions on mobility (1.5)
1974-79	Moderate	Extremely short seasons; timing and occurrence varied; continued restrictions on mobility (0.5).

[a] Subjective appraisal.
[b] Average length of open season in months in parentheses.

Table 2. Reproductive status and age of female brown bears captured on the Black Lake study area, Alaska Peninsula, 1968-77.

Age (years)	No. without young		No. with young
	Not exhibiting signs of estrus	Exhibiting signs of estrus[a]	
2	9	0	0
3	17	15	0
4	4	19	1
5	2	10	4
6	0	9	10
7	0	6	8
8	0	5	13
9	0	5	7
10	1	6	9
11	0	0	7
12	0	0	8
13	0	2	6
14	0	3	5
15	0	4	1
16	0	1	6
17	0	0	2
18	0	1	1
19	0	1	2
20	0	0	1
21	0	0	1
Totals	33	87	92

[a] Turgid vulva = sign of estrus.

Table 3. Numbers and sizes of 0.5, 1.5, 2.5, and 3.5-year-old litters observed with known-age female brown bears in the Black Lake area, 1968-78.

Age of female	Litter size														
	No. 0.5 yr. old cubs				No. 1.5 yr. old cubs				No. 2.5 yr. old cubs				No. 3.5 yr. old cubs		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
3			1												
4															
5	1[a]	1			1		1								
6		2	1		2	5			1						
7					3	4					1				
8	1	1	2			4	2			3	1		1		
9		3	1			3								1	
10	1	2			1	4	1			1	1				
11						4	3		1						
12					1		2			1	1				1
13			1			2	1	1							
14					1	2	1				2				
15			1												
16						1	1	1		1	1				
17						1					1				
18						1									
19									1					1	
20					1										
21									1						
Totals	3	9	7	0	10	31	12	2	4	6	8	0	1	2	1
% of each age category	16	47	37	0	18	56	22	4	22	33	44	0	25	50	25
Mean size for each age category		2.2				2.1				2.2				1.8	

[a] Number of litters observed in each category.

Table 4. Litter size for brown bears as determined in various studies in North America.

Source	Location	Age of young (yr)	No. young	No. litters	Mean litter size (age class) 0.5	1.5	2.0	% change
Craighead et al. 1976	Yellowstone Nat'l Park	0.5	454	213	2.12			0
		1.5				1.88[a]		-10
		2.5					1.47[a]	-22
Mundy 1963	Glacier Nat'l. Park, B.C.	0.5	157	81	1.94			0
		1.5	83	45		1.84		-5
		2.6	31	17			1.82	-1
Troyer and Hensel 1964	Kodiak Island, AK	0.5	92	39	2.36			0
		1.5	126	58		2.17		-8
Hensel et al. 1969	Kodiak Island, AK	0.5	219	98	2.23			0
		1.5	206	103		2.00		-10
Klein 1958	Kodiak Island, AK	0.5	120	52	2.31			0
		1.5	94	41		2.29		-1
	Alaska Peninsula	0.5	167	77	2.7			
		1.5	104	50		2.08		-4
	Southeast Alaska	0.5	54	25	2.16			
		1.5	66	35		1.89		-13
	McNeil River, AK	0.5	267	108	2.46			
		1.5	236	95		2.48		0
Reynolds 1976	Northeast Alaska	0.5	23	13	1.77			0
		1.5	14	7		2.00		+13
		2.6	2	1			2.00	0
1978	Northwest Alaska	0.5	30	15	2.00			0
		1.5	16	7		2.29		+15
		2.5	2	1			2.00	-15
		4.5	2	1			2.00[b]	
Pearson 1975	Southwest Yukon	0.5	19	11	1.73			0
		1.5	16	7		1.45		-16
Glenn et al. 1976 and this study	McNeil River, AK	0.5	103	41	2.5			
		1.5	124	69		1.8		-28
	McNeil River, AK[a]	0.5	58	26	2.15			0
		1.5	35	20		1.75		-19
		2.5	7	4			1.75	0
	Black Lake, AK[a]	0.5	40	19	2.11			0
		1.5	107	51		2.10		0
		2.5	40	18			2.22	+ 6
		3.5	8	4			2.00[c]	-10
	Black Lake, AK[d]	0.5	156	66	2.36			0
	Alaska Peninsula[e]	0.5	370	180	2.06			0

[a] Captured and marked family members and/or ground surveys.
[b] Mean litter size for 5.6-year-old litters.
[c] Mean litter size for 3.5-year-old litters.
[d] Aerial surveys along salmon streams.
[e] Aerial surveys along salmon streams excluding the Black Lake area.

Table 5. Comparison of frequency distribution of litter sizes for brown bear cubs observed in different studies in North America.

Study	Location	Number in litter			
		1	2	3	4
Martinka (1974)	Glacier Nat'l Park, MT	15[a]	16	14	0
Mundy (1963)	Glacier Nat'l Park, B.C.	21	44	16	0
Hensel et al. (1969)	Kodiak Island, AK	22	36	33	6
Troyer and Hensel (1964)	Kodiak Island, AK	8	10	20	1
Klein (1958)	Alaska Peninsula	18	26	15	4
	Kodiak Island, AK	4	13	10	0
	McNeil River, AK	11	41	53	4
Craighead et al. (1976)	Yellowstone Nat'l. Park, WY	9	38	10	3
Reynolds (pers. commun.)	Arctic Alaska	6	18	2	0
This study	Black Lake, AK	7	34	24	3[b]
	McNeil River, AK	4	6	9	1
	Alaska Peninsula	54	116	62	7

[a] Number of litters observed.

[b] Two represent litters of 5 individuals.

Table 6. Survival (mortality) for young brown bears as determined by direct observation of marked, known aged females and their cubs at McNeil River and Black Lake on the Alaska Peninsula, 1963-78.

Study area	Age interval considered (yr)	No. of young surviving from females of specified age		
		<9 years old	>8 years old	All ages
Black Lake	0.5-1.5	0 out of 5 (100)[a]	8 out of 9 (11)	8 out of 14 (43)
	1.5-2.5	3 out of 3 (0)	8 out of 9 (11)	11 out of 12 (8)
McNeil River	0.5-1.5	11 out of 20 (45)	22 out of 28 (21)	33 out of 48 (31)
	1.5-2.5	1 out of 1 (0)	7 out of 11 (36)	8 out of 12 (33)
Black Lake/ McNeil R.	0.5-1.5	11 out of 25 (56)	30 out of 37 (19)	41 out of 62 (34)
combined	1.5-2.5	4 out of 4 (0)	15 out of 20 (25)	19 out of 24 (21)

[a] % mortality in parentheses.

Table 7. Maternal relationships and sex for young brown bears captured in the Black Lake area, Alaska, 1970-72, 1974-75.

Age of young (yr)	No. young with sow		No. young without sow	
	Males	Females	Males	Females
0.5	15	11	0	0
1.5	45	43	3	1
2.5	22	21	32	16
3.5	5	4	41	40

APPENDIX A

Age composition and number of male and female (male, female) brown bears killed by hunters during the spring (January-June) and fall (July-December) season in subunit 1 on the Alaska Peninsula, 1969-78.

Season	Age (years)	Year 1969	1970	1971	1972	1973	1974[1]	1975	1976	1977	1978
Spring	1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	2	0,0	2,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	3,0
	3	0,0	1,0	0,0	0,0	1,2	0,0	1,0	0,3	1,0	4,1
	4	0.0	1,1	0,0	1,1	1,0	0,0	1,2	1,0	0,0	2,0
	5	0,0	1,0	1,0	1,0	2,0	0,0	0,1	0,2	0,0	1,1
	6	1,0	1,0	0,0	0,0	1,0	0,0	2,1	0,2	1,0	1,0
	7	2,0	0,0	0,0	1,0	0,0	0,0	2,1	2,0	0,0	0,1
	8	0,0	1,0	0,0	1,0	0,0	0,0	1,0	1,0	0,0	0,1
	9	0,0	3,0	0,0	2,0	2,0	2,0	0,0	0,0	0,0	1,0
	10	0,0	2,0	0,0	1,0	1,0	0,0	0,0	0,0	0,0	1,0
	11	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,2
	12	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	1,0
	13	0,0	0,0	0,0	0,1	0,0	0,0	0,0	1,0	0,0	1,0
	14	0,0	1,0	1,0	0,0	0,0	0,0	0,0	3,0	0,0	0,0
	15	0,0	2,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	1,0
	16	0,0	0,0	0,0	1,1	1,0	0,0	0,0	0,1	0,0	0,0
	17	0,0	0,0	0,0	2,0	1,0	0,0	0,0	0,0	0,0	0,0
	18	1,0	0,0	1,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
	19	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	20	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	4,0	15,1	2,0	11,4	9,3	0,0	8,5	8,8	2,0	17,6
Fall	1	0,0	0,0	1,1	1,0	0,0	1,0	1,1	0.0	4,0	0,0
	2	0,1	2,0	2,4	4,2	2,2	5,0	4,3	0,1	1,1	0,6
	3	0,0	1,1	2,2	2,1	3,0	5,1	0,0	1,0	3,2	0,0
	4	0,2	0,0	3,1	2,0	4,2	0,2	2,1	0,0	2,2	0,0
	5	2,1	0,0	2,1	2,2	1,2	1,0	1,0	0,0	3,1	0,0
	6	0,0	0,0	0,0	0,1	0,0	0,1	2,1	0,0	1,1	0,0
	7	0,0	0,1	0,0	1,0	1,0	2,0	1,0	1,0	0,0	0,0
	8	0,0	0,0	0,0	1,1	0,2	1,0	0,0	0,0	0,1	0,0
	9	0,1	0,0	0,1	0,0	1,2	0,0	0,1	0,0	0,0	0,0
	10	0,0	0,2	0,0	2,2	0,0	0,0	0,1	0,0	0,0	0,0
	11	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0
	12	0,0	0,0	0,0	0,0	1,1	0,1	0,0	0,0	0,1	0,0
	13	0,0	0,0	0,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0
	14	0,0	0,0	1,0	0,0	1,0	0,0	0,0	0,0	1,0	0,0
	15	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0
	16	0,0	0,0	1,1	0,1	1,0	0,0	1,0	0,0	0,0	0,0
	17	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	18	0,0	0,0	0,0	1,1	1,1	0,0	1,0	0,0	0,0	0,0
	19	0,0	0,0	0,0	0,0	0,0	1,0	1,0	0,0	0,0	0,0
	20	1,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	23	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	3,5	3,4	12,11	22,11	16,13	17,4	14,9	2,1	15,9	0,0

1/ No open hunting season in spring 1974 and 1977 and fall 1975 and 1978, except for special permit hunt in Naknek River drainage.

APPENDIX B

Age composition and number of male and female (male, female) brown bears killed by hunters during the spring (January-June) and fall (July-December) season in subunit 2 on the Alaska Peninsula, 1969-78.

Season	Age (years)	Year 1969	1970	1971	1972	1973	1974[1]	1975	1976	1977	1978
Spring	1	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,0
	3	1,0	0,0	0,0	1,0	1,0	0,0	0,0	4,0	0,0	4,2
	4	1,1	1,1	0,0	0,0	4,5	0,0	0,0	7,3	0,0	5,2
	5	1,0	1,0	1,0	1,0	3,0	0,0	0,0	2,3	0,0	3,4
	6	2,0	1,2	0,0	1,0	1,0	0,0	0,0	4,0	0,0	0,1
	7	0,0	1,0	2,0	0,0	0,0	0,0	0,0	3,0	0,0	4,2
	8	0,0	0,0	0,0	0,0	1,2	0,0	0,0	1,0	0,0	5,0
	9	1,0	2,0	3,0	0,0	0,0	0,0	0,0	2,1	0,0	5,0
	10	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	0,0	2,2
	11	1,0	0,0	1,0	0,0	0,0	0,0	0,0	1,0	0,0	1,1
	12	0,0	0,0	1,0	0,0	1,2	0,0	0,0	0,0	0,0	1,0
	13	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	0,0	2,0
	15	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	1,0
	16	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	17	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	18	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1
	19	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
	20	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Totals	8,1	7,3	9,0	6,0	11,9	0,0	0,0	31,7	0,0	43,15
Fall	1	0,1	1,0	3,1	2,0	0,2	1,0	1,0	0,0	7,2	0,0
	2	3,0	9,2	10,2	7,6	7,0	6,4	6,2	0,0	12,5	1,0
	3	2,3	1,4	5,5	13,6	3,2	6,1	6,6	0,0	5,3	0,0
	4	1,0	0,2	5,3	5,3	3,1	2,2	6,1	0,0	5,2	1,0
	5	0,0	0,0	1,4	0,3	0,4	1,3	1,0	0,0	2,1	0,0
	6	0,0	0,1	1,0	4,3	1,2	2,0	0,0	0,0	0,0	1,0
	7	0,0	2,0	0,0	1,2	0,0	1,2	2,5	0,0	3,4	0,0
	8	0,1	0,0	0,2	2,2	1,2	1,1	0,1	0,0	0,1	0,0
	9	0,0	2,2	0,1	2,0	1,0	0,0	0,1	0,0	0,0	0,0
	10	0,1	1,0	0,1	1,2	1,1	0,0	0,1	0,0	0,1	0,0
	11	0,0	0,2	0,0	0,2	0,0	1,0	1,0	0,0	1,0	0,0
	12	0,0	1,2	0,0	1,1	0,0	1,2	0,2	0,0	2,1	0,0
	13	0,0	0,0	2,0	1,3	0,0	0,2	0,0	0,0	0,2	0,0
	14	0,1	1,1	1,0	0,1	0,0	0,0	0,1	0,0	0,0	0,0
	15	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,1	0,0
	16	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
	17	0,0	1,0	0,0	0,0	0,1	0,0	1,0	0,0	0,0	0,0
	18	0,0	0,0	1,0	0,1	0,0	0,1	1,0	0,0	0,0	0,0
	19	0,0	0,0	1,0	1,0	0,0	0,1	0,0	0,0	0,0	0,0
	20	0,0	0,0	0,0	0,0	0,1	1,0	0,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	6,7	19,16	31,19	40,37	17,16	23,20	25,21	0,0	37,24	3,0

1/ No open hunting in spring 1974, 1975 and 1977 and fall 1976 and 1978, except for special permit hunt in Naknek River drainage.

APPENDIX C

Age composition and number of male and female (male, female) brown bears killed by hunters during the spring (January-June) and fall (July-December) season in subunit 3 on the Alaska Peninsula, 1969-78.

Season	Age (years)	Year 1969	1970	1971	1972	1973	1974[1]	1975	1976	1977	1978
Spring	1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	2	0,0	0,1	0,0	1,0	0,1	0,0	0,0	0,1	0,0	3,2
	3	2,0	0,0	3,2	0,1	0,2	0,0	0,0	1,1	0,0	6,0
	4	2,1	1,0	2,1	3,1	5,0	0,0	0,0	6,2	0,0	2,2
	5	2,0	2,0	2,0	2,1	2,1	0,0	0,0	3,1	0,0	5,1
	6	0,0	1,1	3,0	2,1	2,0	0,0	0,0	1,0	0,0	4,0
	7	2,0	1,0	2,0	0,0	2,0	0,0	0,0	5,0	0,0	2,1
	8	0,0	3,0	1,0	1,1	0,0	0,0	0,0	3,0	0,0	2,0
	9	1,0	1,0	2,0	2,0	0,0	0,0	0,0	2,1	0,0	5,1
	10	0,0	0,0	1,0	0,0	1,1	0,0	0,0	0,1	0,0	3,1
	11	0,0	1,0	1,0	1,0	0,0	0,0	0,0	0,0	0,0	1,1
	12	0,1	1,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	13	0,0	0,0	1,0	1,0	0,0	0,0	0,0	0,0	0,0	1,1
	14	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0
	17	0,0	0,0	2,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0
	18	0,0	0,0	1,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0
	19	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0
	20	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	10,2	11,2	22,3	14,5	14,5	0,0	0,0	23,7	0,0	36,11
Fall	1	0,0	1,0	0,0	3,0	0,0	0,1	2,1	0,0	0,0	0,0
	2	0,0	6,2	5,5	5,3	3,3	2,1	1,2	0,0	7,3	0,0
	3	0,0	3,1	5,3	7,9	4,2	6,4	4,5	0,0	4,2	0,0
	4	2,0	0,1	3,2	3,0	1,3	2,0	1,1	0,0	2,2	0,0
	5	1,0	0,0	0,0	1,3	0,0	1,1	2,1	0,0	2,0	0,0
	6	0,0	1,0	0,0	2,1	1,1	0,1	1,1	0,0	2,1	0,0
	7	1,0	3,0	0,0	2,1	0,0	0,1	0,0	0,0	2,1	0,0
	8	0,0	0,0	0,1	1,1	1,0	0,1	0,0	0,0	1,1	0,0
	9	0,0	0,0	0,1	0,0	1,1	0,1	0,0	0,0	0,2	0,0
	10	0,0	0,0	0,1	0,0	0,2	0,1	0,0	0,0	0,0	0,0
	11	0,0	1,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,0
	12	0,0	1,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
	13	0,0	0,0	1,1	0,2	1,0	0,0	0,0	0,0	0,0	0,0
	14	1,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
	15	0,0	0,0	1,0	0,3	0,1	0,0	0,2	0,0	0,0	0,0
	16	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
	17	0,0	0,0	1,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
	18	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	19	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	20	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	5,0	16,5	16,14	24,27	12,13	11,14	11,13	0,0	20,14	0,0

1/ No open hunting season in spring of 1974, 1975 and 1977 and fall of 1976 and 1978.

APPENDIX D

Age composition and number of male and female (male, female) brown bears killed by hunters during the spring (January-June) and fall (July-December) season in subunit 4 on the Alaska Peninsula, 1969-78.

Season	Age (years)	Year 1969	1970	1971	1972	1973	1974[1]	1975	1976	1977	1978
Spring	1	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
	2	0,0	1,1	0,1	2,0	1,0	0,0	5,0	2,3	0,0	5,2
	3	2,0	2,0	1,1	6,1	6,2	0,0	6,2	4,3	0,0	4,3
	4	3,2	0,2	0,2	2,2	3,4	0,0	3,6	9,1	0,0	6,2
	5	0,1	2,0	2,0	0,0	8,1	0,0	5,1	1,2	0,0	3,3
	6	0,0	1,0	0,1	0,0	7,2	0,0	3,2	4,0	0,0	2,2
	7	0,0	1,0	2,0	0,0	2,1	0,0	2,0	7,0	0,0	1,0
	8	2,0	2,0	0,0	0,0	1,1	0,0	1,2	1,1	0,0	2,0
	9	1,0	1,2	3,0	1,1	1,0	0,0	2,0	2,1	0,0	2,0
	10	0,0	0,1	0,0	0,0	0,1	0,0	0,1	0,2	0,0	1,0
	11	0,0	0,0	0,1	0,0	2,0	0,0	1,2	0,0	0,0	1,0
	12	1,0	1,0	0,0	0,0	0,0	0,0	0 0	1,0	0,0	0,0
	13	0,0	0,0	0,0	0,1	0,0	0,0	2,1	1,0	0,0	2,0
	14	0,0	2,1	0,0	0,1	0,0	0,0	0,0	1,0	0,0	2,0
	15	0,0	1,0	0,0	1,0	0,0	0,0	0,0	2,0	0,0	0,0
	16	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	17	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
	18	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	19	0,0	0,0	0,0	0,1	0,0	0,0	1,0	0,1	0,0	0,0
	20	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	9,3	15,7	8,6	12,7	31,12	0,0	34,18	35,15	0,0	31,12
Fall	1	0,1	1,0	1,0	0,1	1,1	1,0	2,0	0,0	7,3	0,0
	2	1,0	2,1	5,2	4,4	4,3	5,4	9,11	0,0	5,2	0,0
	3	0,0	2,3	1,2	6,2	5,6	3,10	6,2	0,0	4,8	0,0
	4	0,0	0,0	1,1	2,5	3,5	5,4	3,1	0,0	4,1	0,0
	5	0,0	0,0	1,1	3,2	3,0	3,1	1,4	0,0	2,1	0,0
	6	0,0	0,0	2,1	0,3	1,0	1,0	1,1	0,0	1,0	0,0
	7	0,0	0,0	0,0	2,2	2,0	1,0	1,0	0,0	0,1	0,0
	8	0,0	1,1	0,0	0,0	0,1	1,0	0,1	0,0	1,0	0,0
	9	0,0	0,0	1,0	1,1	0,0	0,0	0,0	0,0	0,2	0,0
	10	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,1	0,0
	11	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,1	0,0
	12	1,0	0,0	0,0	0,0	0,0	0,1	1,1	0,0	0,0	0,0
	13	0,0	1,1	0,0	0,1	0,1	0,1	1,1	0,0	0,2	0,0
	14	0,0	0,0	0,0	0,2	0,2	0,0	1,1	0,0	0,0	0,0
	15	0,0	0,0	0,1	0,1	0,0	0,0	0,1	0,0	0,0	0,0
	16	0,0	0,0	0,0	0,0	0,0	0,2	0,2	0,0	0,1	0,0
	17	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0
	18	0,0	0,0	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0
	19	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
	20	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0
	21	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	22	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0
	23	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
	24	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Total	2,1	7,6	12,8	19,24	19,22	22,26	27,28	0,0	25,24	0,0

1/ No open hunting season in spring of 1974 and 1977 and fall of 1976 and 1978

APPENDIX E

Year, age, sex and numbers for brown bears captured on the Black Lake study area (includes bears recaptured in subsequent years), 1970-75.

Age (years)	Sex[1]	Year captured					Sex ratio Total males:females
		1970	1971	1972	1974	1975	
0.5							
	M	1	6	2	3	2	14
	F	1	6	1	4	0	12
1.5							
	M	12(1)2/	0(3)2/	17	13(2)3/	4	46
	F	15	8	8	11(1)3/	3	35
2.5							
	M	11(4)2/	14	8	15	2	50
	F	7	10	6	12(1)3/	4	39
3.5							
	M	6	6	13	13	10	48
	F	11	7	15	7	5	45
4.5							
	M	0	5	4	2	2	13
	F	1	12	6	3	1	23
5.5							
	M	3	0	1	3	2	9
	F	5	4	3	4	0	16
6.5							
	M	3	1	1	1	3	9
	F	4	4	3	5	2	18
7.5							
	M	0	2	0	0	2	4
	F	3	2	5	1	3	15
8.5							
	M	0	0	2	0	0	2
	F	2	4	7	4	0	16
9.5							
	M	0	0	0	0	0	0
	F	4	1	2	3	1	11
10.5							
	M	0	1	0	0	0	1
	F	3	4	2	4	3	16
11.5 and older	M	1	0	2	1	2	6
	F	8	7	8	16	4	43
Annual total	4/	106	107	116	130	55	514

1/ M = male and F = female.

2/ Sex unknown but (unable to capture all members of a family group).

3/ Marked bear identified, but not captured.

4/ Includes bears of unknown sex.

APPENDIX F

Age composition for male and female brown bears captured (n=165) in Black Lake Study area and subsequently recaptured on the Alaska Peninsula, 1968-78.

Sex	Age class at initial capture	No. captured	No. years to last recapture 1	2	3	4	5	6	7	8	No. individuals recaptured
Males											
	0	14	1	0	0	0	0	0	0	0	1
	1	45	3	2	2	0	1	0	0	0	8
	2	41	2	1	0	0	0	0	0	0	3
	3	36	1	0	0	0	0	0	0	0	1
	4	8	0	0	0	0	0	0	0	0	0
	5	7	1	0	0	0	0	0	0	0	1
	6	6	0	1	0	0	0	0	0	0	1
	7	3	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
	10	1	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0
	12	1	0	0	0	0	0	0	0	0	0
	13	1	0	0	0	0	0	0	0	0	0
	14	2	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0	0
Females											
	0	12	2	0	0	0	0	0	0	0	2
	1	46	4	0	3	1	0	1	0	0	9
	2	26	2	2	1	0	1	0	0	0	6
	3	37	4	0	0	1	0	0	1	0	6
	4	10	1	0	1	0	0	0	0	0	2
	5	9	1	0	0	1	3	0	0	0	5
	6	12	1	2	0	1	0	1	0	0	5
	7	10	0	0	1	1	2	1	0	0	5
	8	9	1	0	1	1	0	0	0	0	3
	9	4	0	0	0	0	0	0	0	0	0
	10	6	0	0	1	2	0	0	0	0	3
	11	2	0	0	0	1	0	0	0	0	1
	12	5	0	0	0	0	0	0	0	0	0
	13	5	1	0	0	0	0	0	0	0	1
	14	3	0	1	0	1	0	0	0	0	2
	15	2	0	0	0	0	0	0	0	0	0
	16	4	0	0	0	0	0	0	0	0	0
	17	2	0	0	0	1	0	0	0	0	1
	18	1	0	0	0	0	0	0	0	0	0
	19	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0
	21	1	0	0	0	0	0	0	0	0	0

APPENDIX G

Age composition and number of male and female brown bears captured (n=165) in the Black Lake study area and subsequently killed (n=40) by hunters during the spring and fall (spring, fall) season on the Alaska Peninsula, 1968-78.

Sex	Age class at initial capture	No. captured	No. years to death									No. individuals killed
			0	1	2	3	4	5	6	7	8	
Male												
	0	14	,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1
	1	45	,0	3,3	2,3	2,4	0,0	0,1	0,0	0,0	0,0	7,11
	2	41	,5	2,3	1,3	0,2	0,1	0,1	0,0	0,0	0,1	3,15
	3	36	,3	1,2	0,2	0,1	0,0	0,0	0,0	0,0	0,0	1,8
	4	8	,2	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,3
	5	7	,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1
	6	6	,0	0,0	1,0	0,1	0,0	0,0	0,0	0,0	0,0	1,1
	7	3	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	8	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	9	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	10	1	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	11	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	12	1	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	13	1	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14	2	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	15	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Female												
	0	12	,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	1	46	,0	0,4	1,6	0,3	0,0	0,1	0,0	0,1	0,0	1,15
	2	26	,1	0,2	0,4	0,0	0,0	0,0	1,0	0,1	0,0	1,8
	3	37	,5	0,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,8
	4	10	,1	1,1	0,1	0,0	0,0	0,0	2,0	0,0	0,0	3,3
	5	9	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	6	12	,1	0,0	0,0	0,0	0,1	1,0	0,0	0,0	0,0	1,2
	7	10	,0	0,1	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,2
	8	9	,0	0,0	0,0	0,1	0,0	0,1[a]	0,0	0,0	0,0	0,2
	9	4	,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,2
	10	6	,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,1
	11	2	,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	12	5	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	13	5	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14	3	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	15	2	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16	4	,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	17	2	,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1
	18	1	,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1
	19	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	20	0	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	21	1	,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

[a] Killed in defense of life and property.

APPENDIX H

Sex and subunit (1-4) for brown bears killed in defense of life or property during the spring (January-June) and fall (July-December) season on the Alaska Peninsula, 1963-78.

	Males						Females					Subunit total						Annual	Grand
	1	2	3	4	us	Sex total	1	2	3	4	Sex Total	1	2	3	4	us	ux	total	total
Spring																			
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0
1969	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1972	1	0	2	0	0	3	0	0	1	0	1	1	0	3	0	0	0	4	0
1973	0	2	0	0	1	3	0	0	0	0	0	0	2	0	0	1	0	3	0
1974	0	0	2	0	0	2	0	0	3	0	3	0	0	5	0	0	0	5	0
1975	0	0	0	0	0	0	0	0	1	1	2	1	0	1	1	0	1	3	0
1976	1	0	0	0	0	1	0	0	0	2	2	1	0	0	2	0	0	3	0
1977	0	0	1	0	0	1	0	1	0	0	1	0	1	1	2	0	0	2	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Season total	2	2	6	0	2	12	0	1	6	3	10	3	3	12	3	2	1	23	0
Fall																			
1963	0	0	1	0	0	1	1	0	0	0	1	1	0	1	0	0	0	2	2
1964	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1
1965	1	0	0	0	0	1	4	0	0	0	4	5	0	0	0	0	0	5	6
1966	2	0	0	0	0	2	1	2	0	0	3	3	2	0	0	0	0	5	5
1967	2	0	0	0	0	2	1	0	1	0	2	3	0	1	0	0	0	4	4
1968	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2
1969	1	0	0	0	0	1	2	0	0	0	2	3	0	1	0	0	0	3	4
1970	3	1	0	0	0	4	3	0	0	2	5	6	1	0	2	0	0	9	9
1971	1	1	1	3	0	6	2	0	0	2	4	3	1	1	5	0	0	10	10
1972	0	2	0	0	0	2	0	0	0	1	1	0	0	2	0	1	0	3	7
1973	1	0	0	0	0	1	2	1	1	0	4	3	1	1	0	0	0	5	8
1974	0	1	0	2	0	3	0	0	1	4	5	0	1	1	6	0	0	8	13
1975	2	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	5
1976	0	1	0	0	0	1	2	1	0	0	3	2	2	0	0	0	0	4	7
1977	2	1	1	0	0	4	0	3	0	1	4	2	4	1	1	0	0	8	10
1978	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1
Season total	16	7	3	5	1	32	19	7	3	10	39	35	14	6	15	1	0	71	94
Subunit total[d]	18	9	9	5	3	44	19	8	9	13	49	38	17	18	18	3	1	94	94

[a] Bears for which the subunit (us) or sex (ux) is unknown.
[b] Annual total is the sum for subunits and sexes within years.
[c] Grand total is the sum for subunits, sexes by years.

APPENDIX I

Age of male and female brown bears killed in defense of life or property during spring (January-June) and fall (July-December) seasons on the Alaska Peninsula, 1963-78.

Age	Males			Females			Total
	Spring	Fall	Total	Spring	Fall	Total	
0	0	0	0	0	0	0	0
1	3	5	8	1	7	8	16
2	1	7	8	1	4	5	13
3	1	1	2	1	2	3	5
4	2	2	4	1	0	1	5
5	0	1	1	1	3	4	5
6	1	1	2	1	2	3	5
7	1	1	2	0	1	1	3
8	0	0	0	0	0	0	0
9	0	0	0	0	2	2	2
10	0	1	1	0	0	0	1
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	1	1	0	2	2	3
14	0	1	1	0	1	1	2
15	0	0	0	0	0	0	0
16	0	0	0	1	1	2	2
17	0	0	0				0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	1	1	1
21	0	0	0	0	0	0	0
Total	9	21	30	7	26	33	63