

GRIZZLIES, ESKIMOS, AND BIOLOGISTS: CROSS-CULTURAL BEAR MANAGEMENT IN SOUTHWEST ALASKA

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Abstract: The Alaska National Interest Lands Conservation Act (ANILCA; P.L. [Public Law] 96-487) of 1980 mandated that rural Alaskans be given priority use of fish and wildlife on federal public lands for subsistence purposes. This concept conflicts with the Alaska Constitution, which guarantees equal access to resources to all users. The resulting conflict spawned a dual state/federal management system and considerable controversy. In southwestern Alaska, this dilemma is exacerbated by the equally dominant cultures of indigenous Yup'ik Eskimos and more recent immigrants from western cultures. Although wildlife conservation is an important goal of both cultures, management philosophies and practices are dissimilar and sometimes contradictory. This is especially true for brown bears (*Ursus arctos*), which hold an important place in Yup'ik culture and are highly prized by trophy hunters. In 1991 and 1992, brown bear subsistence hunting seasons were significantly liberalized in southwest Alaska. In recognition of the potential danger of this liberalization, the state and federal regulatory boards concurrently stipulated a research program to determine bear density and harvestable surplus in a representative portion of the area. We began the investigation in 1993, but have been hampered by conflicts between Yup'ik and western beliefs. Nevertheless, we have gained important insights into dynamics of the bear population and attained a better appreciation for Yup'ik traditions. Our null hypothesis was that bear density could withstand increased harvest pressure associated with liberalized hunting seasons. We captured 60 bears and radiotracked 30 adult females for 3-4 yrs each. Our data suggest a stable population with a low reproductive rate. Although we were unable to determine population density, preliminary estimates suggest it is comparable to other areas in interior and northwestern Alaska.

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Key words: Alaska, Alaska National Interest Lands Conservation Act, ANILCA, bears, brown bear, cross-cultural, Eskimo, grizzly, Kuskokwim, subsistence, *Ursus arctos*, Yup'ik

Perhaps the greatest challenge facing wildlife managers in Alaska comes from political and cultural vagaries inherent in working with individuals and organizations with diverse interests and traditions. Our experiences while investigating a population of brown bears (*Ursus arctos*) in the Kuskokwim Mountains of southwest Alaska serves as a focal point where all aspects of this challenge have crystallized, and where we have learned important lessons about how to integrate traditional knowledge and modern science.

In 1991 and 1992, state and federal regulatory boards significantly liberalized brown bear hunting regulations for subsistence hunters in southwest Alaska. The bear population affected by this liberalization had never been investigated, and little was known about its population characteristics. The Federal Subsistence Board (FSB) and the Regional Director of the U.S. Fish and Wildlife Service (USFWS) recognized the insufficiency of management data and directed staff to study the brown bear population.

The purpose of this paper is 2-fold. First, we find it essential that the cultural history and perspective of this bear conservation conflict be fully explained to give relevance and insight to the reader. Second, we have collected substantial biological data which are key to assessing the potential effects of bear harvesting in the study area. These 2 critical aspects of bear management are presented together here because either one presented by itself would be of much lesser value.

STUDY AREA

The study area was in the southwest Kuskokwim Mountains, midway between Dillingham and Bethel, Alaska (Fig. 1). It encompassed 2,850 km² of public lands, including parts of Togiak National Wildlife Refuge (TNWR) (41%), Yukon Delta National Wildlife Refuge (YDNWR) (33%), and Alaska State lands (26%). There were no roads, private inholdings, or permanent structures within the study area. Gold miners used the area extensively

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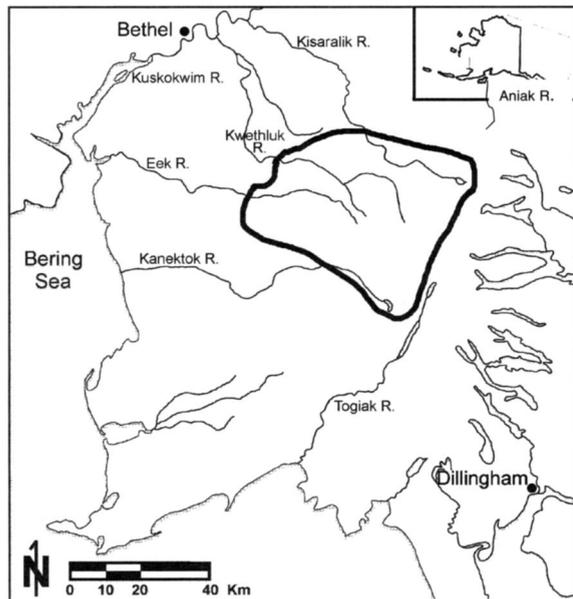


Fig. 1. Brown bear study area in the southwestern Kuskokwim Mountains, Alaska, 1993–97.

during the early part of this century, but recent use was limited to hunters, anglers, and recreational users. Villagers from Kwethluk, Akiak, Akiachak, Bethel, Quinhagak, Togiak, Goodnews Bay, Napaskiak, and Eek traveled to the area to harvest subsistence resources.

Steep, glacier-sculpted peaks, rising to 1,534 m and dividing hydrographically the Nushagak River to the east, the Togiak River to the south, and Kuskokwim watersheds to the west, formed the backbone of the study area. The western slopes of the Kuskokwim mountains were carved into broad, flat valleys containing numerous glacial lakes and the headwaters of the Kwisaralik, Kwethluk, Eek, Togiak, Aniak, and Kanektok Rivers. West of the foothills, these drainages (with the exception of the Togiak and Aniak Rivers) merged into an extensive flat tundra plain, including most of the Yukon and Kuskokwim River deltas. The western portion (~25%) of the study area included a portion of this tundra plain, with a mean elevation of 180 m. The mountains intercepted moist winds blown inland from the Bering Sea, and low clouds and fog often covered the area. Mean annual precipitation was 89 cm, including 177.5 cm of snow. Snow persisted in lower elevations from late October to May, and vegetation developed rapidly during the short growing season. Mean maximum and minimum temperatures for January were -10.5°C and -16.5°C , and for July were 18.5°C and 7°C , respectively (National Weather Service, Bethel, Alaska, USA, unpublished data).

Mountainous portions of the area were sparsely vegetated with low growing shrubs and herbaceous plants. Mid-slope areas (300–600 m) were covered with dwarf

shrubs, including Labrador tea (*Ledum palustre*), crowberry (*Empetrum nigrum*), and sedges (*Carex* spp.) interspersed with dense stands of willow (*Salix* spp.) and mountain alder (*Alnus crispa*), which provided excellent cover for bears. Lowland areas (150–300 m) were dominated by bog willow (*S. arctica*) and dwarf birch (*Betula nana*) as well as various species of berry-producing shrubs including lowbush blueberry (*Vaccinium uliginosum*), cranberries (*V. microcarpus* and *V. vitis-idea*) and bearberry (*Arctostaphylos alpina*). Cottonwoods (*Populus balsamifera*) dominated the overstory in riparian areas, with willows and Kenai birch (*B. kenaica*) in the understorey.

The Kilbuck caribou (*Rangifer tarandus*) herd (~5,000 animals) was resident to the study area, and in recent years the area was used by a portion of the Mulchatna caribou herd (~200,000 animals). Moose (*Alces alces*), relatively new to the area, occurred in low densities along riparian corridors. Other mammals included wolves (*Canis lupus*), beavers (*Castor canadensis*), red and arctic foxes (*Vulpes vulpes* and *Alopex lagopus*), wolverines (*Gulo gulo*), arctic “parka” ground squirrels (*Spermophilus undulatus*), hoary marmots (*Marmota caligata*), snowshoe and arctic hares (*Lepus americanus* and *L. arcticus*), and porcupines (*Erethizon dorsatum*). Willow ptarmigan (*Lagopus lagopus*), golden eagles (*Aquila chrysaetos*), harlequin ducks (*Histrionicus histrionicus*), and numerous other avian species nested in the study area. Area streams provided spawning and rearing habitat for chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), chum (*O. keta*), pink (*O. gorbuscha*), and coho salmon (*O. kisutch*). Rainbow trout (*O. mykiss*), arctic grayling (*Thymallus arcticus*), and Dolly Varden (*Salvelinus malma*) were resident (Marrow 1980).

Human use of the study area has increased substantially over the past decade. TNWR files indicate that the number of rafters floating down the Kanektok River increased from 484 to 820 individuals from 1987–97. Other rivers in the study area experienced similar increases during that same time. Peak rafting use occurred in late June and again in mid-August. Although we did not document any bears killed by rafters, reports of people hazing bears from fishing areas and campsites were common. These activities potentially displaced (spatially, temporally, or both) some bears from important fishing areas and increased vulnerability to human-induced mortality.

Caribou hunters also increased their use of the study area in recent years. The Mulchatna caribou herd expanded into the historic range of the Kilbuck caribou herd in 1994, and as many as 40,000 caribou were within the study area in the fall (Van Daele 1997). This phenomenon prompted liberalization of hunting seasons and bag limits for resident hunters and a subsequent increase in

the number of camps and activity. In September 1996 and 1997, we counted up to 25 caribou hunting camps along headwater lakes and rivers, a 5-fold increase over previous years.

Subsistence use of the study area declined from 1991–97. Local villagers typically established seasonal camps each spring to harvest parka squirrels; however, the number and duration of these camps diminished. Some villagers also chartered aircraft to access caribou hunting and berry picking sites within the study area, and snowmachines were used to hunt caribou in winter and bears in spring, but these activities also declined.

SOCIOLOGICAL BACKGROUND

Yup'ik Eskimos, 1000 A.D. to Present

Archaeologists generally place occupancy of southwest Alaska by people of the "Eskimo" tradition from 1000 A.D. (Dumond 1984). At the time of initial European contact (about 1778), the Yukon-Kuskokwim Delta (YKD) and Bristol Bay regions of southwest Alaska were inhabited by a culturally and linguistically distinct people collectively known as Central Yup'ik Eskimos (Jacobson 1984, Calista Corporation 1991).

Aboriginal Yup'iks lived in small, migratory family groups and relied upon hunting, trapping, fishing and gathering for food, shelter, and clothing (Calista Corporation 1991). Their complex social system emphasized sharing, cooperation, and group harmony as a means of surviving the variable and often unforgiving subarctic environment. Aboriginal Yup'iks had no written language. Elders were revered for their acquired wisdom and were responsible for passing customs and traditional knowledge from one generation to the next (Calista Corporation 1991).

Europeans initiated extensive contact with Eskimos on the YKD in the early 1800s when Russian traders entered the Kuskokwim drainage to trade for furs. Following the U.S. purchase of Alaska from Russia (1867), large numbers of missionaries and other Americans began settling the region (Fienup-Riordan 1982, Calista Corporation 1991). The Native population was not immune to virulent diseases endemic in European populations. Many died from smallpox, measles, influenza, whooping cough, pneumonia, and tuberculosis. In the 100 years following establishment of the Russian fur trade, the Yup'ik population of southwest Alaska was decimated by half or more from a series of epidemics (Fienup-Riordan 1982, Calista Corporation 1991). The very old and young were hardest hit. Loss of the elders was particularly devastating from a cultural perspective because it disrupted and fragmented the passing of Yup'ik traditions to younger generations (Lantis 1959).

Another significant change in Yup'ik culture was the conversion of a highly scattered, migratory population to a more sedentary lifestyle. This process was facilitated by establishment of regional trade centers, improvements in hunting efficiency brought about by the use of firearms, and decreased competition for natural resources as a consequence of disease outbreaks (Fienup-Riordan 1982). Instituting public services in the late 1940s and 1950s, such as education and medical care, accelerated the transformation. Introduction of faster, more efficient modes of transportation such as outboard motors, snowmachines (Fienup-Riordan 1982), inter-village air service, and improved housing, electrical, water, and sewer utilities as well as access to manufactured goods and other services in the 1950s and 1960s, completed the process (Langdon 1995). Exposure to a job- and cash-based economy has further influenced the change. Contemporary Yup'ik people still travel to traditional camps for subsistence hunting, fishing, and gathering, but for shorter periods of time (Langdon 1995).

Improved medical care following World War II (coupled with other social welfare programs) allowed Native populations to recover to pre-contact levels (USFWS 1988). The current population on the YKD is estimated at 20,000, of which approximately 85% are Yup'ik Eskimos (Calista Corporation 1991). Yup'ik is the primary language spoken in the area, although most residents also speak or understand English. The population resides in >40 villages scattered throughout 150,000 km² (Calista Corporation 1991). A burgeoning regional population, coupled with outside pressures from non-local hunters and fishers, increased demands on the natural resources Yup'ik Eskimos rely upon for subsistence and cultural needs.

Yup'ik Eskimos and Grizzly Bears

Brown bears have historically been an important source of food and hides for Native residents of Southwest Alaska. Traditionally, a limited number of adult men hunted bears. These men were considered expert bear hunters because of their knowledge of bear habits. They were well versed in the customs of showing respect for the bear, processing the hide and meat, and sharing the harvest. Although hunting brown bears for food is no longer common practice, some Yup'ik individuals and families still follow the bear hunting beliefs and practices of their forefathers (Coffing 1991; J. Andrews, Bethel, Alaska, USA, personal communication, 1997).

Bears were traditionally hunted in the fall and early spring (J. Andrews, USFWS, personal communication), sometimes while still in the den (Coffing 1991). When a bear was killed, the entire carcass was used for food, oil, and medicine (Coffing 1992). Hides were used for sleeping pads, clothing, and in some areas, for skin-covered

boats for transporting hunters, their families, gear, and meat down river from spring camps (Coffing 1992; J. Andrews, personal communication).

The traditional Yup'ik belief system includes an elaborate oral history on how brown bears are to be treated, indicating spiritual significance. For example, traditionalists believe it is improper for brown bear hunters to speak of their hunting abilities or intentions because bears "...can hear you through the ground you stand on" (J. Andrews, personal communication). Talking about bears in this fashion is disrespectful and can cause the hunt to fail or the animal to harm the hunter (Coffing 1992). When an animal is taken, the skull is buried in the field facing east, covered with boulders, or sunk in a nearby water body (Coffing 1992). Failure to salvage all of the meat is offensive to bears and may cause them to be unavailable for future harvest (Coffing 1992).

Unfortunately, traditional practices and beliefs are diminishing, and few contemporary subsistence hunters adhere to them. Bears are more often perceived as competitors for food and nuisances near villages and fish camps. Fear and disrespect have replaced reverence in many cases, and bears are one of the few large mammals that are wantonly shot and abandoned. This contemporary dichotomy results in social friction within villages and presents additional challenges to wildlife managers.

Yup'ik Eskimos gather information on wildlife behavior and abundance by observation. Systematic data collection is largely a foreign concept (J. Andrews, personal communication). Beyond a general sense of relative abundance across time (more versus fewer), Yup'iks do not feel compelled to quantify wildlife population and habitat parameters. Instead, they are secure in the belief that if they are respectful of wildlife, the animals will continue to present themselves for harvest when needed.

Subsistence hunters find it offensive that state regulations (Table 1) only require sport hunters to salvage the skull, hide, and claws of brown bears and allow hunters to leave edible meat in the field (J. Andrews, personal communication). This goes to the heart of the Yup'ik dis-

tinction between subsistence and "sport" hunting. A commonly held belief by Yup'iks is that subsistence users do not waste food. Furthermore, Yup'iks perceive that they must subsistence hunt because they need the flesh of wild animals for survival. This need goes beyond a mere dietary consideration. Gathering of subsistence foods is a cultural and traditional necessity and requisite for health and spiritual well being. Conversely, Yup'iks believe that sport hunters' connection with the land has been severed, and they no longer require meat of wild animals. Instead, sport hunters kill for pleasure or for play, hence the use of such terms as game, sport, and trophy. Eskimo hunters make a further distinction between an animal killed for subsistence and one taken for sport. The former is viewed as natural, a part of the way things have always been, and in harmony with nature. The latter, is foreign, unnatural, and at times, a cause of wildlife shortages.

Because of these cultural differences, efforts by state and federal agencies to collect subsistence harvest information on brown bears in southwest Alaska have met with limited success. Few subsistence hunters complied with reporting requirements, and they recognized that chances of contact with a law enforcement officer were minimal. This was partly in resistance to perceived interference in the conduct of traditional hunting practices and partly due to cultural taboos on discussing bear hunting intentions and on removing the skull from the field.

Similarly, efforts by government biologists to collect quantitative information on basic brown bear biology were met with resistance by elements of the Native community. There were concerns that capture drugs would permanently render bear meat unfit for human consumption, that radiocollars would cause mechanical and physiological harm, and that handling hurts bears and makes them more aggressive toward humans.

Political Factors and Bear Management

Passage of 2 federal laws had profound and fundamental consequences for the State of Alaska in terms of altering established roles in managing resident wildlife

Table 1. Regulations for resident Alaskans hunting brown bears in the Western Alaska Brown Bear Management Area (WABBMA) during the general or subsistence seasons, as modified by the Federal Subsistence Board in 1991.

General hunt	Subsistence hunt
Locking tag required	Registration permit required
\$25 resident tag fee	No resident fee
10–25 May and 10 Sep–10 Oct seasons	1 Sep–31 May season
1 bear every 4 regulatory years	1 bear/regulatory year
Cubs and sows with cubs protected	Cubs and sows with cubs protected
Hide and skull must be salvaged	Salvage of the hide and/or skull optional
Hide and skull must be sealed within 30 days of take by an Alaska Department of Fish and Game (ADF&G) representative	Hide and skull need not be sealed, but must be sealed by an ADF&G representative and trophy value destroyed if hide or skull are removed from the WABBMA
No requirement to salvage meat	All edible meat must be salvaged for human consumption

resources on federal public lands. The Alaska Native Claims Settlement Act (ANCSA; P.L. 92-203) of 1971 settled aboriginal claims of Alaska's Native peoples through grants of land and money. In exchange for this settlement, all aboriginal titles and claims, including any hunting and fishing rights, were extinguished. Section 17(d)(2)(A) of ANCSA provided the basis for enacting ANILCA in 1980. Section 801(4) of ANILCA affirmed the authority of Congress to "...protect and provide opportunity for continued subsistence uses on the public lands by Native and non-Native rural residents." Furthermore, Section 804 established "...the taking on public lands of fish and wildlife for non-wasteful subsistence uses shall be accorded priority over the taking on such lands of fish and wildlife for other purposes." Finally, Section 805(d) provided for continued state management of fish and wildlife resources on public lands, provided that the state enact and implement laws consistent with subsistence preferences identified in ANILCA.

Alaska passed its first subsistence law in 1978. In 1982, the U.S. Secretary of the Interior determined this law was consistent with ANILCA; however, in 1985, the Alaska Supreme Court ruled the State's subsistence law did not specifically allow the Board of Game (BOG) and Board of Fisheries to grant priority to rural residents (*Madison versus Alaska*, 696 P2d 168). This resulted in the U.S. Department of the Interior ruling that the State did not comply with ANILCA. In order to forestall a federal takeover of subsistence management on federal public lands, in 1986 the State Legislature amended the subsistence law so that only rural residents qualified as subsistence users. This led to the 9th Federal Circuit Court of Appeals ruling in 1989 that the State's definition of rural was inconsistent with ANILCA's intent (*Kenaitze Indian Tribe versus Alaska*, 860 F2d 213). The State's management of subsistence on federal lands was further eroded in 1989 by a ruling by the Alaska Supreme Court that the State law granting subsistence priority based on area of residency (rural versus non-rural) was unconstitutional under the Alaska State Constitution's guarantee of equal access to fish and wildlife for all Alaska's citizens (*McDowell versus Alaska*, 785 P2d 1). On 1 July 1990 the federal government assumed responsibility for management of subsistence taking of fish and wildlife on federal public lands in Alaska, thus ushering in the era of dual management.

Prior to July 1990, all harvest seasons, bag limits, and methods of take regulations were determined by the Alaska BOG. Currently 5 federal agencies are required by the Secretaries of the Interior and Agriculture to establish an independent set of regulations for subsistence hunters, trappers, and anglers on federal public lands. This is accomplished through the FSB. Like the BOG, individuals and

agencies submit proposals to the FSB for review. Similar to the BOG, there are 10 regional advisory councils that review proposals and provide recommendations to the FSB. Regional advisory councils are comprised of local residents and subsistence users. The FSB is limited by ANILCA in that a recommendation by a regional advisory council can only be rejected if it is contrary to sound wildlife management principles, would be detrimental to subsistence users, or is not supported by adequate evidence.

The BOG addresses regulations for all hunters and trappers, resident and non-resident, on all lands throughout the State. Conversely, the FSB regulations only apply to rural residents of Alaska and to federal public lands in Alaska. This dual system has created a situation where hunters and trappers must determine if federal subsistence regulations apply to them, and if so, where and when they apply. Hunters and trappers not subject to federal subsistence regulations must not only consult regulations issued by the BOG, but also must consult federal subsistence regulations to ensure the FSB has not closed or altered federal public land opportunities to non-subsistence hunters and trappers.

Cultural Conflicts

In the early 1990s little was known about brown bear population size, structure, and distribution in the southwestern Kuskokwim Mountains and adjacent ranges. Although sport and defense of life or property harvests were reasonably well documented, the number of brown bears taken by subsistence hunters was largely unknown. Furthermore, there was evidence to suggest an illegal trade in bear parts with Asian markets. It was unclear what effect the unreported kill, in concert with known harvest, was having on this brown bear population. In spite of these concerns by state and federal managers, a small but vocal group of subsistence users from the village of Kwethluk was determined to make brown bear regulations more liberal and less culturally intrusive.

In the spring of 1991 villagers from the YKD submitted several proposals requesting significant liberalization of brown bear regulations. The FSB agreed to the liberalization (Table 1), and directed staff from USFWS and Alaska Department of Fish and Game (ADF&G) to develop a study to assess impacts of the new regulations on brown bear populations (study methods and results are described later).

Two weeks prior to the first bear capture operation in 1993, villagers sought a temporary restraining order to prevent the study because of their opposition to use of the immobilizing drug Telazol (A.H. Robbins Co., Richmond, Virginia, USA; Alaska Federal District Court files). One week before captures were scheduled to begin, the court

rejected the suit.

During the fall of 1993, agency and Native representatives met to discuss cooperative bear management, Native concerns over drug use and collars, and incorporating traditional ecological knowledge into western science. In spite of this effort, in January 1994 villagers filed suit to halt the second year's capture and marking effort. A few weeks prior to the scheduled capture, another meeting was held and villagers heard a report from an independent bear researcher they had employed to develop a culturally acceptable alternative program (Jonkel 1994). Unfortunately, the proposal had been developed with limited knowledge of the logistical considerations inherent to the area and without adequate consultation with knowledgeable local people. Attendees at the meeting supported more communication, local involvement, and sharing knowledge. However, professional biologists reviewing the alternative proposal, both within and outside Alaska, unanimously agreed it had major technical deficiencies.

The day before the 1994 capture operation was to commence, the USFWS Director determined that a compromise was necessary to diffuse the increasingly volatile issue. USFWS and ADF&G agreed to capture and collar only 9 new bears. This number would return the sample to the 1993 objective of 30 radiocollared bears.

The following spring (1995), agency and Native representatives agreed to set goals for managing brown bears in western Alaska. While this cooperative management plan was being developed, we postponed additional bear collaring activities, continued monitoring already collared bears, and developed an aggressive outreach program that included villager participation in telemetry flights.

By late 1996, the framework for a management plan was in place and the working group voted unanimously to replace old collars. This was a significant breakthrough. In June 1997 we invited 4 villagers to join us in field operations. A second helicopter with villager participants and a biologist followed the capture helicopter. Each villager observed at least 3 bear captures and they helped collect data from immobilized bears. Extensive time was spent discussing bear biology, capture techniques and traditional beliefs with agency biologists. The shared venture was an invaluable learning experience for biologists and villagers alike. It underscored that members of 2 cultures do not necessarily have to share the same beliefs to have common goals.

BEAR POPULATION STUDY METHODS

We located bears using fixed wing aircraft (PA-18 Super Cub) and captured adults and subadults by darting them from a Hughes 500D helicopter using a powder fired Cap-Chur rifle (Palmer Chemical and Equipment Co., Inc.,

Douglasville, Georgia, USA). Bears were chemically immobilized using Telazol (Taylor et al. 1989). We marked each bear with individually numbered ear tags and lip tattoos. Selected bears were fitted with radio telemetry collars (Mod 600, Telonics, Inc., Mesa, Arizona, USA). In 1993, each subadult bear (age 3–5 yrs) was fitted with a radiotelemetry collar containing a canvas spacer (3 or 6 x 50 x 102 mm) designed to deteriorate in approximately 18 months. We weighed captured bears by suspending them below the helicopter in a cargo net attached to a dial scale.

We collected standard measurements (total length, heart girth, shoulder height, neck circumference, and skull length and width), hair and blood samples, and an upper first premolar from each captured bear. Body measurements were taken with a flexible tape and followed body contours. Matson's Laboratory (Milltown, Montana, USA) provided cementum-aging analysis (Matson et al. 1993).

We used fixed wing aircraft (PA-18 Super Cub, Cessna 185, Cessna 206, or Maule M-7) to radiotrack instrumented bears twice monthly during April–October, and monthly during November–March. We used the Global Positioning System to delineate bear locations and standardized forms to record data on habitat, elevation, bear activities and their associations with other bears. We transferred location data to maps with Atlas GIS software (Version 3.0, ESRI, Redlands, California, USA), and generated minimum convex polygons (MCP) to investigate home range sizes of bears with at least 15 relocations. Although the MCP method has been critiqued by numerous authors and other home range methods are available (Worton 1987, Larkin and Halkin 1994), we used it because it was most readily comparable to other brown bear studies in Alaska (Reynolds and Hechtel 1986; Miller 1987, 1993; Smith and Van Daele 1991; Reynolds and Boudreau 1992; Ballard et al. 1993).

We noted our observations of bear movements, behavior, and food habits during capture operations and tracking flights. We used methods described by Craighead et al. (1995) to project reproductive intervals for radiocollared females and estimate the mean time between weaning successful litters (reproductive interval). These methods included extrapolating reproductive histories for known-aged litters born before families were captured. Age of first reproduction was calculated using cementum aging (to determine age) and direct observation of maternal females that were captured and marked. Extrapolation of reproductive histories for known-age litters was also used in this calculation.

Our original study design entailed capture–mark–resight (CMR) methods (Miller et al. 1987, Miller et al. 1997) to estimate bear density in 1995 and 1997. A CMR was

never conducted due to political constraints, and thus a minimum density estimate was determined from capture data.

Our null hypothesis was that the brown bear population was adequate to sustain increased harvest that could result from liberalized hunting seasons. We used reproductive parameters and density estimates to calculate the harvestable surplus of bears in the study area. We recognize that many of the data used in these calculations are preliminary, but the exercise allowed us to make a conjecture about the impacts of human harvest on the population. As more refined data become available, they can be used to improve this estimate.

RESEARCH RESULTS

Capture

We captured and marked 60 bears (21 males, 39 females) (Table 2). Telemetry collars were attached to 4 males and 22 females in 1993. Males shed their collars 2–83 days after being marked. One female shed a collar after carrying it for 53 days in 1993. Due to the difficulty in keeping telemetry collars on males, only females were collared in 1994 (8 new collars and 4 replacement collars). We were limited to replacing existing collars in 1997 ($n = 25$). Ages of captured bears ranged from 0.5 to 29.5 yrs. Weights of adult males averaged 236 kg ($n = 3$), and adult females averaged 133 kg ($n = 23$). These were the first morphometric data collected from brown bears in this portion of Alaska.

Radiotelemetry

From June 1993 through December 1997, we collected 1,760 locations for 34 radiocollared bears and saw non-collared bears 719 times. We recorded an average of 3.5 relocations for 4 adult males (range = 2–5). Conversely, females had a median of 63.5 relocations/bear ($n = 30$, $\bar{x} = 57.4$, range = 19–77).

Reproductive Parameters

The mean age at which females first produced cubs (age of first reproduction) was 6.3 yrs ($n = 6$; Table 3). The

oldest female we observed accompanied by cubs was 29.5 yrs old; and 17% of the females >20 yrs old ($n = 5/29$) were accompanied by cubs. The mean time between weaning successful litters (reproductive interval) was 4.5 yrs ($n = 34$). The mean number of cubs of the year (COY) emerging from dens (litter size) was 1.9 ($n = 33$ litters), and the mean number of cubs weaned (cub production) was 1.8 ($n = 8$ litters). Twenty-six percent of cubs survived from COY to 2 or 3 yrs of age (weaning success; $n = 14$). The mean age of weaning was 3.0 yrs (2.5 yrs = 50%; 3.5 yrs = 50%; $n = 10$).

Home Range and Habitat

The mean home range for adult females in the study area was 398.1 km² (SD = 237.8, $n = 29$, range = 102–1,013). This average does not include the home range of a female born in 1985 whose home range was more than twice the size (2,334 km²) of the second largest home range. That individual was often seen running, and exhibited behaviors unlike those seen from other bears in the area. If we include her data in the analysis, the mean home range for radiocollared females was 462.6 km². Our data for the adult females that were followed consistently throughout the study did not indicate significant correlation between the number of locations and the size of the home range calculated ($r = 0.044$, $n = 30$) or between the age of bear and the size of home range ($r = 0.004$, $n = 30$).

We located 87 dens for 30 bears. Mean den elevation was 632 m ($n = 87$, range = 336–1,220). Most dens were in steep, rocky areas (71%), while 13% were in tundra habitats. Most individual bears used the same denning area in consecutive years. The mean maximum distance between dens used by an individual bear was 7.1 km ($n = 29$, range = 0.6–37.7). Den entrance began in early October and continued through November. Emergence began in late April, and all bears were out of their dens by the end of May. One bear changed dens in mid-winter (once in Dec 1996 and once in Jan 1998). The distance between relocated dens of this bear was 1.0 km and 15.7 km in 1996 and 1998, respectively.

Mating pairs were observed from mid-May through late June. Although other males were sometimes near the pairs, we saw little evidence of breeding groups as described on

Table 2. Sizes of adult (>5.5 yrs old) brown bears captured in the southwestern Kuskokwim Mountains, Alaska, 1993–97.

	Adult males			Adult females		
	mean (SD)	n^a	range	mean (SD)	n^a	range
Skull size ^b (cm)	61.7 (4.1)	13	55.5–70.2	55.2 (2.3)	41	49.2–59.9
Body Length ^c (cm)	206.0 (14.2)	10	177.2–223.0	180.6 (11.3)	40	151.0–202.0
Weight (kg)	235.9 (71.3)	3	158.8–299.4	133.0 (23.5)	23	99.8–200.0

^a Sample size

^b Live measurement of skull length plus skull width

^c Total body length (nose to tip of tail bone along midline)

Table 3. Selected population parameters for several Alaska brown bear populations.

	Age of first reproduction (yrs)	Reproductive interval (yrs)	Litter size (COYs)	Mean number cubs weaned	Mean weaning age (yrs)	Cubs weaned / year ^a	Adult female home range (km ²)	Density ^b / 1,000 km ² (range)
Kuskokwim Mountains ^c	6.33	4.53	1.94	1.75 cubs	3.00	0.39 cubs	398 ^d	unknown (18.2—unknown)
Northcentral Alaska Range ^e	6.30	4.20	2.14	2.00 cubs	2.78	0.48 cubs	233	10.3 (5.3—16.8)
Noatak River, Northwest Alaska ^f	6.30	5.00	2.54	1.89 cubs	2.89	0.38 cubs	993	13.9 (11.8—17.2)
Susitna River, Southcentral Alaska ^g	5.60	4.10	2.10	1.79 cubs	2.86	0.44 cubs	501	18.8 (15.2—24.3)
Terror Lake, Kodiak Island ^h	5.30	4.37	2.48	2.03 cubs	2.70	0.46 cubs	28	233.8 (191.6—304.2)

^a Calculated by dividing mean number of cubs weaned by the reproductive interval.

^b Density estimates for independent bears (Miller et al. 1997).

^c This study.

^d Excluding 1 individual with a home range of 2,334 km.

^e Reynolds and Hechtel 1986, Reynolds and Boudreau 1992.

^f Ballard et al. 1993.

^g Miller 1987, 1993.

^h Smith and Van Daele 1991.

Kodiak Island (Smith and Van Daele 1991). Most breeding activity took place at mid-elevations (300–600 m) where newly emergent vegetation (sedges, horsetails [*Equisetum* spp.], and oak ferns [*Gymnocarpium dryopteris*]), calving caribou, and parka squirrels provided the first abundant food since den emergence. During that time, most females with COYs retreated into remote, rugged areas. Even those denning at lower elevations (<600 m) moved to rugged areas, presumably trading feeding opportunities for protection from adult males.

By early July, most collared bears moved to mid and lower elevations (150–600 m) where they were observed eating emergent herbaceous vegetation, squirrels, ptarmigan, and caribou. Bears rested in alder and willow thickets when the extended daylight hours resulted in higher ambient temperatures. This pattern persisted until late July when spawning chinook salmon arrived in the study area and some bears moved to rivers and spawning streams. There were no concentrated feeding areas in the study area where large numbers of bears congregated; rather, they were spread along riparian areas. This distribution pattern persisted through August.

On 14–17 July 1997, a wildfire burned approximately 95 km² of willow and wet tundra near the center of the study area. The fire was slow moving with flames <1 m high and copious amounts of smoke. Some fires appeared to be subterranean. In spite of flames and smoke, bears tracked during the fire did not appear to be adversely affected. Bears ≤1 km from the active fire zones were seen resting or walking in usual areas, and after rains extinguished the fires, bears traversed burned areas regularly.

By early September hard frosts had yellowed most her-

baceous vegetation and many shrubs and trees had lost their leaves. Bears began to devote most of their waking hours to feeding on various species of berries. As the month progressed, observations during tracking flights suggested that the bears expanded their foraging activities to include all available food sources. Denning activity (movement to denning areas and digging) commenced by late September, and most were in their dens by late October.

Density

We were not able to accurately estimate bear density because of the limitations imposed by legal actions. Using only the marked adult bears, we know that there was a minimum population of 52 independent bears (21 males, 31 females) within the 2,850 km² study area, suggesting a minimum density of 18.2 bears/1,000 km². Based on these data and on observations of unmarked bears, we suspect actual density was nearly twice that size, and thus contained 50–60 adult females.

Mortality of Marked Bears

Seven marked bears were known to have died during this study. Two (1 male, 1 female) died because of capture operations; 1 drowned after being immobilized and the other never recovered from immobilization. Sport hunters harvested 4 marked bears (1 male, 3 females). All 3 females were radiocollared; 2 were harvested in the spring of 1995 and 1 in the spring of 1997. The marked male was not collared and was shot in fall 1993. One 29.5-yr-old female apparently died of natural causes in fall 1997. Because of the small sample size, we opted to

forego calculating mortality rates for this population until more data are collected.

Harvest

The general (sport) hunting seasons for brown bears in the study area occurred during 10–25 May and 10 September–10 October (Table 1). Nonresident hunters were required to employ a registered guide. ADF&G records indicate the mean annual sport harvest of brown bears within the study area between 1987–97 was 1.8 bears, of which 45% were males. Between 1987–94, the mean annual harvest was 0.9 bears/yr; the harvest rate increased to 4.0 bears/yr between 1995–97. Because 79% of this harvest was by nonresident hunters, the number and type of bears taken were greatly influenced by guide activity.

From the inception of the liberalized regulations in fall 1992 until 1997, 205 subsistence bear hunting permits were issued (\bar{x} = 34.2/yr) for the WABBMA. Three bears were reportedly harvested from the WABBMA, including 1 from our study area (ADF&G files, Dillingham, Alaska, USA). Harvest data collected by the Association of Village Council Presidents suggest a higher harvest rate (Andrew and Brelsford 1993; Hensel 1994, 1995), but bear hunting still appeared to be uncommon within the study area.

No bears were reported as killed in defense of life or property within the study area during this study. We suspect that few, if any, nuisance bears were killed and not reported within the study area because of the lack of permanent human habitation and the frequent river patrols during the summer by agency personnel.

Harvestable Surplus

Reproductive data suggest that female bears in the Kuskokwim Mountains have a potential maximum reproductive life of about 20 yrs. With a reproductive interval of 4.5 yrs, each female could produce up to 4 successful litters/lifetime. The mean number of cubs weaned was 1.8/litter, yielding 7.2 cubs successfully weaned/female. Assuming the sex ratio of weaned cubs was 50:50, there would be 3.6 female cubs produced/lifetime. Assuming cub survivorship from weaning to adulthood was 60% (extrapolating from Wiegus et al. 1994) on average, each adult female in the study area could produce about 2 reproductively active females and 2 adult males during her life.

In her reproductive life, each female must produce at least 1 reproductively active female to replace herself. Consequently, the other female and the 2 males produced can be considered “surplus” (assuming there are enough males to ensure successful matings). This would suggest an annual harvestable surplus of 0.15 adult bears/yr/adult female (3 bears/20 years) with a sex ratio of the harvest

being 67% males and 33% females (2 surplus males and 1 surplus female). Therefore, if the population included 50 adult females, with little natural mortality (annual survival rate = 0.96; Wiegus et al. 1994) between ages 6 and 26, it would yield a maximum sustainable harvest of 7 adult bears/year (5 males, 2 females). It is important to emphasize; however, that these calculations represent a theoretical maximum. Calculations using the average reproductive life span of a bear population with an annual adult survival rate of 0.96 (13.5 yrs) would yield 3 litters per lifetime and a harvestable surplus of 2.3 males and 1.5 females per year.

DISCUSSION

Cultural Aspects

We learned many valuable lessons during our 8 years (1991–98) of involvement with this project. While these lessons are not new, they are seldom taught in university classrooms and should be emphasized to all wildlife biologists. Cultural and political factors beyond our control drove issues in constantly changing directions. We were forced to respond to those factors while maintaining professional integrity and pursuing the course of action we felt was best for the resource. Our most important lessons were: (1) prior to starting a project, be cognizant of the cultural and sociological ramifications of the research; (2) work closely with all affected parties throughout the project; (3) seek and build on common ground; and, (4) never compromise the welfare of the resource for political gain.

The success of our project was initially compromised because we were not fully aware of the significance of brown bears to our Yup'ik neighbors. The Yup'ik culture is changing rapidly and there can be vast and often contradictory differences in beliefs between regions, villages, and age groups. Because of these differences, it was especially difficult for managers to measure the impacts of their actions on the region. In the case of this project, the vehement opposition to bear collaring was not expected. Similar projects on other species had been supported in the past, as had bear projects in nearby areas. The best way to approach these concerns would have been to spend more time exploring culturally sensitive means of collecting the necessary biological information and blending the best parts of traditional knowledge and western science. The conundrum, however, was that the regulatory boards liberalized subsistence hunting regulations first, and research funding materialized after the fact, thereby negating opportunities for adequate preparation.

Project accomplishments were primarily a result of cooperation and communication between agency field staff.

At a time when state and federal governments were engaged in a struggle over management authority of Alaska's fish and wildlife resources, it was up to the field staff of all agencies to rise above these disputes and focus on protection of the resources. By adopting a team approach, we were able to accomplish our biological goals while maintaining a unified front. This level of cooperation did not initially extend to individuals opposed to the project. A degree of frustration and distrust, with the agencies on one side and some Native groups on the other, hampered constructive dialogue and fostered legal action. Fortunately, we were able to enlist villagers as partners in the field and in meeting rooms. Many of the controversies would never have materialized if we had enjoyed this cooperation earlier in the project.

The common ground we shared was a concern for the welfare of the bears and their habitat. However, our methods of reaching that objective were different. Yup'ik perceptions were that it was best to leave the bears alone and allow Native hunters to harvest what they needed. Agency biologists, however, feared that liberalized harvests, coupled with increasing recreational use of the area, jeopardized the resource. Similar impacts had adversely affected bears throughout North America, and we believed the best approach was to improve our knowledge of the bear population. Only by constantly reminding ourselves of our common ground were we able to overcome our differences.

Dedication to the welfare of the resource is our professional duty. This charge takes precedence over all political, personal, or cultural concerns. This is not to say, however, that biologists should charge ahead on crusades regardless of outside factors. The most effective way to protect a resource is to work with the human elements that can affect it and create a team effort to reach an achievable goal (Kessler 1995). During this project, we were forced to react to what appeared to be an immediate threat to a vulnerable bear population. It may have reduced controversy to delay the project and go through a more complete public involvement process, but we were obligated to expedite the process so we could evaluate the impacts of the new regulations on the bears. Our experience reinforces the need to inform regulatory boards and commissions about the ramifications of promulgating regulations with inadequate information. When such decisions are made, the result is often expensive, frustrating, polarizing, and potentially damaging to the resource.

Biological Aspects

Movements, behavior, and food habits data obtained during this project provided us with baseline information on a portion of the brown bear's range that was previously uninvestigated. The study area was beyond the tree

line and typical of much of western Alaska. There was a short growing season and limited resources, yet there were significant runs of various salmon species. Bears within the area exhibited characteristics (color, size, and behavior) that suggested the population was a mixing area for coastal brown bears and interior grizzly bears.

Our results suggest that current harvest rates may adversely affect the bear population in the study area. Capture information suggests the bear population occupying the southwest portion of the Kuskokwim Mountains is at least as dense as other bear populations in interior and northwestern Alaska (Miller et al. 1997; Table 3). Female home ranges are much larger than those noted on Kodiak Island, but are comparable to other interior Alaska brown bear populations, suggesting habitat similarities (Table 3). Productivity is relatively low (Table 3). Reproductive data and estimates of density suggest a sustainable harvest rate of about 4–7 adult bears/yr, assuming a population of 50 adult female bears. Historic harvest rates have been below these threshold levels, but current rates are approaching it. Although the population has not been threatened by hunting, any increase in harvest levels, including non-sport kills, may jeopardize the future prospects of this population, and all harvest should be closely monitored.

We documented no increase in harvest that could be attributed to liberalized subsistence regulations. The Yup'iks' desire for a liberalized season apparently stemmed more from their need for self-determination and reassertion of traditional hunting patterns than it did with harvesting more bears. Similar motives have been noted for Native Americans in Washington State (McCorquodale 1997) and Arizona (Czech 1995). In each case, the level of harvest attributed to Natives was only a fraction of that taken by other hunters, in spite of more liberal hunting seasons.

Continuation of this project should provide information necessary to better manage the bears in southwest Alaska. We have integrated all affected parties into our planning and research efforts, and there is a commitment on all sides to work together. Hopefully, we will be able to develop culturally sensitive methods of collecting bear population data. These data will be important in the near future as bears in this remote corner of Alaska face increasing human pressures.

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