

BROWN BEAR-HUMAN INTERACTIONS ASSOCIATED WITH DEER HUNTING ON KODIAK ISLAND

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Abstract: I compared distribution and range of brown bears (*Ursus arctos middendorffi*) with temporal and spatial distribution of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) hunting activity on westside Kodiak Island, Alaska, to examine impacts of deer hunting on bears. Mean number of bears that annually ranged ≤ 5 km from the coast, > 5 km inland from the coast, or in both areas was 10, 8, and 11, respectively. Bears that exclusively or seasonally occupied the coast zone were usually classed as having moderate or high potential to interact with hunters because most hunter access and effort ($> 95\%$) was via the coast. Bears that ranged exclusively inland were considered unlikely to encounter hunters. Animals that ranged in both zones often (39%) moved inland during fall (Oct-Dec) and most bears (70%) denned in the inland zone. Females that denned near the coast entered dens later ($\bar{x} = 22$ Nov) than females that denned inland ($\bar{x} = 12$ Nov). Two radio-collared bears were known to raid deer-hunting camps and 9 other marked bears were observed by hunters or were located < 200 m from hunting camps. Deer-hunter surveys revealed that more than two-thirds of the deer harvest occurred during October-November. About half of the hunters observed at least 1 bear during their hunt. Seven to 21% of the respondents reported having a threatening encounter with a bear and 5-26% reported losing deer meat to bears. Human-induced mortality to radio-collared bears occurred more often near the coast (5) than inland (3); 7 bears were harvested by sport hunters and 1 was killed (nonsport) in a Native village. Deer hunters killed 2 unmarked females in defense of life or property situations in the study area. High bear densities and concentrated deer-hunting activity combine to make conflicts unavoidable. Adverse impacts to bears can be minimized by maintaining low levels of human activity in inland areas and improving hunter awareness of bear ecology and behavior.

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Management of wildlands to simultaneously preserve wildlife and provide recreational opportunity can result in conflicting goals (Cole and Knight 1991, Knight and Cole 1991). This problem is especially applicable to brown bears because they require large areas of wildland with limited human disturbance (Mattson 1990, Schoen 1990). Loss of habitat and human disturbance usually leads to population declines.

Brown bears on Kodiak Island, Alaska, occur at high densities (Barnes et al. 1988), and the population appears healthy primarily because food is abundant (Barnes 1990, Smith and Van Daele 1990), sport harvest is intensively managed, and there are large tracts of remote and inaccessible habitat. About two-thirds of the island is within the Kodiak National Wildlife Refuge (NWR), which has a primary goal of conserving brown bears and their habitat. The Kodiak NWR also accommodates seasonally high concentrations of people engaged in hunting, fishing, or other recreational activities. Levels of human activity have risen sharply in recent years and that trend is expected to continue into the foreseeable future (U.S. Fish and Wildlife Service 1987). The task of maintaining a healthy bear population and satisfying increased demand for recreation will ultimately result in conflicting goals on specific areas of the refuge. The development of guidelines to effectively minimize conflicts will require an improved understanding of bear-human interactions associated with specific recreational activities.

Sitka black-tailed deer were introduced to the Kodiak Archipelago in 1924 and had become common to abundant in most areas by the late 1970s (Smith 1979).

A dramatic escalation in deer-hunter effort paralleled rapid growth and expansion of the deer population (Burris and McKnight 1973, Smith 1979, Smith et al. 1989). Conflicts between bears and hunters became inevitable as increasing numbers of hunters encroached on occupied bear habitat and because the activity created new sources of food (gut piles, meat caches, garbage) attractive to bears. By the mid-1980s deer hunters had become the leading cause of defense of life or property (DLP) kills and were primarily responsible for an overall increasing trend in DLP mortality (Smith et al. 1989). It is reasonable to suspect that an increase in unreported nonsport kills of bear by deer hunters has also occurred (Miller and Chihuly 1987). Risk to hunters also became an issue (Medred 1987); 6 nonfatal maulings of deer hunters were documented during 1981-88. Resource managers recognized that misinformation concerning danger to hunters could increase the incidence of nonsport kills (Smith et al. 1989).

This study was undertaken in response to a growing concern for potential adverse impacts of deer-hunting activity on brown bears. Principal objectives were to (1) assess effects of deer-hunting activity on range and movement patterns of brown bears and (2) evaluate real or potential interactions between deer hunters and bears.

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STUDY AREA

The study area encompassed about 1,400 km² on the west side of Kodiak Island, Alaska, and included Amook Island and the Browns Lagoon River, Zachar River, Spiridon River, and Little River drainages (Fig. 1). Approximately 94% of land was in the Kodiak NWR; the remainder was private land located primarily along the coast. Climate of the region is maritime and characterized year-round by overcast skies, cool temperatures, moderate to heavy precipitation, fog, and wind. Annual precipitation at Kodiak city, about 70 km east of the study area, averages 157 cm; summer temperatures range from 13–18°C and winter temperatures seldom fall below -6°C.

Topography of the study area varied from flat along river bottoms and on coastal benches to steep, mountainous terrain that rose to over 1,300 m elevation. The coastline was irregular and included rugged headlands, rock outcroppings, gravel and boulder-strewn beaches, and intertidal flats at the heads of bays.

Vegetation in lowland areas included halophytic associations, cottonwood (*Populus balsamifera*)—and willow (*Salix* spp.)—dominated communities along stream bottoms, and shrub/forb/grass communities elsewhere. Midslope vegetation was characterized by dense to broken shrub thickets interspersed with meadows (Smith and Van Daele 1990). Representative species in lowland and midslope habitat included alder (*Alnus crispa*), red elderberry (*Sambucus racemosa*), salmonberry (*Rubus spectabilis*), bluejoint grass (*Calamagrostis canadensis*), ferns (Polypodiaceae), fireweed (*Epilobium angustifolium*), and heath (Ericaceae). Alpine vegetative communities were composed of various mixtures of low willow, sedge (*Carex* spp.), grasses, forbs, and heath (Atwell et

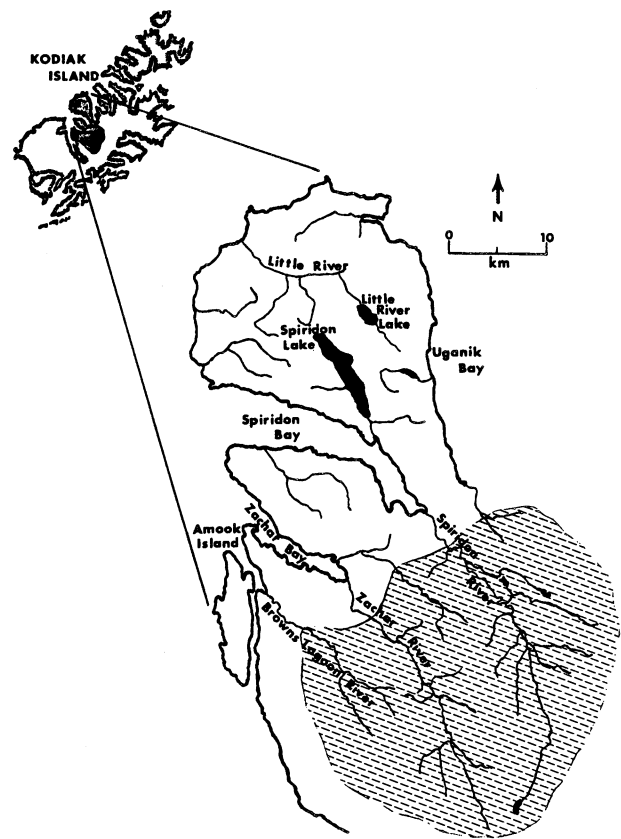


Fig. 1. Inland (cross-hatch) and coast zones of the brown bear-deer hunter interaction study area, Kodiak Island, Alaska.

al. 1980).

Sitka black-tailed deer were abundant throughout the study area. Deer-hunting season for most of Kodiak Island, including the study area, extended from 1 August to 7 January (1987-90). Bag limit was 5 deer for the 1987-88 through 1990-91 seasons.

Brown bear density was estimated at about 1 bear/3 km² throughout most of the area and 1 bear/6 km² on that portion north and west of Spiridon Lake (Barnes et al. 1988). The fall sport harvest season (permit hunt) for brown bear extended from 25 October to 30 November.

Spawning chum (*Oncorhynchus keta*), pink (*O. gorbuscha*), and coho (*O. kisutch*) salmon were seasonally abundant in the area, with the strongest runs occurring in Browns Lagoon, Zachar, and Spiridon Rivers. Additionally, sockeye salmon (*O. nerka*) were plentiful during summer in the Little River drainage.

METHODS

Brown Bear Activity

The study area was partitioned into 2 zones to test the null hypothesis that all bears were equally affected by deer-hunting activity. Hunter access to the study area was almost exclusively by marine vessel or floatplane. Thus, I identified the coast zone as the area of primary hunting activity and defined it as the area ≤ 5 km straight-line distance from the coast. This zone also included an area that was > 5 km from the coast but readily accessed via Spiridon and Little River lakes (Fig. 1). Limited floatplane access was provided by 3 small (< 20 ha) lakes in the inland zone. The 5 km distance used to separate zones was a subjective estimate of the maximum distance most deer hunters would hike from the coast while hunting. Also, home range of adult females ($\bar{x} = 28$ km²) on a nearby study area of similar habitat (Smith and Van Daele 1990) suggested that a 5-km distance would isolate ranges of some animals in the inland zone if they were not drawn to hunting activity. The coast and inland zones comprised approximately 60% and 40% of the study area, respectively.

Brown bear movements, range, and activities were examined with a sample of radio-collared animals. Bears were captured using helicopter darting procedures during late June and early July, 1988-90. Capture efforts were guided by the objectives to (1) mark equal numbers of bears in the coast and inland zones, and (2) distribute marks among the sex-age classes in the population. Marked bears were radiotracked from fixed-wing aircraft at 7-10 day intervals, weather permitting, from April through December and usually 2-3 times while they were in winter dens. Usually $> 90\%$ of the available sample of marked bears was relocated during each tracking flight. Analysis of distribution and range was limited to bears that were relocated ≥ 10 times from July into October. Mean annual frequency of relocations of bears ranged from 13 ± 1 SD in 1988 to 25 ± 3 SD in 1991; sample size ranged from 20 (1991) to 33 (1989).

Movement and range data were analyzed using the ARC/INFO geographic information system and program HOME RANGE (Samuel et al. 1985). Annual range was determined from relocations recorded between 1 June and 31 May, 1988-89 through 1990-91; summer and fall seasonal ranges during 1988-1991 were defined as July-September and October-December, respectively. Estimated date of entrance into a winter den was the mid-point between the last date a bear was located outside its den and the first date the animal was known

to be in its den (Van Daele et al. 1990).

The potential for interaction between deer hunters and brown bears was evaluated by relating bear relocations to the distribution of hunter effort. Bears that were relocated < 6 times during deer season were censored from this evaluation. A majority of the bears were relocated 7-9 times during that period. Each year individual bears were assigned to 1 of 4 interaction categories based on the following criteria:

High = relocated > 3 times in a coast zone area that received moderate to heavy hunting effort.

Moderate = relocated > 3 times in a coast zone area that received light hunting effort.

Low = relocated 1-3 times in the coast zone.

Negligible = no relocations in the coast zone.

For this evaluation I considered interactions to include a broad array of association between bears and people, ranging from direct conflict to avoidance by either bears or people.

Hunter Effort

Distribution of hunter effort throughout the study area was determined from a combination of aerial observations and use estimates for private and public facilities. During tracking flights for radio-collared bears, observations of camps, hunters, marine vessels, skiffs, rafts, and beached aircraft were plotted on 1:63,360-scale topographic maps. These data were recorded during September-December when most deer hunting occurred, but were not recorded in August to avoid bias from commercial fishing activity. Although a majority of the observations probably were correctly identified as deer hunting, other forms of activity, and especially bear hunting, were undoubtedly recorded.

Deer-hunting activity conducted out of cabin-lodge facilities was estimated from reservation lists (public cabins) or information provided by owner-operators of private facilities. Two cabins managed by the Kodiak NWR were utilized by the public through a lottery system. Other deer-hunting effort based out of cabins or lodges originated primarily from 4 commercial hunting facilities and 3 private cabins.

Hunter-effort data were summarized as hunt units. For observations recorded during radio-tracking flights, the sighting of a hunter, skiff, raft, or plane within 1 km of a tent camp, building, or marine vessel was considered a part of the base camp and was not recorded as a separate unit. Hunt-unit data were used as an index of relative hunter effort in different portions of the study area rather than as a measure of actual hunter use.

Hunter Surveys

Data on deer-hunter characteristics, observations, interactions with bears, and attitudes toward bears were obtained from 2 types of survey. The first source, a mail questionnaire conducted by the ADF&G, was a comprehensive survey of deer hunting in Game Management Unit 8 (Kodiak Archipelago). Questionnaires were mailed to a random sample constituting about 61% of the people who obtained deer-harvest tickets for the 1987-88 hunting season (Smith and Becker 1988). I examined those questionnaires returned by people who hunted in the study area and recorded data on deer harvest and hunting effort, mode of transportation, type of lodging, use of commercial services, and interactions with brown bears.

The second source of information was a survey form distributed to hunters by the Kodiak NWR during the 1988-89 through 1990-91 hunting seasons. Survey forms, including mail-return envelopes, were made available to deer hunters at aircraft-charter offices, on vessels of commercial marine transporters, through commercial outfitter-guides, and at the Kodiak NWR and ADF&G offices in Kodiak. These forms queried hunters regarding deer harvest and hunter effort, transport and lodging, commercial services, residency, bear observations, conflicts with bears, measures used to avoid bear problems, and concern about hunting in bear-occupied habitat.

Statistical analyses were performed with program SOLO (BMDP Statistical Software, Inc.). I used Mann-Whitney and Kruskal-Wallis tests to compare annual and seasonal ranges. Hunter-effort, deer-harvest, and den-entrance data were examined with analysis of variance and *t*-tests. Chi-square contingency and 2 sample proportional tests were used to analyze frequency distributions. Significance level was $P \leq 0.05$.

RESULTS

Brown Bear Distribution and Range

Forty-two brown bears were radiocollared, including 30 in 1988, 10 in 1989, and 2 in 1990. Twenty-two (52%) and 20 (48%) were marked in the coast and inland zones, respectively. Composition of the sample by zone and age at time of capture was adult (≥ 5 yr) female (15 coast, 15 inland), adult male (3 coast, 2 inland), and subadult (< 5 yr; 4 coast, 3 inland). Six of 7 subadults were males. Compared to the estimated population structure (Barnes et al. 1988), adult females

were over-represented and subadults were under-represented in the sample. Additional bias toward adult females was caused by disproportionate loss of males from the sample by mortality and shed collars.

Division of capture effort into areas \leq and > 5 km from the coastline resulted in the marking of animals that ranged exclusively in coast or inland zones (Table 1). The average number of radio-collared bears that annually ranged in the coast zone declined from 12.5 (41%) during 1988-89 to 7.0 (27%) for 1990-91. Conversely, mean number of bears with ranges in the inland zone increased from 6.5 (21%) in 1988-89 to 9.0 (35%) in 1990-91. The change in proportion of animals in respective zones was caused primarily by greater mortality to bears captured in the coast zone.

The proportion of radio-collared bears that ranged in both areas was similar (36-39%) among years. There was a tendency for bears that ranged in both zones to occupy the inland zone during fall (Oct-Dec). That shift in distribution occurred in 16 (39%) of 41 bear years compared to 5 (12%) cases where bears ranged only in the coast zone. The proportion of bears that

Table 1. Annual distribution of radio-collared brown bears that ranged in the coast zone, inland zone, or both zones on westside Kodiak Island, Alaska.

	1988	1989	1990	1991
Adult female				
Coast ^a	8	11	6	5
Inland ^a	5	7	11	6
Both	7	8	8	8
Adult male				
Coast	1	1	0	1
Inland	1	0	0	0
Both	1	3	4	0
Subadult ^b				
Coast	3	1	2	0
Inland	0	0	0	0
Both	2	2	0	0
All bears				
Coast	12	13	8	6
Inland	6	7	11	6
Both	10	13	12	8

^a Coast = ≤ 5 km from coastline, Inland = > 5 km from coastline.

^b Six males, 1 female (1988-89).

ranged in the coast zone, inland zone, or both areas during fall was 38%, 43% and 19%, respectively.

Annual range of females in the coast zone ($n = 20$, $\bar{x} = 21 \text{ km}^2 \pm 16 \text{ SD}$) was similar ($z = 0.76$, $P = 0.93$) to that of females in the inland zone ($n = 22$, $\bar{x} = 24 \text{ km}^2 \pm 22 \text{ SD}$) and annual range of females within each zone did not differ among years (coast: $T = 0.85$, $P = 0.66$, inland: $T = 0.14$, $P = 0.93$). In contrast, annual range of females ($n = 21$) that ranged in both zones ($\bar{x} = 94 \text{ km}^2 \pm 79 \text{ SD}$) was 2-5 times larger than ranges of females that exclusively occupied either zone. This difference was not significant in 1988-89 ($T = 4.16$, $P = 0.13$) but was significant in 1989-90 ($T = 10.25$, $P = 0.01$) and 1990-91 ($T = 6.87$, $P = 0.03$).

Mean (\bar{x}) annual range of males ($n = 4$) that ranged in the coast zone was $203 \text{ km}^2 \pm 151 \text{ SD}$, compared to $108 \text{ km}^2 \pm 40 \text{ SD}$ for males ($n = 3$) that ranged in both areas. Range of 1 adult male that utilized the inland zone during 1988-89 was 89 km^2 . Sample sizes of radio-collared males were insufficient to analyze for range differences between age classes, zones, or years.

Summer ranges of females that occupied the coast zone ($\bar{x} = 12 \text{ km}^2 \pm 10 \text{ SD}$), inland zone ($\bar{x} = 11 \text{ km}^2 \pm 10 \text{ SD}$), or both zones ($\bar{x} = 54 \text{ km}^2 \pm 54 \text{ SD}$) were larger ($z = 3.92$ - 2.16 , $P < 0.001$ - 0.03) than corresponding fall ranges (coast: $\bar{x} = 5 \text{ km}^2 \pm 4 \text{ SD}$, inland: $\bar{x} = 4 \text{ km}^2 \pm 5 \text{ SD}$, both: $\bar{x} = 12 \text{ km}^2 \pm 32 \text{ SD}$). Similarly, summer range of males ($\bar{x} = 58 \text{ km}^2 \pm 49 \text{ SD}$) was larger ($z = 2.33$, $P = 0.02$) than fall range ($\bar{x} = 26 \text{ km}^2 \pm 29 \text{ SD}$).

Most winter denning occurred in the inland zone; 58 (71%) of 82 dens of females and 9 (64%) of 14 dens of males were in that zone. Two males did not enter dens and ranged in the coast zone during the 1988-89 winter. Females in the coast zone entered dens ($\bar{x} = 22 \text{ Nov} \pm 18 \text{ days SD}$) later ($t = 2.51$, $P = 0.02$) than females in the inland zone ($\bar{x} = 12 \text{ Nov} \pm 14 \text{ days SD}$). Den entrance dates for males in the coast ($\bar{x} = 26 \text{ Nov} \pm 10 \text{ days SD}$) and inland ($\bar{x} = 30 \text{ Nov} \pm 27 \text{ days SD}$) were similar ($t = 0.37$, $P = 0.71$).

Hunter Effort

Aerial observations of hunting activity resulted in tabulation of 51, 10, and 21 hunt units during 1988, 1989, and 1990, respectively. Tent camps (37), skiffs or rafts (24), and marine vessels (17) accounted for 95% of the observations. Three (4%) and 79 (96%) of the sightings were made in the inland and coast zones, respectively.

Number of hunt units observed per hour of flight time was 0.91 in 1988, 0.20 in 1989, and 0.44 in 1990. These data indicated reduced deer-hunting effort in

1989-90. Aerial observations (1988-90) indicated hunter effort was low in September (0.02 units/hr), increased in October (0.70 units/hr), reached a peak in November (1.04 units/hr), and declined in December (0.35 units/hr).

I attempted to conservatively estimate hunter effort originating from cabin-lodge facilities and did not adjust for a suspected decline in hunter effort in 1989 and 1990. The Chief Cove and Little River public-use cabins were assigned 8 and 6 hunt units each year based on average reservation rates of 48% and 35% for September-December. Three private lodges that specialized in deer hunting were each assigned 8 hunt units per year. Four other cabins that periodically accommodated deer hunters were each assigned 3 hunt units per year.

Total hunt units recorded for the coast and inland zones were 211 and 3, respectively. Distribution of hunt units on the coast zone was (1) Amook Island-Browns Lagoon, 42 (20%); (2) Zachar Bay (north and south coast), 69 (33%); (3) south and southeast coast of Spiridon Bay, 4 (2%); (4) northeast coast of Spiridon Bay and Spiridon Lake, 49 (23%); (5) outer (northwest) coast of Spiridon Peninsula, 1 (<1%); (6) north half of Uganik Bay, 32 (15%); and (7) south half of Uganik Bay, 14 (7%). Areas 1, 2, 4 and 6 were classed as receiving high hunter effort, area 7 was classed as receiving moderate hunting effort, and areas 3 and 5 were classed as receiving light hunting effort.

Bear-Hunter Interaction

Each year 8-15 ($\bar{x} = 12$; 44%) radio-collared bears were classed as having high potential for interacting with deer hunters and 7-10 ($\bar{x} = 8$; 30%) were considered to have had little or no association with hunters (Table 2). With 3 exceptions, animals classed as having negligible interaction potential were those that ranged exclusively in the inland zone. Bears that exclusively occupied the coast zone ($n = 38$ bear years) were more often (87%) classed in the high interaction category ($z = -5.16$, $P < 0.001$) than were bears that ranged in both zones (29%). Conversely, bears that ranged in both zones ($n = 41$ bear years) were often (44%) assigned low interaction potential as opposed to no cases for bears in the coast zone ($z = -4.65$, $P < 0.001$). The 2 bear groups had similar ($z = -0.76$, $P = 0.45$) frequencies (13% and 20%) of moderate classification.

Direct observation or strong evidence of interaction between deer hunters and bears in the coast zone was documented for 11 radio-collared bears. The animals were relocated ≥ 1 time < 200 m from a deer-hunting

Table 2. Annual distribution of radio-collared brown bears among categories of potential interaction with deer hunters, Kodiak Island, Alaska.

Interaction potential ^a	1988	1989	1990	1991
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Female				
High	12	9	12	7
Moderate	1	4	1	2
Low	2	7	1	3
Negligible	5	7	10	7
Male				
High	3	2	1	1
Moderate	1	0	3	0
Low	1	3	1	0
Negligible	2	1	0	0
All Bears				
High	15 (56)	11 (33)	13 (45)	8 (40)
Moderate	2 (7)	4 (12)	4 (14)	2 (10)
Low	3 (11)	10 (30)	2 (7)	3 (15)
Negligible	7 (26)	8 (24)	10 (34)	7 (35)

^a High = relocated >3 times in area with moderate to heavy hunt effort; Moderate = relocated >3 times in area with low hunt effort; Low = relocated 1-3 times within 5 km of coastline; Negligible = no relocations within 5 km of coastline.

camp and/or were observed by hunters. Adult females were involved in 4 reports of hunters sighting a radio-collared bear while in the field; 2 hunters observed bears (>100 m) that were unaware of their presence and 2 other hunters reported surprise encounters at <30 m in which the bears fled.

Two radio-collared bears became conditioned to foods associated with hunting and were considered problem animals. In 1988 a female with 2 yearling cubs was observed feeding at deer-kill sites and visiting camp facilities in Zachar Bay. On about 2 November she was observed by hunters fighting with a large, single bear at a deer-kill site and was found dead on 7 November. A necropsy revealed wounds inflicted by another bear, incurred during a fall, or a combination or those factors. Gunshot was eliminated as a causal factor.

Another female with 3 yearling cubs was located twice during October 1989 in a popular deer-hunting area in Zachar Bay and on 4 December was backtracked in snow to a deer-hunting shack at Browns

Lagoon. This latter observation coincided with hunter reports of night-time raids at the shack by a family group. One hunting party reported losing approximately 12 deer to the bears. In September 1990, this female (single) traveled to Karluk Village and began visiting the village landfill and raiding fish smokehouses. In early October she was shot as a DLP kill while raiding a smokehouse.

Brown Bear Mortality

Fate of radio-collared bears was determined for 33 (79%) of 42 animals; 8 of the remaining bears (3 F, 5 M) shed collars and the signal of 1 female was lost for unknown reasons. Eight (30%) of 27 females died during the study, including 2 taken by sport hunters, 5 that died of natural causes, and 1 that was a DLP kill in a Native village. Five of 6 males were taken by sport hunters. Among sport-killed animals, the 2 females represented 9% of the total sport harvest of females in the study area (fall 1988-fall 1991) and the 5 males represented 14% of the male harvest.

Eight (62%) and 5 (38%) mortalities were attributed to human and natural causes, respectively. Among human-caused mortalities, 4 (2 M, 2 F) were animals that ranged exclusively in the coast zone. Four other human-caused mortalities were animals that ranged in both zones; 3 were males taken by sport hunters in the inland zone and 1 was a female taken by a sport hunter along the coast.

Deer hunters were responsible for 2 reported DLP mortalities to unmarked females in the study area. Both females were killed in November 1991, and each had cubs.

Deer-Hunter Surveys

Data on deer hunter and hunting activity characteristics were obtained from 135 responses to the ADF&G survey (1987-88) and 190 responses to the Kodiak NWR survey (Tables 3 and 4). A higher response rate to the Kodiak NWR survey for the 1988-89 season (96) compared to the 1989-90 (52) and 1990-91 (42) seasons may reflect, in part, less hunter effort in the study area in the latter 2 seasons.

Responses to the Kodiak NWR survey disclosed that 85% (161 of 190) of the hunters were residents of Alaska. Sixty percent (58 of 96) of the respondents hunted in the Amook Island-Browns Lagoon-Zachar Bay area, 30% (29) hunted in the Spiridon Bay area, and 9% (9) hunted in the Uganik Bay portion of the study area. This distribution of hunter effort was similar to that revealed by aerial observations and estimates of cabin-lodge uses (Amook Island-Zachar

Table 3. Responses to deer hunter surveys, Kodiak Island, Alaska: characteristics of hunters and their hunts.

	Hunting seasons			
	1987-88 ^a		1988-90 ^b	
	<i>n</i>	%	<i>n</i>	%
No. respondents ^c	135		190	
Month hunted				
August	4	4	0	0
September	4	4	7	3
October	20	18	57	27
November	62	57	128	60
December	18	17	20	9
January	1	1	2	1
Lodging used				
Marine Vessel	26	20	5	5
Private Cabin	38	29	40	42
Public Cabin	11	8	23	24
Tent	51	39	27	28
None	6	5	0	0
Observed ≥ 1 bear	58	45	100	53
Encountered bear in threatening situation	9	7	26	15
Lost deer carcass/meat to a bear	No data		25	14
Days hunted (\bar{x})	4.4 ± 2.8 SD		6.1 ± 2.9 SD	
Deer killed (\bar{x})	3.0 ± 1.7 SD		2.8 ± 1.6 SD	

^a Data from ADF&G questionnaire (Smith and Becker 1988).

^b Kodiak NWR hunter surveys, 3 seasons combined.

^c Response sample does not equal respondent sample for some categories due to no response or multiple responses (months, lodging), and lodging data not collected 1988-89.

Bay = 52%, Spiridon Bay = 25%, Uganik Bay = 22%). Ninety-nine (52%) of the respondents hunted within 1.6 km of the coast, 54 (28%) hunted up to 3.2 km from the coast, and 37 (19%) ventured >3.2 km from the coast.

Some questions were common to both hunter surveys and were comparatively examined (Table 3). Number of deer killed per hunter ($F = 0.31$, $P = 0.74$) and number of days hunted ($F = 1.92$, $P = 0.15$) did not differ among years in the Kodiak NWR survey and were pooled. Mean kill per hunter in 1987-88 (3.0) was similar ($t = 1.18$, $P = 0.24$) to that reported for 1988-89 through 1990-91 (2.8), but respondents reported hunting fewer days ($t = 5.23$, $P < 0.001$) in

Table 4. Responses of 190 hunters to deer hunter surveys, 1988-89 to 1990-91 seasons, Kodiak Island, Alaska: methods used to avoid bear problems and influence of bears in planning future hunts.

Responses ^a	<i>n</i>	%
Avoidance methods used		
None ^b	63	21
Avoid where bears/sign observed ^b	50	17
Hang and/or store meat away from camp	30	10
Avoid dense cover ^b	28	9
Store meat in a structure	27	9
Keep a clean camp	21	7
Stay alert while hunting	16	5
Remove deer from field quickly	14	5
Avoid areas of previous kills	12	4
Make noise in dense cover	12	4
Other responses combined	23	8
Influence of bears on hunt plans		
No concern ^b	91	43
Avoid areas of high bear numbers ^b	39	18
Hunt only with cabin or boat lodging ^b	37	18
Use common sense	11	5
Concerned but will still hunt	6	3
Hunt with partners	6	3
Use a larger gun	4	2
Hunt later in the season	2	1
Will not hunt on Kodiak Island ^b	0	0
Other responses combined	15	7

^a Responses exceed number of respondents within categories due to multiple responses.

^b Alternative responses listed on survey form; all other responses volunteered in other category.

the ADF&G survey (4.4) than in the Kodiak NWR survey (6.1). I believe this discrepancy might be due to a bias in the Kodiak NWR survey; hunters that traveled and lodged on private marine vessels or used private (noncommercial) aircraft probably were inadequately sampled in the Kodiak NWR survey (Table 3) and those individuals may tend to hunt fewer days than hunters using other forms of transport and lodging. Reported use of outfitter-guide services for deer hunting was low in both the ADF&G (10%, $n = 10$) and Kodiak NWR (17%, $n = 16$) surveys.

The 2 surveys indicated that roughly one-third of the

deer hunters used tents for lodging (Table 3). Differences between the surveys were higher use of marine vessels by respondents to the ADF&G survey and higher use of public cabins reported in the Kodiak NWR survey ($\chi^2 = 41.13$, $P < 0.001$). Data on means of transportation were not collected in the Kodiak NWR survey; commercial air charter and private marine vessel accounted for >80% of travel methods reported on the ADF&G survey.

Reported hunter effort for all years combined (Table 3) was low (<8%) in August and September, increased in October (16-33%), peaked in November (54-72%), declined in December (5-23%), and was minimal in January (<2%). Heavy hunter effort reported for October and November is consistent with observations reported during radio-tracking flights (this study) and with DLP kills of bear reported by deer hunters in past years (Smith et al. 1989).

Approximately half of the surveyed deer hunters reported seeing at least 1 bear during their hunt (Table 3) and that proportion did not vary among years ($\chi^2 = 3.06$, $P = 0.38$). The number of incidents in which hunters reported encountering a bear(s) in a situation they considered threatening varied from 8 (9%) during 1988-89 to 10 (21%) during 1989-90 ($\chi^2 = 11.38$, $P = 0.01$). Similarly, the number of hunters that reported losing deer or deer meat to bears varied from 2 (5%) in 1990-91 to 12 (26%) in 1989-90 ($\chi^2 = 8.20$, $P = 0.02$). Seasonal variation in reported incidents was probably due to small sample size. Fifteen (58%) of 26 threatening situations reported in the Kodiak NWR survey were encounters in the field at 10-50 m where the bear bluff charged, did not retreat, or was surprised. Smith et al. (1989) noted that DLP kills of brown bear by deer hunters occurred more often in the field (58%) than in the camp area (32%). Other threat situations reported in this study included bears in camp, knowledge that bears were in the area, and a bear chasing a wounded deer. Ten (40%) hunters reported they lost deer in or near camp, 9 (36%) lost deer that were left in the field overnight, and 6 (24%) lost deer in the field the same day they were shot.

DISCUSSION

Deer hunting on Kodiak Island is a recreational activity predisposed to interaction between brown bears and deer hunters. The activity occurs in areas of high bear density and hunters tend to concentrate at specific, weather-protected localities along the coast or near freshwater lakes. The compounding factors of high bear density and concentrated human activity enhance

the probability for conflict. About half of the hunters observe bears and it is certain that others are near bears that are not sighted. Fortunately, the data suggest that bears and hunters avoid each other in most situations.

Conflict between bears and deer hunters usually can be attributed directly or indirectly to the large amount of food created by hunters. Liberal bag limits result in localized concentrations of food in the form of carcass waste, wounded deer, unrecovered kills, and meat stored at or near camps. More than two-thirds of the harvest occurs during October-November when availability of salmon, berries, and other important bear food is declining (Smith and Becker 1988, Smith et al. 1989). Hunters often do not have access to buildings or boats for use as food caches and trees for hanging meat are usually scarce or absent. Inclement weather can delay air charter pick-up of hunters, which in turn leads to food spoilage and increased risk of bear problems. All of these factors compromise or oppose recommended procedures for avoiding bear problems in remote areas (Herrero 1985).

Concern for impact of deer-hunting activity on brown bears has focused on what proportion of the population is affected and to what degree. The idea that bears were attracted long distances to deer-hunting activity was popular among hunters and was suggested in the media; some individuals even postulated that bears had learned to associate gunfire with availability of food. This study provides evidence to reject the hypothesis that all bears are equally affected by deer hunting. Furthermore, the data suggest that bears in areas >3 km from good access points are unlikely to encounter deer hunters.

More than 40% of the bear population in the area of this study probably had little or no interaction with deer hunters. Bears that ranged >5 km from the coast clearly fell into that category. Few hunters (19%) reported traveling >3.2 km from the coast while hunting. Bears whose ranges overlapped the inland and coast zones had a greater chance of interacting with hunters but the likelihood of that occurring was often low because more than a third (39%) of those bears ranged inland during the October-November period when hunting effort was greatest. Additional movement of bears inland occurred as fall progressed and ultimately 70% of the bears denned in that area. My assessment of interaction potential probably was biased toward high and moderate classification because I did not compensate for movement of bears into inland areas in late summer and fall.

Although deer hunting creates relatively concentrated food sources attractive to brown bears on Kodiak, the

quantity and/or extent of concentration is insufficient to attract bears to the extent they are drawn to traditional sites of food abundance. In this study, movement of bears to streams with spawning salmon caused aggregations of 3-7 radio-collared bears and greater numbers of unmarked bears. The largest aggregations occurred on the Zachar and Spiridon Rivers during August and September and they occurred in both inland and coast zones. Radio-collared bears moved up to 25 km from inland areas to feed on salmon near the coast. Movement of bears to exploit salmon probably was an important factor contributing to larger ranges in summer than in fall (Barnes 1990). Discernable feeding concentrations of bears were also evident in alpine areas during July and August (Atwell et al. 1980 and Smith and Van Daele 1990). Similar movement or concentration of bears in response to localized areas of heavy deer-hunting activity was not evident.

Bears that spend most or all of the nondenning period near the coast are susceptible to moderate or high levels of interaction with deer hunters. A high incidence of interaction can be expected where the normal range of ≥ 1 bear overlaps an area of heavy deer harvest. Because high bear densities are common on Kodiak and adjacent islands, several bears may converge on locales of extensive hunter activity. This enhances the chance of surprise encounters, but, more important, it allows some animals to become conditioned to scavenging carcass waste or obtaining meat and garbage at camps. Over time, individual animals or their attendant offspring may develop feeding strategies oriented toward scavenging deer waste and preying on wounded and/or weak deer. This behavior could explain why bears near the coast tend to enter dens later than those farther inland. On southwest Kodiak Island, late-season availability of salmon is thought to be associated with late den entrance (Van Daele et al. 1990). Delayed denning near the coast, alternatively, could also be related to the warm microclimate that typically occurs near saltwater. Regardless, bears along the coast are most susceptible to encounters with deer hunters because of concentrated human activity, plentiful food, and late denning.

The vulnerability of brown bears to human-induced mortality in areas readily accessed by humans is well documented (Miller and Chihuly 1987, McLellan 1990, and others). Although the sample size is small, that correlation was apparent in this study. Furthermore, 3 adult females were known losses to nonsport mortality during the study. Nonsport mortality is a primary concern on the Kodiak Archipelago because adult females have small annual ranges (Berns et al. 1980,

Barnes 1990, Smith and Van Daele 1990) and they comprise a majority of DLP kills by deer hunters (Smith et al. 1989). Thus, there is the potential that bear density could be reduced in areas of extensive human activity. The threat would be greatest where ≥ 2 factors (e.g. sport harvest, village and hunter DLP kills) are present.

At the present time, DLP mortality by deer hunters appears to be a chronic rather than acute problem. In the mid-1980s concern over DLP kills by deer hunters intensified because DLP mortality was increasing and deer hunters were the primary cause. Reported DLP mortality by deer hunters averaged 8 bears annually during 1984-86 (Smith et al. 1989). Since then (1987-91) the average has been 4 bears annually. Reasons for this decline are unknown but could include decreased hunter effort or improved hunter awareness. Reduced DLP mortality in recent years should not be interpreted as a reason to disregard hunter-caused DLP mortality or reduce efforts to minimize DLP kills.

Surveys of persons that hunted on the study area during 1987-90 provided insight into hunter effort, harvest, modes of travel and transportation, measures that hunters took to avoid conflict with bears, and hunter attitudes toward bears. The 1987-88 ADF&G survey indicated that approximately 12-14% of the hunter effort on the Kodiak Archipelago occurred within the study area (Smith and Becker 1988).

The Kodiak NWR survey primarily sampled hunters that used air taxi services for transport; hunters that used private marine vessels were poorly represented. This bias clearly resulted in a low estimate for hunters using boats as lodging. It may also have caused the sample to overestimate the number of days hunters were afield and the incidence of conflicts between bears and hunters. People who lodged on boats, in particular, should be less susceptible to problems with food-conditioned bears than those that lodged in cabins or tents.

The number of hunters responding to the Kodiak NWR survey declined sharply in the second and third years of sampling. A similar trend was noted in the number of hunt units observed per hour of flight time. These data reflect diminished hunting effort in the 1989-90 and 1990-91 seasons. Deer numbers on Kodiak Island were near peak levels in 1987 and 1988, but began to decline in 1989 and 1990 due to harsh winter conditions and resultant mortality (R.B. Smith, ADF&G, Kodiak, pers. commun.). I believe that substantially fewer hunters went afield during the 1989-90 and 1990-91 seasons because of widespread reports of the deer decline and concern over the possibility of

poor hunting. The effect of reduced hunter effort on interactions between hunters and bears was not clear.

Virtually all persons who hunt deer on the Kodiak Archipelago are aware that brown bears can affect their hunt experiences. Information disseminated by ADF&G and USFWS provide guidelines for proper behavior in bear-occupied habitat and the media often reports real or potential problems. Frequent observations of bears and their sign in the field, together with uncommon but recurring incidents with bears, reinforce the notion of risk to hunters. Responses to the surveys support the contention that bears are a concern, but they also reveal that risk of conflict between deer hunters and bears is less than commonly believed.

The relatively low number of hunters that reported threatening encounters is encouraging. Interpreting perceived threats is difficult, but accounts provided by several respondents suggest that there were few actual confrontations between hunters and bears. Some hunters felt threatened simply because they knew bears were in the general area, they heard bears fleeing, or they observed bears fleeing. Although human attitudes toward bears may be difficult to influence (McCool and Braithwaite 1989), continued efforts to improve hunter knowledge of bear behavior should reduce the incidence of encounters that are perceived as threatening.

Respondents to the Kodiak NWR survey reported use of several methods to avoid problems with bears (Table 4). Some methods that were listed, such as prompt removal of deer from the field and avoidance of previous kill sites, resemble guidance provided in agency brochures. Furthermore, many hunters expressed a willingness to consider brown bears when planning future hunts and to employ strategies that reduce chance for conflict. No hunters indicated they would refuse to hunt on Kodiak because of brown bears. It's important that several hunters indicated that the opportunity to observe bears enriched their hunting experience. These positive attitudes lend support for increased and improved educational effort and especially programs that focus on ecological and naturalistic values of brown bear (McCool and Braithwaite 1989).

MANAGEMENT IMPLICATIONS

Conflicts between brown bears and deer hunters are unavoidable and will continue to be problematic. A low incidence of nonsport bear mortality associated with deer hunting should be expected and incorporated into population management strategies. Additionally, there is an important need to estimate illegal mortality and

determine how it relates to reported DLP mortality.

Concern for the impact of deer hunting on brown bears has prompted suggestions to reduce the sport harvest of bear in specific areas, reduce deer bag limits, or close deer season during certain time periods. Current information indicates these management options are not warranted at this time.

Minimizing conflicts between brown bears and deer hunters on the Kodiak Archipelago can best be accomplished by maintaining access at current levels and improving communication of bear behavior, ecology, and problem avoidance information to recreationalists. Preserving the integrity of inland areas is important because much of that area serves as "refuge" habitat where a component of the bear population can exist with minimal human disturbance. Development of improved access into these remote areas would be the first step toward unacceptable levels of interaction between bears and hunters.

Improvement of education and information programs is a common but nonetheless important recommendation for bear management. Specific needs for the Kodiak region are a more comprehensive examination of hunter beliefs and attitudes, and development of high quality audio-visual materials that address conditions and circumstances of the Kodiak Archipelago.

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