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# Effort and success of brown bear hunters in Alaska

*David M. Albert, R. Terry Bowyer, and Sterling D. Miller*

**Abstract** Understanding hunter motivation, effort, and success is crucial to manage the harvest of wildlife populations, especially for large mammals with comparatively low intrinsic rates of increase. We conducted a survey of hunters based on 3,241 respondents who purchased hunting tags for brown bear (*Ursus arctos*) in Alaska during 1985–86 to document hunting effort and identify variables correlated with hunting trip success. Success was greater for nonresidents (55.9%) than for Alaskans (8.7%). Based on statewide sales of brown bear tags and sealing data, success of nonresident (51.3%) and resident (9.3%) hunters did not differ from what was reported in the questionnaire. Stepwise logistic regression identified differences in primary motivation, use of professional guides, and regional distribution of hunting effort between successful and unsuccessful hunters. With other factors held equal, hunter success was lower in regions with greater human populations and higher in regions with fewer people. Hunters who used airplanes and chartered boats were more successful than those who did not do so, indicating the importance of access to remote locations. Hunting trips conducted in spring were more successful (20%) than autumn hunts (9%), because a greater proportion of hunters specifically sought brown bears in spring. In addition, a greater proportion of trophy bears was harvested during spring (4.3%) than autumn (1.6%). Because trophy criteria differ between grizzly (*Ursus arctos horribilis*) and Alaskan brown bears (*U. a. middendorfi* and related subspecies), the greatest proportion of trophy bears came from northwest and interior Alaska. Trophy hunting likely reflects motivational differences in hunters; individuals hunting in northwest Alaska, where harvest of trophies was greatest, sought principally brown bears. Such baseline data are useful to assess future demands for services related to hunting brown bears, documenting and tracking hunter motivations, and potentially better understanding bear population dynamics in relation to harvest in Alaska and elsewhere.

**Key words** Alaska, brown bears, effort, harvest, hunter motivation, hunter success, transportation, trophy hunting, *Ursus arctos*

People visit Alaska from around the world for the opportunity to view (Albert and Bowyer 1991) and hunt brown bears (*Ursus arctos*). Hunters contribute to the Alaskan economy by purchasing licenses and tags, transportation, food, equipment, and by hiring professional guides (Snepenger and Bowyer 1990, Miller et al. 1998). Thus, Alaskans benefit from viable populations of brown bears. The Alaska Department of Fish and Game (ADF&G) monitors population trends and regulates harvest

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Brown bear sow and cub along a salmon stream in southeastern Alaska.

to ensure the long-term viability of brown bears. Harvest level is regulated by setting hunting seasons and harvest limits, and designating special drawings or registration hunts (Miller 1990a, b). Long-term trends in hunter success rates coupled with other data on population demography may signal changes in distribution and abundance of bear populations.

Except in Alaska, brown bears are listed as a threatened species in the United States; correspondingly, legal hunting of these large carnivores is restricted to Alaska (McLellan et al. 1999). Hunting brown bears, however, is permitted in Canada, although harvests there are controversial (McLellan et al. 1999). Understanding patterns of hunter success in Alaska is important to managing brown bear harvests in Canada, as well as in the contiguous United States, should populations of brown bears in Wyoming and Montana recover sufficiently to allow delisting. Similarly, recovering populations of brown bears may allow more widespread legal hunting in Fenoscandia and Russia (Swenson et al. 1994, 1998; Revenko 1998; Tufto et al. 1999). Information on patterns of hunter behavior in Alaska, where sample sizes are relatively large, will assist those managing harvests of brown bears in other areas with fewer hunters. Likewise, such data should be of value to biologists responsible for managing populations of black bears (*Ursus americanus*).

Typically, hunting effort is recorded from successful hunters only, but approximately 80% of bear hunters are unsuccessful, based on tag sales and reports of bears harvested in Alaska (Miller 1990c). Hunting effort, location of hunting trips, and motivation of unsuccessful hunters are unknown. Thus,

differences in hunting effort and success among regions, seasons, and between residents and non-residents have not been documented adequately (Miller 1990a). Our objectives were to document effort by brown bear hunters in Alaska; identify specific characteristics of motivation, effort, and transportation correlated with hunting trip success; and test for differences among variables. These data will be useful to assess future demands for services related to brown bear hunting and potentially understanding population dynamics of bears in relation to harvest.

## Methods

Alaska Department of Fish and Game (ADF&G) sent questionnaires to all individuals purchasing hunting tags for brown bears in 1985 and 1986 following the hunting seasons. ADF&G provided return postage to encourage return of questionnaires. Further, hunting equipment was given away in a drawing of survey respondents. Those techniques increase response rates to mail surveys (Fillion 1975, Yammarino et al. 1991). On the questionnaire, hunters reported residency status, motivation for purchasing a brown bear tag, and number of hunting trips with brown bears as a primary or secondary objective conducted in 1985-86. In Alaska, state law requires all nonresident hunters of brown bears to hire a professional hunting guide or be accompanied by an immediate family member who is a resident. Questionnaires requested specific information on their most recent hunting trips ( $\leq 5$ ). We estimated effort by dividing number of hunting trips by total days spent hunting in 1985-86. In some portions of Alaska, subsistence hunters are not required to purchase brown bear



Availability of salmon is an important factor affecting differences in growth and body size of brown bears among regions of Alaska.

tags; those individuals were not included in our analysis.

We compensated for small sample sizes by pooling data for 26 game management units (GMUs) into 5 regions that reflected similarities in climate, vegetation, access type, and level of hunting pressure (Figure 1). Dates of spring and autumn hunting seasons varied by GMU. In GMU 9, hunting is closed in alternate regulatory years (i.e., autumn of one year and spring of the following year) to limit harvests. Consequently, hunting was closed in GMU 9 during spring 1985 and autumn 1986.

Transportation used by hunters included chartered and private airplanes, boats, automobiles, all-terrain vehicles (ATVs), snowmobiles, horses, and foot travel. Transportation use was not exclusive, and several modes may have been used on a single hunting trip. We tested differences in motivation, season, year, and regional distribution of hunting effort between Alaska residents and nonresidents in 2-way contingency tables with the likelihood-ratio chi-square (Agresti 1990). We controlled for experiment-wide error with the method of Goodman (1969):

$$\alpha' = 1 - (1 - \alpha)^{1/s} - 1,$$

where

$\alpha'$  = corrected probability (0.0034 in our study),

$s$  = number of comparisons, and

$\alpha = 0.05$ .

We classified a hunting trip as successful if a brown bear was harvested. We conducted univariate tests of hunter success among categorical variables with the likelihood-ratio chi-square. We included variables with at least marginal significance ( $\leq 0.25$ ) for potential analysis in the stepwise logistic-regression model of hunter success.

Use of discrete dependent variables has been used previously to help understand human dimensions of wildlife management issues (Boxall and McFarlane 1995). We used stepwise logistic regression to identify the linear combination of explanatory variables that differentiated successful from unsuccessful hunting trips with the fewest variables. We tested for differences in successful bear hunts among regions using 2-way interaction terms of region with motivation, transportation, and

effort. We used a correlation matrix to examine relations among independent variables. One of any pair of variables with  $r^2 = 0.5$  was eliminated from consideration in logistic models. Variables were evaluated for entry ( $P$  to enter and remain = 0.05) into the model based on maximum-likelihood coefficients. We generated marginal design matrices for categorical variables (Dixon 1990). Hosmer-Lemeshow goodness-of-fit chi-square tested whether the logistic link adequately fit the proposed model (Hosmer and Lemeshow 1989). Model interpretation was based on regression coefficients and associated standard errors, aptness of the logistic link, and

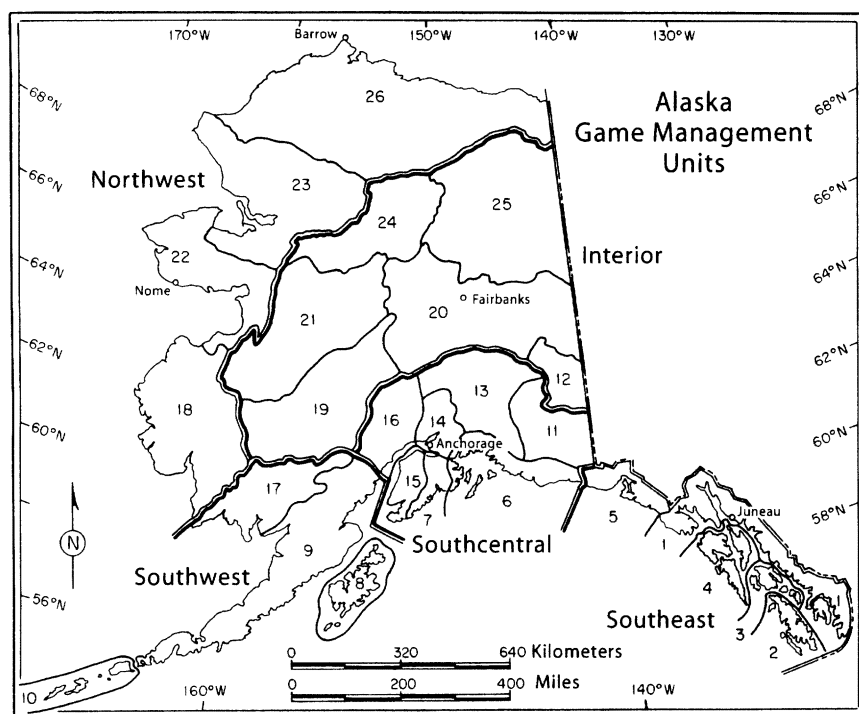


Figure 1. Location of game management units (GMUs) used to assess brown bear harvest in Alaska. Heavy lines delineate regional boundaries for southeast (GMUs 1–5), south-central (GMUs 6, 7, 11, 13–16), southwest (GMUs 8–10, 17), northwest (GMUs 18, 22, 23, 26), and interior (GMUs 12, 19–25) Alaska.

Akaike information criteria (Cressie 1993). We determined percentage of those data classified correctly by jackknifed reclassification (Dixon 1990).

Alaska state law requires all successful hunters of brown bears to present their kill to ADF&G for sealing (attachment of locking tags). Brown bear hides were examined for mammae and remains of exterior genitalia to determine sex. A premolar tooth was collected and sectioned so that cementum annuli could be counted to determine age (Mundy and Fuller 1964). In addition, date and harvest location, hunter residence, and whether a professional guide was used were recorded. Maximum length and zygomatic width were measured from cleaned, dried skulls to the nearest 2 mm. We defined total skull size as the sum of maximum length and zygomatic width. The Boone and Crockett Club classifies as trophies bears with skull size >61 cm for animals from interior and northwest Alaska (excluding GMU 18) and >71 cm for those from southeast, south-central, and southwest Alaska. We evaluated trophy bears harvested in GMU 18 using criteria for coastal brown bears (Nesbitt and Wright 1981). We analyzed sealing documents from 1985 to 1986 to identify differences in proportion of trophy animals harvested among seasons and regions.

## Results

Alaska Department of Fish and Game mailed 12,322 questionnaires to those purchasing brown bear hunting tags in 1985-86. Nonresident hunters came from the 48 contiguous United States and 22 foreign countries. Ten percent of all questionnaires were returned without delivery, 60% were delivered and not returned, and 30% were delivered and returned. Final sample size was 3,241 responses representing 4,371 brown bear tags, about 29% of all tags sold in Alaska in 1985-86 (ADF&G files). Tags were bought on a calendar-year basis, so some

Table 1. Number of trips, percentage of primary brown bear hunts, and percentage success within 5 regions of Alaska by resident and nonresident hunters based on a survey conducted by the Alaska Department of Fish and Game, 1985-86.

Season Region	Alaska resident			Nonresident		
	Hunting trips (n)	Primary brown bear hunts (%)	Success (%)	Hunting trips (n)	Primary brown bear hunts (%)	Success (%)
Spring						
southeast	211	91.4	11.0	74	97.3	52.7
south-central	686	73.2	5.5	46	97.8	45.7
southwest	227	98.7	24.2	179	100.0	66.8
interior	180	84.4	4.4	17	100.0	29.4
northwest	9	88.9	33.3	29	96.6	66.9
all	1,313	82.0	9.7	345	98.8	58.4
Autumn						
southeast	363	43.1	5.1	50	100.0	61.8
south-central	2,166	16.0	3.1	90	68.9	35.6
southwest	571	32.0	9.8	150	90.7	64.7
interior	866	13.8	3.6	88	45.5	25.0
northwest	136	22.5	9.6	62	85.3	52.5
all	4,102	20.4	4.6	440	77.5	46.6

individuals responded for tags purchased in 1985 and 1986. Twenty-five percent of respondents hunted in 1985 only, 44% hunted in 1986 only, 30% hunted in both years, and 1% did not hunt in 1985 or 1986. Respondents who hunted reported a mean ( $\pm$ SE) of 1.9 ( $\pm$ 0.1) hunting trips/year. This sample represented 6,200 trips, for a total of 39,198 days (6.3 days/trip) of hunter effort (Table 1).

Sealing documents ( $n=2,289$ ) for brown bears from 1985 to 1986 indicated that Alaska residents harvested 46.3%. Proportion of successful resident ( $n=317$ , 43%) and nonresident hunters ( $n=421$ , 57%) responding to the questionnaire did not differ ( $\chi^2_1=3.34$ ,  $P=0.07$ ). On the basis of survey responses for 4,371 tags sold, overall rate of success was 8.7% for residents and 55.9% for nonresident hunters. Those values did not differ from success of resident (9.3%,  $\chi^2_1=0.769$ ,  $P=0.48$ ) and nonresident hunters (51.3%,  $\chi^2_1=1.458$ ,  $P=0.33$ ) based on statewide sale of brown bear tags and sealing data.

Brown bears were the primary objective of a hunt more often for nonresidents than for Alaskans across all regions and during both seasons (Table 1). Additionally, objectives of Alaskans differed between spring and autumn hunting seasons (Table 2). Although hunting brown bears was the primary objective in 82% of 1,313 trips conducted by Alaskans in spring, only 20% of 4,102 were primarily hunting brown bears during autumn (Table 1). Many Alaskans with brown bear tags also hunted

Table 2. Success of brown bear hunters in Alaska based on a survey conducted by the Alaska Department of Fish and Game, 1985–86.

Variable	Category	n	Success (%)	$\chi^2$	P-value <sup>a</sup>
Residence status:	Alaska residents	5,260	6.2	1,371.09	< 0.001
	nonresidents	756	53.2		
Primary objective:	brown bear	2,522	23.9	616.44	< 0.001
	other	3,494	3.0		
Hunting guide:	yes	735	54.1	1,442.55	< 0.001
	no	5,281	5.9		
Hunting season:	spring	1,613	20.0	143.09	< 0.001
	autumn	4,403	8.8		
Year:	1985	2,372	12.5	1.43	0.23
	1986	3,644	11.5		
Region:	southeast	668	16.1	545.35	< 0.001
	south-central	3,030	5.3		
	southwest	1,113	28.9		
	interior	1,028	5.7		
	northwest	177	30.0		

<sup>a</sup> P-values are for chi-square tests of independence between residence and effort variables and hunter success; tests have 1 df except for Region, which has 4 df.

moose (*Alces alces*), caribou (*Rangifer tarandus*), Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), Dall's sheep (*Ovis dalli dalli*), black bears, or other game (Figure 2). Individuals with brown bear tags were hunting other species in autumn because seasons for those species (except black bear) seldom were open in spring.

The greatest percentage of Alaska residents hunted in south-central and interior Alaska (Table 1) and used automobiles, private boats, and other transportation such as ATVs (Figure 3). Conversely, the greatest percentage of nonresidents hunted in southwest Alaska and used chartered and private airplanes. As expected, 90% of nonresident hunters used professional guides, whereas only 1% of Alaskans did so.

Logistic regression identified use of hunting guides, primary trip objective (motive), and region (especially northwest) as the most significant indicators of successful hunting trips (Table 3). Hunter residence was correlated with use of professional hunting guides ( $r = -0.9$ ), and residence was excluded

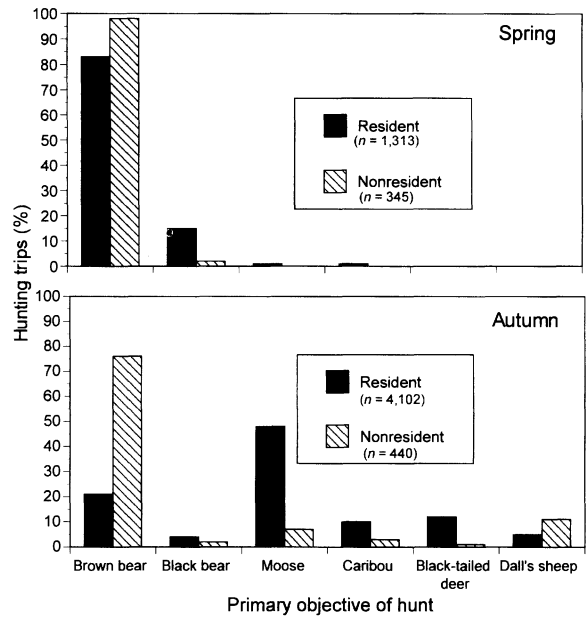


Figure 2. Primary objective of spring and autumn hunting trips conducted by Alaska residents and nonresidents, 1985–86.

ed from the logistic model. Hunters with professional guides were more successful than those without guides, and those primarily hunting brown bears were more successful than hunters seeking other species. With other factors held equal, hunting trips conducted in south-central and interior Alaska had less success and trips in northwest Alaska had greater success than average (Table 3). Further, difference in success between hunters primarily seeking brown bears and those seeking other species was greatest in southwest Alaska (Table 3). Percentage use of airplanes and chartered boats also differed between successful and unsuccessful

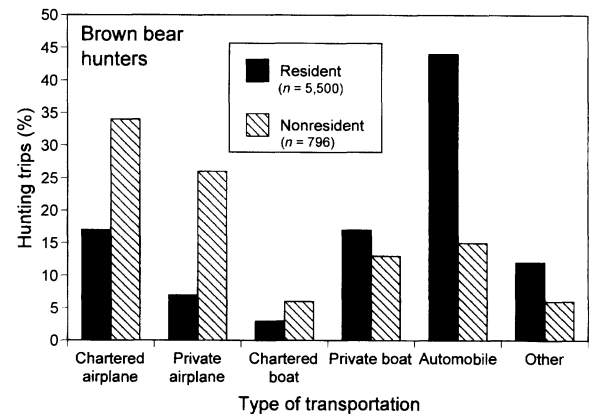


Figure 3. Percentage of transportation types used by Alaska resident and nonresident hunters based on response to a survey of brown bear hunters conducted by Alaska Department of Fish and Game, 1985–86.

Table 3. Estimated regression coefficients, standard errors, and odds-ratios ( $\psi$ ) for main effect and interaction variables selected in a stepwise logistic-regression model for success of brown bear hunters in Alaska, 1985-86.

Variable <sup>a</sup>	Estimated coefficient	Standard error	$\psi^b$	95% CI ( $\Psi^c$ )
Hunting guide	0.933	0.057	2.54	(2.27-2.85)*
Motive <sup>d</sup>	0.740	0.076	2.09	(1.80-2.43)*
Region:				
southeast	-0.251	0.277	0.778	(0.45-1.34)
south-central	-0.261	0.119	0.771	(0.61-0.97)*
southwest	0.183	0.153	1.20	(0.89-1.62)
interior	-0.320	0.147	0.726	(0.54-0.97)*
northwest	0.648	0.180	1.91	(1.34-2.72)*
Private airplane	0.254	0.084	1.29	(1.09-1.52)*
Charter airplane	0.213	0.058	1.24	(1.10-1.39)*
Charter boat	0.342	0.125	1.41	(1.10-1.80)*
Motive $\times$ region				
southeast	0.091	0.184	1.10	(0.76-1.57)
south-central	-0.127	0.102	0.881	(0.7-1.08)
southwest	0.494	0.137	1.64	(1.25-2.15)*
interior	-0.171	0.134	0.832	(0.65-1.09)
northwest	-0.287	0.171	0.751	(0.5-1.05)
Private airplane $\times$ region				
southeast	-0.330	0.231	0.719	(0.46-1.13)
south-central	0.269	0.107	1.31	(1.06-1.61)*
southwest	-0.119	0.106	0.888	(0.72-1.09)
interior	0.028	0.139	1.03	(0.78-1.35)
northwest	0.151	0.160	1.16	(0.89-1.59)
Constant	-1.225	0.152	0.294	(0.22-0.40)*

<sup>a</sup> Design matrices for categorical variables were coded (1) for positive and (-1) for negative responses unless otherwise noted.

<sup>b</sup> The estimated odds-ratio ( $\psi$ ) represents the rate of success of a group divided by average success of the population. For example, using a professional hunting guide increased the likelihood of success 2.54 times above the average rate of success.

<sup>c</sup> Ninety-five percent CI for  $\psi$  indicate a significant difference (\*) in a group from the population as a whole if they do not overlap 1.

<sup>d</sup> Design matrix for motive was coded (1) for primary brown bear hunt and (-1) for other game.

hunts (Table 3). Finally, difference in success between those who used private airplanes and those who did not was greater in south-central Alaska than other areas of the state. Hosmer-Lemeshow goodness-of-fit test indicated that the logistic model was apt ( $\chi^2_8=8.136, P=0.42$ ) and classified 72.4% of successful and 87.0% of unsuccessful hunting trips correctly (85.3% overall). Individuals who hunted in spring of both years were more successful than those hunting in autumn (Table 2), but season failed to enter the logistic model.

Based on sealing records, <3% of 2,235 hunter-harvested bears qualified as Boone and Crockett tro-

phies. Further, 9.8% of 457 grizzly bears had total skull size >61 cm, whereas <1% ( $n=17$ ) of 1,778 brown bears were >71 cm. Northwest Alaska exhibited the greatest rate (10.8%) of trophy bears killed by hunters, followed by interior (8.4%) and southwest Alaska (1.8%). No trophy bears were harvested in south-central or southeast Alaska during 1985-86. Moreover, a greater proportion of trophy bears were harvested during spring (4.3%) than autumn hunting seasons (1.6%,  $\chi^2_1=13.921, P\leq 0.001$ ).

## Discussion

Our study confirmed that most individuals who purchased brown bear tags in Alaska did not hunt primarily for brown bears. For instance, Alaskan residents, who hunted primarily for ungulates in autumn, purchased most brown bear tags. Nonetheless, success of those hunters was substantially less than success among those who primarily hunted for brown bears, and that result was not related to season. Lesser success in autumn reflected a greater proportion of people with bear tags hunting species other than brown bears. Consequently, ratio of hunting tags sold to hunters that were successful is not an accurate estimate of success unless primary motivation can be accounted for. In addition, we do not recommend using hunter success or catch/unit effort to index population size; success may vary independently of population size based on hunter experience, skill, or other variables (Bowyer et al. 1999).

Professional guides often are experienced hunters, and our analysis indicated that hunters with guides were more successful than individuals who did not hire guides. Likewise, airplanes and chartered boats allowed access to remote areas and also were associated with successful hunting trips. Types of transportation differed between residents and nonresidents and resulted in greater success among nonresident hunters. According to our logistic-regression model, the most successful hunting strategy in 1985-86 was to hunt primarily for brown bears, in southwest Alaska, using a professional guide with a chartered boat. The estimated probability of success for that scenario was 69%, slightly >65.8% success observed for all nonresidents hunting in southwest Alaska. Conversely, probability of a hunter harvesting a brown bear in south-central Alaska without a guide, airplane, or chartered boat, while not primarily hunting brown bears was 2.0%. That outcome was slightly <3.0% observed among all hunters who carried brown

bear tags while primarily hunting other game.

With other factors held equal, hunter success was greatest in northwest and least in interior and south-central Alaska. South-central and interior Alaska have the largest centers of human population and hunter success in those regions was below average. Moreover, in south-central Alaska, difference in success between hunters who used private airplanes and those who did not was greater than in other regions. That outcome indicated that, to a greater extent than in other regions, brown bears were more abundant in areas accessible by airplane, but not in areas accessible by other means of transport. Conversely, hunter success in northwest Alaska was above average; differences in success between those hunting primarily for brown bears and those hunting other species were small. Nonetheless, importance of airplanes and chartered boats indicated that access away from the road system was necessary for hunting trips to be successful in all regions.

Based on statewide sales of brown bear tags and sealing data, success of resident and nonresident hunters did not differ from what was reported in the questionnaire. Therefore, we believe hunters who returned the questionnaire constituted a representative sample of brown bear hunters. Nonetheless, we have no way to determine how nonrespondents might have differed in other characteristics from hunters who returned the questionnaire. Consequently, our inference is restricted mostly to those 3,241 individuals who cooperated in this hunting survey.

Rausch (1963) documented variation in skull size of bears throughout Alaska and concluded that formal recognition of interior and coastal bears as distinct subspecies was not justified (but see Talbot and Shields [1996] for a more recent phylogenetic analysis). The Boone and Crockett Club uses different criteria to determine trophy status of the smaller grizzly bear and generally larger brown bears. As a result, the proportion of bears that qualified as trophy animals from interior and northwest Alaska was greater than that of southeast, south-central, or southwest Alaska. In addition, the greater proportion of trophy animals taken during spring reflected greater vulnerability of adult males to hunters during that season (Miller 1990a).

Acquiring a trophy bear could be a motivating factor that was not addressed directly in the questionnaire. For instance, nonresident hunters in GMU 4 in southeast Alaska favored having a greater availability of older brown bears to hunt compared

with Alaska residents; that difference likely reflected a preference for trophy bears associated with the expense of hiring a guide (J. Faro, E. Becker, L. Bergdoll Schmidt, Alaska Department of Fish and Game, unpublished report). Consequently, understanding the distribution of trophy animals and differing motivations of resident and nonresident hunters may help explain some patterns of hunter effort. Indeed, hunters in northwest Alaska, where the harvest of trophies was greatest, hunted principally for brown bears.

### *Management implications*

Several authors have noted that understanding motivations and attitudes of hunters is essential to manage wildlife; our knowledge of hunters often is less than that of the game they hunt (Hendee 1974, Decker et al. 1980, McCullough and Carmen 1982, Miller et al. 1994, Klein et al. 1999). We demonstrated that success of brown bear hunters was related primarily to motivation, use of professional guides, transportation, and location of hunting trips. Thus, for meaningful comparisons of hunter success, those variables also must be accounted for. Moreover, attitudes (and hence motivations) of hunters are likely to change over time (Lautenschlager and Bowyer 1985, Miller et al. 1998), and base-line information on hunter behavior is necessary to assess such change. We believe our study provides an essential first step in that process and that our results will be useful to individuals responsible for managing the harvest of bears in Alaska and elsewhere.

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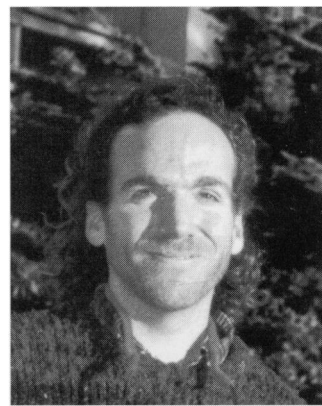
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