THE ALASKA DEPARTMENT OF FISH AND GAME,

THE NATIONAL PARK SERVICE,

AND THE

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DYNAMICS OF A HUNTED BROWN BEAR POPULATION AT BLACK LAKE, ALASKA

A COOPERATIVE INTERAGENCY STUDY

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SUMMARY

This report presents results obtained during the third year of an interagency study of the dynamics, including population density and structure, of a hunted brown bear population near Black Lake on the Alaska Peninsula. Several of the original objectives of this study, including the density estimate and description of the current population composition, have been completed and previously reported (Miller and Sellers 1990). The number of bears captured in this study by year was 59, 40 (including 7 recaptures) and 5 in 1988, 1989 and 1990 respectively. In total, 63 radio collars, including 22 with break-away features, and 19 glue-on radios were deployed. Based on the percentage of marked bears killed and on the total harvest from a 1,531 sq. mile area around Black Lake where the bear population was estimated by extrapolation from the census area, average annual exploitation rates during 1989-1990 were calculated as 5.1-5.7%. Preliminary brown bear population estimates were made by extrapolation from the Black Lake study area to the rest of GMU 9. These estimates are especially questionable for the northern half of GMU 9. In subunits 9E and 9D, the bear population was estimated to be 4,100. The 1989-90 harvest from these 2 subunits was 457 bears. These values provided an 5.6% annual exploitation rate estimate. Because harvests were increasing steadily, the fall 1991 season was reduced by 6 days. Preliminary survival rates for COY, yearlings, females => 3 , and males => 3 were calculated to be 0.48, 0.84, 0.87 and 0.85, respectively. Over 1200 relocations have been recorded, and 28 bears (all females except one) with functioning radio collars entered dens in 1990. Five replicate stream surveys were conducted during 3-7 August, and an average of 185 (range 169-200) bears were seen per survey.

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BACKGROUND

Both exploited and unexploited brown bear populations are difficult to manage. This is because there are few techniques available by which to document population trends directly and because the species is highly sensitive to disturbances related to human development and activity. Also, brown bears have reproductive rates among the lowest of North American mammals and populations, as a result, can sustain only low rates of harvest and are slow to recover from inadvertent overharvests.

The need for baseline data on population parameters of brown bears on the Alaska Peninsula was a primary motive for this study. The importance of good baseline data was demonstrated by the March 1989 Exxon Valdez oil spill. The lack of baseline information on population density, reproductive rates, survival rates, movements, and habitat use will confound attempts to assess the impact of this oil spill on brown bears. However, results of this study can serve as surrogate baseline information by which to measure probable changes in bear populations exposed to oil from the Exxon Valdez. Such assessment work is proceeding along the coast of Katmai National Park. In addition, the Katmai project can function as a companion to this study, allowing comparisons of population dynamics between an unhunted population and a moderately harvested population at Black Lake.

Effective management of brown bear populations exploited by hunters depends on good information on population status, trends, and harvest rates. On the Alaska Peninsula, as elsewhere, information on population size and trend is seldom available in reliable form because of the expense and technical difficulties of obtaining accurate estimates. The Alaska Peninsula supports important brown bear populations which are subject to intensive harvest pressure (Sellers and McNay 1984). During the early 1970's an extensive tagging study (Glenn 1980, Glenn and Miller 1980) coincided with a period of excessive harvests. Hunting seasons in 1974 and 1975 were curtailed by emergency orders which closed the spring seasons. During the next 10 years of restrictive alternating seasons, the bear population grew. Since 1980, there has been increased hunting pressure on the growing population and harvests have increased. In 1985, the fall season was extended by including the first 6 days of October. Fall harvests have increased dramatically, yet there has been intensive pressure, both from the guide industry and local residents, to further liberalize regulations and harvest more bears. It is desirable to determine population size, sustainable harvest levels, and the effects of past

and current harvest levels on the number and composition of the Alaska Peninsula bear population in order to evaluate existing management strategies and, if necessary, to formulate new strategies.

The earlier studies in this area provide an opportunity to compare characteristics of a heavily overexploited population with those of the current population. Bears in the earlier study were tagged during 1970-1975, excluding 1973. The current and former study areas were illustrated by Miller and Sellers (1990:Fig. 1). During these studies 344 bears were handled 489 times and 136 of the bears were shot by hunters.

OBJECTIVES

1. To estimate spring density of brown bears in a 500 square mile study area near Black Lake;

2. To estimate sex and age composition of the brown bear population inhabiting the study area;

3. To estimate productivity of Black Lake bears, including: litter size, age at first reproduction, reproductive interval, and recruitment;

4. To estimate mortality rates for several sex/age groups and for natural versus hunting mortality;

5. To compare and evaluate changes in density, population composition, reproductive rates, recruitment rates, and mortality rates that have occurred in the study area since the early 1970's;

6. To document the timing and intensity of use by bears of habitats of special importance such as denning areas, salmon streams, berry and vegetation foraging areas, ungulate calving areas, and others that may become evident through monitoring. Determine if different subpopulations of bears use these areas;

7. To evaluate the efficacy of aerial stream surveys in estimating trends in bear population size and composition; and

8. To estimate bear numbers for Game Management Units 9E and 9D by extrapolation from the study density estimate.

STUDY AREA AND METHODS

Descriptions of the study area and methods were reported earlier (Miller and Sellers 1990). During the current reporting period, work focused on monitoring radio-marked bears, retrieving collars that dropped off or were associated with dead bears, conducting standardized aerial surveys of bears along salmon streams, and analyzing data.

RESULTS AND DISCUSSION

Population and Density Estimate

The Capture-Mark-Resight (CMR) estimate of population density (Objective 1) was completed in 1989 and has been previously reported (Miller and Sellers 1990). The calculated density of 191 bears/1000 km^2 (1 bear/2.02 mi^2) ranks this population the 5th highest among the 9 areas in Alaska where CMR density estimates have been made (Miller et al. in prep). Bear density at Black Lake ranked behind the Katmai Coast, Admiralty Island and two areas on Kodiak Island. Bears at Black Lake were over 7 times more dense than in any studies in interior Alaska.

Population Composition

Objectives 2 and 5 involve determining the composition of the current Black Lake bear population and making comparisons with the composition of the population in the early 1970's. Preliminary comparisons of capture samples showed an increase in adult male:female sex ratio and suggested an increase in mean ages of adults (Miller and Sellers 1990). Analysis has continued during this reporting period, but a question about comparability of teeth ages has arrisen. We are considering having the early 1970's capture sample reaged by the contractor who is currently aging all harvest and research teeth for ADF&G. The emphasis of the following discussion is to evaluate biases in different methods of collecting population composition data.

Three independent sources of data on population composition are available for making comparisons: 1.) capture samples, 2.) aerial surveys, including both stream surveys and observations made during the 1989 density estimate, and 3.) harvest statistics. Each of these methods have associated biases and/or practical limitations which are discussed below. Regardless, each provides insights into the population composition and, considered jointly, permit evaluation of changes in population composition over time.

Capture Samples:

There is a bias against females with cubs-of-the-year (COY) during captures and observations in May and June (Glenn and Miller 1980, Miller et al. 1987). This bias is associated with the tendency for females with COY to remain at higher elevations where terrain and weather combine to hamper seach efforts. During the early 1970's, only 4.7% of adult females (> 5.0 years-old; N = 107) captured in June had litters with COY compared to 35% in July (N = 23). During 1988 and 1989, only 8% of all bears captured were in family groups that included COYs compared to 22% of bears seen during August stream surveys. These data indicate that captures or observations later in the summer tend to indicate a higher proportion of COY litters than captures or observations during early spring.

To minimize this spring capture bias based on reproductive status and to compensate for a slight difference in the timing of capture work between the early 1970's (when 90% of the captures were made between 10 June and 8 July) and 1988-89 (when all captures were from 21 May-5 June), sex and age composition was determined over a two year period, with adjustment of the second year's sample to reflect the age and status of the bears in the previous year (Miller and Sellers 1990). For example, a 10 year old female captured in 1989 with 2 yearling males was tallied as a 9 year old female with two COY

~~males~~ for the 1988-89 sample. These adjustments also help to correct for possible sources of bias based on failure to capture bears in the order in which they were observed during the 1988 capture period (Miller and Sellers 1990). These same adjustments were made for the sample of bears captured during the earlier studies in the 1970's so that comparisons could be made. The years for which these adjustments are made are indicated as hyphenated years (e.g. 1970-71 includes as "COY" in 1970, the sample of bears captured as yearlings in 1971; and the period 1971-72 includes these same bears as yearlings). Adjusted composition data from capture samples are presented in Table 1.

Production. Despite the slight difference in timing of capture work in the two Black Lake studies and the associated bias discribed above, the adjusted composition data indicated about the same proportion of adult females had COYs in both time periods (23% in early 1970's compared to 21% during 1988-89, Table 1). This may be explained by the high percentage of females with COY litters (65% of the total for both study periods) that were orginally captured with yearling litters and back-dated.

Adult Sex ratios. Sex ratios in the sample of captured bears during recent studies were compared with those in previous studies. There were no significant differences in sex ratio of captured adults during the 1970's (χ^2 = 0.40, df=2, P=0.82) (Table 1), so these data were treated as a single sample (1970-74). The adult sex ratio increased significantly from 21 adult males:100 adult females during 1970-74 to 39 adult males:100 adult females during 1988-89 (t=1.63, df=194, P=0.052) (Table 1). The increased proportion of adult males in the population probably reflects lower harvest rates during 1975-85 that permitted the population to recover.

Age Structure and Subadult Sex ratios. Analysis of age data and subadult sex ratios continued during this reporting period, but further reporting on these topics will be delayed until teeth taken from the early 1970's are reaged by the current contractor to insure recent capture and harvest samples are aged comparably.

Population composition comparisons between capture sample, census observations (1989), and stream surveys:

Adult males composed 10.7% of the 1988/89 capture sample (Table 1). During the replicate census flights in 1989, a total of 607 bears were seen. Based on very large size for single bears or association as a breeding pair, 10.9% of all bears seen were classified as adult males. The proportion of bears in family groups was also similar between captures in 1988/89 (56%) and the 1989 census observations (55.5%). This similarity suggests that we were successful in capturing a representative sample of the bears visible during late May and early June.

Fewer bears were seen in families that included COY during captures and census work than during stream surveys. This supports speculation of an observation bias against females with COY litters (Miller et al. 1987, Miller 1990). During the 1989 stream survey, 63% of all bears observed (n = 883) were in family groups, 18% of all bears observed were in families that included COY. During the census flights between 28 May-4 June only 10.4% (n = 63) of all bears seen were in families that included COY. Absent an observation bias against COY litters in the spring, it would be expected that more would be seen during spring than during summer because of high mortality rates of COY (Bunnell and Tait 1985, Miller 1990).

As compared to spring capture and census observation samples, August stream surveys suffered from a bias against seeing adult males. During 1989 stream surveys

only 0.8% of 883 bears were classified as adult males, compared to 10.7% in the capture sample and 10.9% during census flights. This may result from adult males in August being more nocturnal and/or more adept at hiding from aircraft than they are in spring during the peak of breeding season and prior to leaf emergence.

Composition of Harvests:

One long standing subject of concern to brown bear management biologists is whether harvest statistic can be useful in analyzing the status of the population. Most of the work done recently on interpretation of harvest data has focused on computer models, and a number of potentially serious problems have been raised (Miller and Miller 1988, 1990, Harris 1984, Tait 1983). The work at Black Lake offers a rare opportunity to compare independent measurements of population status (both density and composition) between two time periods having measurably different exploitation rates (Miller and Sellers 1990). As discussed above, capture data collected in similar fashion in the same area have shown a significant increase in the proportion of adult males, and preliminary age analysis suggests an increase in adult ages. Whether these changes in population composition are reflected in harvest statistics will be evaluated after all relevant teeth have been reaged by the current contractor.

Status of Marked Bears

The number of bears captured in this study was 59, 40 (including 7 recaptures), and 5 during 1988, 1989, and 1990, respectively. The 5 bears captured in 1990 (4 females and 1 male, Table 2) were collared in conjunction with retrieval of several collars that were shed or on dead bears. In total, 63 radio collars, including 22 with break-away features (either canvas or surgical rubber spacers), and 19 glue-on radios were put on bears.

The glue-on radios were designed to be put on young bears or on adult males whose necks were larger than their heads, thus precluding the use of collars. The primary purpose was to have an unbiased sample of radio-marked bears for the census. For such use it was necessary for the glue-on radios to stay attached for at least the census period (i.e. about 14 days from the time of capture). Two glue-on radios remained attached from 173 to 219 days, 2 lasted between 30-70 days, 6 remained on for 4-14 days, and 9 fell off in less than 4 days.

Sixteen of the 22 collars designed to fall off had a canvas spacer and 6 were attached with surgical rubber tubing. Of the 16 collars with canvas spacers, one transmitter malfunctioned within several days of deployment; 2 transmitters quit after being on for 100-180 days. One bear carried its transmitter for at least 120 days before it died of natural causes. One bear had its collar on for 499 days when it was killed by a hunter who reported that the neck was cut by the collar and was infected. Another bear was captured in October 1990 to remove its collar which had been on for 505 days. This collar caused no ill effects and was badly frayed, indicating it probably would have dropped off before doing any damage to the bear. The other 10 fell off because the canvas rotted. Approximate life expectancy for the canvas spacers was calculated using midpoints between the last date the collar was known to have been on the bear and the first date it was confirmed to have been shed. Sometimes this period span several months, as in cases when the collar was shed in a den. On average, the canvas spacers lasted approximately 1 year. Five of the 16 were on longer than a year, and one could have remained on for as long as 670 days. The surgical tubing lasted a shorter time, with only 1 of 6 staying on for more than a year. Of the 41 regular collars put on bears,

3 were pulled off. Two of these were shucked almost immediately after capture, and 1 was shed after being on nearly a year.

The fate of 3 bears was determined to have been different than reported by Miller and Sellers (1990). Bears #48 and #82 shed their collars before den entrance, and bear # 78 died of unknown causes prior to entering a den.

At the start of 1990, 29 bears were alive with functioning radio collars. Counting the 5 new collars put on in June 1990, 34 bears with functioning transmitters were located a total of 415 times during 15 monitoring surveys (involving 18 days of flying) in 1990. Two radio failures (one possibly involving illegal hunting) were suspected to have occurred during the spring. One collar dropped off in the spring and one was removed from a male (#91) in October. One bear was legally killed by a hunter, and two bears died of natural causes as described below.

Bear # 23, a 19 year old female, entered a den between 25 Oct and 6 Nov and was still in it on 25 Apr. She was not located on the 1 Jun 1990 monitoring flight and on 14 Jun she was found dead. A field necropsy revealed several puncture wounds to the head, including one through the top of the skull. She apparently was killed less than 1 week before being examined and had been fed upon by a wolverine. Cause of death was attributed to another bear. She had weaned two 2.5 year old cubs the previous spring and was lactating when killed, suggesting that she may have had a new litter of cubs, although no evidence of cubs was found.

Bear # 46, an 11 year old female died between 9 July and 6 August. The carcass was submerged in the Alec River and was examined on 9 August. Decomposition was well advanced and no cause of death could be determined. The skull was recovered and showed no sign of damage.

The current status of radio collared bears is listed in Table 3.

Exploitation Rates

At the beginning of the 1990 spring bear hunting season, a maximum of 72 marked bears = >2.5 years old were alive. Only 1 marked bear was legally harvested during the May 1990 season, for a 1.4% harvest rate. One other bear (#92), a young female with a radio that was functional two weeks before the start of the hunting season, could not be found after the hunting season ended. Given her last location (close to the beach) and the timing of her disappearance, there is some likelihood that she was a victim of illegal harvest. If this bear is included as a hunting mortality, the spring 1990 exploitation rate for bears would be at least 2.8% for bears = >2.5 years old. Because of the alternating hunting seasons in Unit 9, the most realistic way to measure exploitation is to average the harvest over two calendar years so that one fall and one spring hunt is included. Thus for the fall 1989 and spring 1990 season, a total of 12 marked bears (assuming #92 was an illegal kill) were killed by hunters, and the average annual exploitation rate for 1989-1990 was 7.2% for bears = >2.5 years old. If this exploitation rate is adjusted to include the entire population (Miller and Sellers 1990), the average exploitation rate is 5.3%. This is considered a minimum exploitation rate because it does not factor in natural mortality for marked bears without functioning radio transmitters that would reduce the number of marked bears available to be harvested, and also because it assumes all marked bears that are harvested (except #92) were identified when the hides were sealed. This latter assumption was violated in 1990 when an inexperienced

technician in Anchorage failed to note the lip tattoo of a marked bear (#59) he sealed. Fortunately we were notified by the guide who turned in the radio collar.

In future reports these exploitation rates will be compared in more detail with those estimated during the early 1970's (Miller and Sellers 1990). In addition, survival rates for females will be applied to the marked sample to arrive at a more precise exploitation rate for the current study. Because relatively few males have been radio-collared in this study, and their survival rate is not well measured, it may not be feasible to continue to calculate exploitation rate for marked males beyond the spring 1992 hunting season.

The extrapolated bear population for Uniform Coding Units (UCU's) 09E-1201 and 2001 is 450-500 bears (Miller and Sellers 1990). During the spring 1990 hunting season 20 bears were killed from this area, giving an exploitation rate of 4.0-4.4%. For the 1989-90 regulatory year, a total of 51 bears were killed by hunters from this 1,537 square mile area. This represents an estimated harvest rate of 10.2-11.3% of the population, or an annual harvest rate of 5.1-5.7%. During these two hunts, a total of 6 adult females were taken by hunters. Expressed on an annual basis, hunters removed adult females at a rate of about 0.6-0.7% of the total population. It has been recommended for polar bears that harvest of adult females should not exceed 1.6% of the total population (Taylor et al. 1987). Using a similar approach, Miller (1988) estimated that <2% of a highly productive grizzly bear population in GMU 13 should be harvested as adult females

After two years of hunting, the minimum estimate for annual exploitation rate of marked bears was estimated as 5.3%. Calculated independently using the extrapolated density estimates for UCU's 1201 and 2001 the exploitation rate was estimated as 5.1-5.7%. These rates are considerably lower than calculated just from the fall 1989 hunt (Miller and Sellers, 1990). Severe weather during the May 1990 season reduced hunter success.

Estimated Survival Rates

Survival estimates have been updated through 1990 (Table 4), but are considered preliminary. The most important estimate (adult females) will improve with additional years of study. Annual survival for females =>3 is 0.87 for all causes of mortality; Survival from natural mortality was 0.92. This was not significantly different from the survival rate of 0.95 for females in the Katmai study area (X^2 = 0.98, 1 df, $P < 0.30$) (unpublished data). The survival rate for COY declined to 0.48.

In addition to mortality detected through radio telemetry, two dead bears were found during streams surveys in early August. One was a 2 year old female found on the West Fork that was believed to have been killed on 5 August when a large bear was spotted fleeing from the carcass. When inspected 4 days later, it had not been fed upon, but no cause of death could be determined. The other was spotted on 3 August near Boulevard Creek. The carcass looked fresh and was intact. The carcass was investigated 6 days later, but by then had been nearly totally consummed. The skull was undamaged (tooth was aged as a yearling), but the sex could not be determined. A third carcass was spotted along the Clark River on a routine tracking flight on 26 Nov 1990. It was not inspected, but appeared from the air to be a subadult.

Extrapolated Population Estimates

Objective #8 was to estimate bear numbers for GMU Subunits 9E and 9D by extrapolating from the Black Lake density estimate. Because brown bear hunting regulation proposals (which are considered only every 2 years by the Alaska Board of Game) were on the spring 1990 agenda, and because harvests in Unit 9 were increasing steadily, meeting Objective #8 and presenting these data to the Board for their consideration became a high priority for this reporting period. For the purpose of Board discussion this objective was expanded to encompass all of Unit 9. It is difficult to make accurate extrapolations to some areas, such as western 9B, without additional density estimates for these different ecological regions. The Unit 9 extrapolation was based on UCU's (the smallest geographic units with readily available area measurements). Waterbodies larger than 10 sq. mi. were excluded from the extrapolation. The results are presented in Table 5. The agreement between the harvest rate of marked bears and an independent harvest rate calculated from extrapolating the density estimate from the census area to UCUs 1201 and 2201 lend credibility to the extrapolations. Future refinements in these estimates are expected, especially for the northern half of Unit 9. Nevertheless, these preliminary estimates were presented to the Board for their deliberations. At the Board meeting approximately 10 guides were present to give testimony on the Department's proposal to reduce the fall season by 6 days in Subunits 9C, 9D and 9E. Virtually every guide was opposed to any season curtailment. Most guides willingly participated in an exercise where they independently estimated how many bears were in their individual guide areas. Some of these guides have had decades of experience within their hunting areas. In all cases except one (whose estimate was the same as Sellers') the guides estimated fewer bears in their areas than estimated by extrapolation. Sustainable harvest was calculated at 5% of the estimated population for each subunit. For Subunits 9E and 9D the allowable harvest was exceeded by 12% for the 1989-90 regulatory year. Had weather been more favorable during May 1990, the harvest would have been substantially higher because more hunters were in the field than ever before. With a pronounced trend of increasing harvests, which exceeded the estimated sustainable level in 1989-90, the Board unanimously adopted the Department's recommendation for more conservative seasons. This process illustrates the benefits of density estimates such as that conducted in the Black Lake area during 1989.

Stream Surveys

During 3-7 August 1990, 5 replicates of the Black Lake stream survey area were completed (Table 6). A total of 927 bears were classified (mean of 185 per survey, range 169-200). Production of COYs was improved over the previous year. Since the resumption of stream surveys in 1982, COY have comprised between 12-27% of the population, while older cubs still with mothers have ranged from 19-31%. Better than average COY production occurred in 1983; very poor production occurred in 1986 and 1989.

Movements of Marked Bears

Seventeen females first captured in 1988 now have been relocated an average of 34 times each (range 29-41). In total over 1200 locations have been recorded for all bears marked during this study. Several streams in the Black Lake area have late runs of salmon which attract bears. In 1990, the Clark River held a concentration of bears through December. On 17 December, 16 bears were counted along the stream, and on

31 December, 3 bears were present. Analysis of movements, home range and habitat use awaits digitizing of these locations and mapping of cover types.

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Table 1. Sex and age composition of brown bears captured near Black Lake, Alaska, using capture samples from consecutive years with status adjusted for the first year listed.

Category	1970-71 Number	(%)	1971-72 Number	(%)	1974-75 Number	(%)	1988-89 Number	(%)
Cubs of the year								
Males	1		22		7		0	
Females	9		12		7		2	
Unk sex	3		0		0		15	
Total	13	8	34	18	14	9	17	14
Yearlings								
Male	20		5		13		6	
Females	19		10		11		3	
Unk sex	1		4		0		11	
Total	40	25	19	10	24	15	20	17
Age 2-4								
Male	23	14	38	20	42	27	20	17
Female	34	21	43	23	27	17	16	13
Unk sex	3	0	1	2				
Total	60	37	81	44	70	45	38	31
Adult females								
Single	15	9	12	6	14	8	9	7
With coy	5	3	17	9	7	4	7	5
With 1-yr-olds	18	11	6	3	11	7	10	8
With 2-yr-olds	2	1	9	4	8	5	7	5
Total	40	24	44	23	40	25	33	27
Adult males	10	6	8	4	8	5	13	10
Total bears	163		186		156		121	
Ad males:100 ad females	25.0		17.4		20.0		39.4	
Mean age of ad males	6.6		7.9		7.2		9.9	
Mean age of ad females	9.0		9.0		10.6		12.2	
Subad males:100 subad females	67.6		88.4		155.6		125.0	
Mean age of males => 2	3.6		3.5		3.4		5.6	
Mean age of females => 2	6.1		6.0		7.4		9.2	

Table 2. Brown bear capture records at Black Lake, Alaska, 1990.

ID	Sex	Age	Wt. (lbs)	Capture date	Eartags Left	Eartags Right	Eartags (Color)	Collar Type	Comments
095	F	20	430	6/13/90	167	3027	(Y)	Normal	W/ad. mal
096	F	14	375	6/13/90	376	189	(Y)	Normal	Alone, broken leg
097	F	11	400	6/13/90	269	261	(Y)	Normal	W/2@1
098	F	11	375	6/13/90	28	152	(Y)	Normal	W/2@1
178	M	6	500	6/13/90	67	66	(R)	Spacer	Alone

Table 3. Current status of brown bears marked near Black Lake 1988-90.

Bear #	Sex	Age at last contact	Date last location	Current status
001	F	13	12/17/90	Alive, denned alone
002	F	2		Weaned by 06/14, status unknown
011	F	27	12/17/90	Alive, denned alone
012	F	11	10/19/90	Alive, w/2@1, den location unk.
013	F	4	06/14/90	Collar dropped by 06/24/90
017	F	20	12/17/90	Alive, denned alone
018	F	13	12/31/90	Alive, denned alone
023	F	20	06/14/90	Natural Mortality before 06/14
026	F	13	12/17/90	Alive, denned alone, lost 3 COY
030	F	11	12/31/90	Alive, denned alone
034	F	14	12/31/90	Alive, denned alone
037	F	7	12/31/90	Alive, denned alone
038	F	17	12/31/90	Alive, denned w/1@1
040	F	6	12/31/90	Alive, denned w/1 COY, lost 2 COY
046	F	12	07/09/90	Natural mortality by 08/06/90
048	M	5	06/01/90	Collar shed before denning in 1989
050	F	6	12/31/90	Alive, denned alone
051	F	14	12/17/90	Alive, denned alone
052	F	5	12/31/90	Alive, denned alone
055	F	11	12/17/90	Alive, denned alone
057	F	10	12/17/90	Alive, denned alone
058	F	20	12/17/90	Alive, denned w/2 COY
059	F	7	05/18/90	Hunter kill
060	F	10	12/31/90	Alive, denned w/1 COY, lost 2 COY
065	F	11	12/31/90	Alive, denned alone, lost 3 COY
070	F	8	12/31/90	Alive, denned w/2@2
076	F	15	12/17/90	Alive, denned alone
078	M	5	06/13/90	Mortality, cause unk.
082	F	15	12/31/90	Alive, denned w/1 COY, lost 2 COY
083	M	7	04/25/90	Collar shed before denning in 1989
087	F	13	12/17/90	Alive, denned w/3@2
090	F	20	12/18/89	Radio failed
091	M	5	10/11/90	Collar removed
092	F	4	04/25/90	Radio failed or hunter kill
095	F	20	12/31/90	Alive, denned alone
096	F	14	12/31/90	Alive, denned alone
097	F	11	12/17/90	Alive, denned w/1@1, lost 1 ylg
098	F	11	12/17/90	Alive, denned w/2@1
178	M	6	12/17/90	Alive, denned

Table 4. Survival rates of radio-marked brown bears at Black Lake, Alaska , 1988-90 calculated using modified Kaplan-Meir procedures.

CUBS-OF-THE-YEAR WITH RADIOED MOTHERS

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	17	0	1.00	0	0	1.00	1.00
5/16-5/23	17	0	1.00	0	2	1.00	1.00
5/24-5/31	19	0	1.00	0	2	1.00	1.00
6/1-6/7	21	0	1.00	0	6	1.00	1.00
6/8-6/15	27	3	0.89	0	0	0.78	1.00
6/16-6/23	24	0	0.89	0	0	0.77	1.01
6/24-6/30	24	1	0.85	0	0	0.72	0.98
7/1-7/31	23	4	0.70	0	0	0.55	0.86
8/1-8/31	19	3	0.59	0	0	0.42	0.76
9/1-9/30	16	1	0.56	0	0	0.37	0.74
10/1-10/31	15	2	0.48	0	0	0.31	0.66
11/1-4/30	13	2	0.41	5	0	ERR	ERR

YEARLINGS, ALL MORTALITIES, INCLUDING 3 ASSUMED MORTALITIES

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	4	0	1.00	0	0	1.00	1.00
5/16-5/23	4	0	1.00	0	5	1.00	1.00
5/24-5/31	9	0	1.00	0	3	1.00	1.00
6/1-6/7	12	0	1.00	0	9	1.00	1.00
6/8-6/15	21	0	1.00	0	4	1.00	1.00
6/16-6/23	25	0	1.00	0	0	1.00	1.00
6/24-6/30	25	0	1.00	0	0	1.00	1.00
7/1-7/31	25	4	0.84	0	0	0.71	0.97
8/1-8/31	21	0	0.84	0	0	0.70	0.98
9/1-9/30	21	0	0.84	0	0	0.70	0.98
10/1-10/31	21	0	0.84	4	0	0.70	0.98
11/1-4/30	17	0	0.84	0	0	0.68	1.00

ALL 2-YEAR OLDS, ALL MORTALITIES,

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	8	0	1.00	0	0	1.00	1.00
5/16-5/23	8	0	1.00	0	2	1.00	1.00
5/24-5/31	10	0	1.00	0	1	1.00	1.00
6/1-6/7	11	0	1.00	1	6	1.00	1.00
6/8-6/15	16	0	1.00	0	8	1.00	1.00
6/16-6/23	24	0	1.00	2	0	1.00	1.00
6/24-6/30	22	0	1.00	0	0	1.00	1.00
7/1-7/31	22	0	1.00	4	0	1.00	1.00
8/1-8/31	18	0	1.00	2	0	1.00	1.00
9/1-9/30	16	0	1.00	1	0	1.00	1.00
10/1-10/31	15	0	1.00	1	0	1.00	1.00
11/1-4/30	14	0	1.00	3	0	1.00	1.00

Table 4 (Con't.).

FEMALES >=3 ALL TYPES OF MORTALITY

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	52	0	1.00	1	1	1.00	1.00
5/16-5/23	52	1	0.98	2	14	0.94	1.02
5/24-5/31	63	1	0.97	0	28	0.92	1.01
6/1-6/7	90	1	0.95	0	0	0.91	1.00
6/8-6/15	89	1	0.94	1	4	0.90	0.99
6/16-6/23	91	0	0.94	1	0	0.90	0.99
6/24-6/30	90	0	0.94	0	0	0.90	0.99
7/1-7/31	90	3	0.91	0	0	0.86	0.97
8/1-8/31	87	0	0.91	0	0	0.86	0.97
9/1-9/30	87	0	0.91	2	0	0.86	0.97
10/1-10/31	85	4	0.87	1	0	0.80	0.94
11/1-4/30	80	0	0.87	1	0	0.80	0.94

FEMALES >=3 HUNTING MORTALITY ONLY

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	52	0	1.00	1	1	1.00	1.00
5/16-5/23	52	1	0.98	2	14	0.94	1.02
5/24-5/31	63	0	0.98	1	28	0.95	1.01
6/1-6/7	90	0	0.98	1	0	0.95	1.01
6/8-6/15	89	0	0.98	2	4	0.95	1.01
6/16-6/23	91	0	0.98	1	0	0.95	1.01
6/24-6/30	90	0	0.98	0	0	0.95	1.01
7/1-7/31	90	0	0.98	3	0	0.95	1.01
8/1-8/31	87	0	0.98	0	0	0.95	1.01
9/1-9/30	87	0	0.98	2	0	0.95	1.01
10/1-10/31	85	3	0.95	2	0	0.90	0.99
11/1-4/30	80	0	0.95	2	0	0.90	0.99

FEMALES >=3, NATURAL MORTALITY ONLY

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	52	0	1.00	1	1	1.00	1.00
5/16-5/23	52	0	1.00	3	14	1.00	1.00
5/24-5/31	63	1	0.98	0	28	0.95	1.01
6/1-6/7	90	1	0.97	0	0	0.94	1.01
6/8-6/15	89	1	0.96	1	4	0.92	1.00
6/16-6/23	91	0	0.96	1	0	0.92	1.00
6/24-6/30	90	0	0.96	0	0	0.92	1.00
7/1-7/31	90	3	0.93	0	0	0.88	0.98
8/1-8/31	87	0	0.93	0	0	0.88	0.98
9/1-9/30	87	0	0.93	2	0	0.88	0.98
10/1-10/31	85	1	0.92	4	0	0.86	0.97
11/1-4/30	80	0	0.92	1	0	0.86	0.98

Table 4. (Con't.).

MALES >=3, ALL MORTALITIES (ONE NATURAL AND ONE HUNTING)

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	2	0	1.00	0	0	1.00	1.00
5/16-5/23	2	0	1.00	0	10	1.00	1.00
5/24-5/31	12	0	1.00	1	7	1.00	1.00
6/1-6/7	18	0	1.00	0	0	1.00	1.00
6/8-6/15	18	0	1.00	0	1	1.00	1.00
6/16-6/23	19	0	1.00	0	0	1.00	1.00
6/24-6/30	19	0	1.00	1	0	1.00	1.00
7/1-7/31	18	0	1.00	3	0	1.00	1.00
8/1-8/31	15	0	1.00	1	0	1.00	1.00
9/1-9/30	14	0	1.00	1	0	1.00	1.00
10/1-10/31	13	2	0.85	3	0	0.67	1.03
11/1-4/30	8	0	0.85	5	0	0.62	1.08

BOTH SEXES >=3, ALL MORTALITIES

DATES	NO. @ RISK	NO. @ DEATHS	SURVIVAL RATE	NO. CENSORED	NO. ADDED	LOWER CI	UPPER CI
5/1-5/15	54	0	1.00	1	1	1.00	1.00
5/16-5/23	54	1	0.98	2	24	0.95	1.02
5/24-5/31	75	1	0.97	1	35	0.93	1.01
6/1-6/7	108	1	0.96	0	0	0.92	1.00
6/8-6/15	107	1	0.95	1	5	0.91	0.99
6/16-6/23	110	0	0.95	1	0	0.91	0.99
6/24-6/30	109	0	0.95	1	0	0.91	0.99
7/1-7/31	108	3	0.92	3	0	0.88	0.97
8/1-8/31	102	0	0.92	1	0	0.87	0.97
9/1-9/30	101	0	0.92	3	0	0.87	0.97
10/1-10/31	98	6	0.87	4	0	0.80	0.93
11/1-4/30	88	0	0.87	6	0	0.80	0.93

Table 5. Brown bear population estimates by Uniform Coding Units for areas open to hunting on the Alaska Peninsula (Game Management Unit 9) based on extrapolation from the Black Lake study area, and allowable harvests (calculated at 5% of estimated population).

UCU	Size sq. mi	Estimated Density (sq. mi.)	Extrapolated no. bears (sq. mi./bear)	Allowable Harvest	Average Annual harvest 1989-90
Subunit 9A					
0201	468	2	234		
0301	250	4	62		
Total	718	2.43	296	15	22
Subunit 9B					
0101	211	12	18		
0201	553	12	46		
0202	463	7	66		
0203	580	10	58		
0300	1,861	4	465		
0401	58	6	10		
0501	351	6	58		
0600	400	7	57		
0701	761	12	63		
0702	368	10	37		
Total	5,606	6.38	878	44	15
Subunit 9C					
0602	400	4	100		
0603	325	7	46		
0604	100	3	33		
0605	220	4	55		
0701	600	5	120		
0702	300	4	75		
Total	1,945	4.53	429	21	12
Subunit 9D					
0101	79	2	40		
0201	1,090	4.36	250		
0301	362	4	90		
0401	287	2	143		
0402	137	4	34		
0403	364	4	91		
0501	361	4	90		
0701	645	4	161		
Total	3,325	3.69	900	45	63

(continued on next page)

Table 5 (Con't.).

UCU	Size sq. mi	Estimated Density (sq. mi.)	Extrapolated no. bears (sq. mi./bear)	Allowable Harvest	Average Annual harvest 1989-90
Subunit 9E					
0101	306	7	44		
0201	608	5	121		
0301	243	7	35		
0302	250	7	36		
0400					
0501	1,000	3	333		
1501					
0601	503	7	72		
0700	1,100	3.8	287		
0801	400	3.7	107		
0901	207	4	52		
0902	233	4	58		
0903	299	3	100		
1001	501	4	125		
1002	268	3	89		
1101	976	4	244		
1201	764	5	153		
1301	965	3.5	276		
1401	118	3	39		
1601	172	3	57		
1701	492	3	164		
1801	367	3	122		
1901	226	3	75		
2001	770	2.5	308		
2101	469	4	117		
2201	649	4	162		
Total	11,886	3.74	3,176	159	165
Total Unit 9	23,480	4.13	5,679	284	278

Table 6. Black Lake stream survey results. 1982-90.

Date	Females w/young no.	%	COY no.	%	>COY no.	%	Single bears no.	%	Total sample	Bears per hour	Comments
1982											
8/8 am	26	19	25	19	25	19	58	43	134	40.20	
8/8 pm	27	18	37	25	29	20	55	37	148	50.74	
Mean	27	19	31	22	27	19	57	40	141	45.47	
1983											
8/9 pm	34	24	33	24	35	25	38	27	140	48.00	USFWS
8/10 am	41	25	49	29	34	20	43	26	167	51.12	USFWS
8/10 pm	29	19	42	28	24	16	56	37	151	61.22	USFWS
8/12 am	35	20	47	27	29	17	62	36	173	55.81	USFWS
Mean	35	22	43	27	31	20	50	32	158	54.04	
1984											
8/7 am	28	25	32	29	22	20	28	25	110	33.85	
8/7 pm	37	22	32	19	47	27	55	32	171	64.04	
8/8 am*	31	27	20	17	36	31	29	25	116	61.88	
8/8 pm	37	24	26	17	44	29	46	30	153	61.20	
Mean	33	24	28	21	37	27	40	29	138	55.24	
1985											
8/5 pm	47	23	35	17	60	29	64	31	206	68.70	
8/6 am	35	20	36	20	45	25	62	35	178	59.30	
8/8 am	47	22	37	17	65	30	66	31	215	67.90	
Mean	43	21	36	18	57	28	64	32	200	65.30	
1986											
8/6 pm	38	22	27	16	46	27	62	36	173	49.40	
8/7 am	25	15	17	10	36	22	85	52	163	51.40	
8/7 pm	41	20	29	14	44	22	88	44	202	61.60	
8/8 pm	34	20	21	13	40	24	71	43	166	47.40	
Mean	35	20	24	13	42	24	77	43	176	52.45	

* Includes the mean number of bears seen 3 other 1984 surveys for the portion not covered.

Table 6. (Con't.).

Date	Females w/young no.	%	COY no.	%	>COY no.	%	Single bears no.	%	Total sample	Bears per hour	Comments
1987											
8/7 pm	3	11	2	7	5	18	18	64	28		aborted
8/12 pm	27	18	34	23	28	19	58	39	147	51.88	late survey
1988											
8/8 pm	40	25	34	22	47	30	37	23	158	45.14	
8/9 am	51	24	49	23	65	30	50	23	217	62.00	
8/10 am	31	20	23	15	43	28	57	37	154	48.13	
8/10 pm	38	24	31	20	50	32	38	24	157	49.58	
Mean	40	23	34	20	51	30	46	27	172	51.21	
1989											
8/9 am	37	20	26	14	53	29	65	36	181	62.06	
8/9 pm	40	21	25	13	55	29	72	38	192	66.59	
8/10 am*	32	18	20	11	54	31	70	40	175	62.32	
8/12 am	34	19	20	11	56	32	65	37	175	66.88	
8/12 pm	39	22	19	10	64	35	59	33	181	65.03	
Mean	36	20	22	12	56	31	66	37	181	64.58	
1990											
8/3 pm	36	21	25	15	41	24	67	40	169	54.17	
8/4 pm	43	23	31	16	56	29	61	32	191	67.49	
8/5 pm	41	21	37	19	48	24	74	37	200	66.67	
8/6 pm	36	20	36	20	44	24	68	37	184	62.80	
8/7 am	38	21	41	22	43	23	61	33	183	61.00	
Mean	39	21	34	18	46	25	66	36	185	62.42	

* This survey includes the mean number of bears seen in the West Fork drainage on the other 1989 surveys.