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BROWN BEAR DENSITY ON THE ALASKA PENINSULA AT BLACK LAKE, ALASKA

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BROWN BEAR DENSITY ON THE ALASKA PENINSULA AT BLACK LAKE, ALASKA.

A preliminary report on completion of the density estimation objective of cooperative interagency studies on brown bears on the Alaska Peninsula supported by:

The US National Park Service,
The US Fish and Wildlife Service, and
The Alaska Dept. of Fish and Game.

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Abstract: Brown bear (Ursus arctos) density was estimated in a 469.31 mi^2 portion of the Alaska Peninsula near Chignik. The study area was a representative cross section of all habitats available to bears in an area considered to be receiving moderate hunting pressure. Six replicate searches were accomplished during 28 May-6 June, 1989. Using a bear days estimator described by Miller et al. (1987) estimated density for all bears was 2.0 mi^2/bear with a 95% CI of 1.74-2.27 mi^2/bear, estimated density for independent bears (excluding offspring with their mothers) was 3.13 mi^2/bear (95% CI=2.62-3.66), and estimated density for bears older than 2.0 years in estimated age was 2.67 (95% CI = 2.27-3.07). For data of this type, Eberhardt (in press) recommended using the mean of Lincoln-Petersen estimates obtained during each replicate and confidence intervals based on the variance of this mean. Using this approach the density estimate for all bears was 1.93 mi^2/bear (95% CI = 1.59-2.47), for independent bears the estimate was 3.10 (95% CI = 2.63-3.78), and for bears older than 2.0 years in age the estimate was 2.64 (95% CI = 2.17-3.35). In this study the sample sizes were large (estimated total population was 242.7 bears and estimated number of independent bears was 151.41), sightability was high (42% for independent bears), and proportion of the population marked averaged 28%. Because of the large sample, the bias correction factor proposed by Eberhardt (in press) resulted in no change from the original estimates.

As speculated elsewhere (Miller et al. 1987, Miller and Ballard 1982), at Black Lake females accompanied by newborn cubs were thought to have lower sightability than other segments of the population. Under the circumstances existing during this study, this bias would most likely result in an underestimation of bear density. We estimated, based on number of females with litters of yearlings, that this bias could have caused an underestimation of 4% in number of independent bears.

Bear density varied markedly between different quadrats in the search area. An estimate of the density of bears in each quadrat during spring was independently obtained using the estimated total number bears present and data for each quadrat on search effort expended per bear seen. Based on this we estimated that a quarter of the search area had an overall density of 1 mi^2/bear and a quarter of the area had a density less than 5 mi^2/bear.

Acknowledgements: During spring 1989, field assistance was provided by Dale Taylor and Ron Squibb (Natl. Park Service), Rich Poetter and Dwight Mumma (Fish and Wildlife Service), and Ken Taylor, Bill Taylor, and Larry Van Daele (Alaska Fish and Game). Special thanks are due to Dennis McAllister who organized the equipment, and Bill Taylor for supervising the immobilization procedures. Additional support for field activities was provided by Karl Schneider, John Trent, and Dave Johnson. Greg Bos (ADF&G) and Layne Adams (NPS) merit recognition for their efforts in getting this project approved. Our special thanks to fixed-wing pilots Harley McMahon, Chuck McMahon, Jerry Lee, and Joe Collins and to helicopter pilot Chris Soloy. This project was funded with equal financial contributions from the National Park Service, the Fish and Wildlife Service, and the Alaska Dept. of Fish and Game.

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METHODS

Bears were captured and marked during 21-24 May 1989 following procedures outlined by Miller and Sellers (1988). Bears were captured in the order they were spotted by a fixed-wing aircraft. During the first days of the capture operation, 4 previously radio-marked bears were still in dens, 2 of these were subsequently determined to have litters of newborn cubs.

A study area was described which represented a cross section of habitat across the Alaska Peninsula from the Pacific coast to the Bristol Bay coast. The study area was wedge-shaped and the borderes were drawn to benefit from natural barriers to movement. The total circumference of the study area was approximately 165.3 km. Of this large bodies of water (Chignik Lagoon(20.5 km), Bristol Bay(9.8 km), Black Lake(10.6 km) and Chignik Lake(11.6 km)) represented 32%, the Chignik River (18.8 km) represented 11%, and high mountain ridges (23.3 km) represented 14%. Except for the relatively minor barrier represented by the Chignik River these were very effective barriers to movement. The remaining 43% of the periphery (70.7 km) represented no barrier to bear movements but almost all of this was on the Bristol Bay flatlands where there were few bears to challenge our boundaries. The study area encompassed a 2-dimensional area of 469.31 mi^2. This area was broken up into 11 quadrats. Following procedures described by Miller et al. (1987), each quadrat was searched during each replicate by 1 of 4 search planes. It was determined which radio-marked bears were present within the total area searched during each survey. Six replicate searches were accomplished during the period 28 May-4 June. Replicates 3 and 4 were both accomplished on 31 May. The western portion of replicate 5 was accomplished on 1 June and the eastern portion on 3 June because of weather conditions. All other replicates were accomplished on 1 day. Weather conditions precluded complete searches of portions of some quadrats on some days; areas missed were the higher elevations where clouds were sometimes present or where wind conditions precluded safe flying. Radio-marked bears seen during these searches were classified as recaptures of marked animals, bears seen that were not radio-marked were classified as captures of unmarked animals. Following procedures utilized by investigators applying this technique in other areas of high bear density (Barnes et al. 1988, Schoen 1988), unmarked bears seen during searches were not captured and marked.

Search planes were instructed to search at an intensity of approximately 2 minutes/mi^2 on the Bristol Bay flats where bears are highly visible (quadrats 1-3) and at approximately 3 minutes/mi^2 in the more mountainous terrain (quadrats 4-11). We estimated that these different search intensities would make the probability of seeing any individual bear more nearly equal between these different habitats and, considering the 3-dimensional nature of the mountanous terrain, made actual search intensity more nearly equal between quadrats.

In calculating estimates of total population size, offspring accompanying their mothers were classified as marked or unmarked depending on whether their mother was marked or unmarked. This procedure violates the basic assumption that observations are independent of each other. Simulation studies have indicated that violation of this assumption results in a slight tendency to overestimate population size and in an underestimation of variance associated with the estimate (Miller in press). The degree to which the variance is underestimated is directly related to the degree to which the independent assumption is violated. In order to avoid this bias an additional estimate was calculated for "independent" bears (Barnes et al. 1988). This is a population estimate which excludes dependent offspring of whatever age. In order to provide a comparison with densities in other areas where bears may separate from their mothers at different ages, a third density estimate was calculated for that segment of the population 2 years old or older. This eliminates the dependence problem with cubs and yearlings but has more dependence problems than the estimate of independent bears since some 2- and 3-year olds are still with their mothers.

These data were analyzed using the bear-days estimator described by Miller et al. (1987) and using the mean of Lincoln-Petersen estimates from each replicate as recommended by Eberhardt (in press). The sample estimate of variance for this estimate described by Eberhardt(in press) was:

$$s2 = \frac{\text{summation}(N_i - \text{Nbar})^2}{(k-1)}$$

where k is the number of replicate estimates available, and Nbar is the mean of the estimates from each replication. The confidence interval for this estimate described by Eberhardt (in press) is:

$$+/- \frac{(s)*(t)}{(k)^{1/2}}$$

where (t) has (k-1) degrees of freedom and is read from a table of T statistics for the alpha level desired (95% and 80% CIs are reported here).

Eberhardt (in press, equation 13) also proposed a bias correction factor designed to correct for bias that results from low sample size and low number of resighted marks.

This correction factor was applied to the data collected in this study.

Sightability was calculated as the proportion of bears present that were seen. Proportion of the population marked was calculated as mean of the daily values based on the number of marks present divided by the Lincoln-Petersen estimate for that day.

RESULTS AND DISCUSSION

Prior to the census estimate 40 bears were captured and marked. One mortality resulted from the capture operation when a partially immobilized 2-year old bear fell off a cliff. Capture statistics and marking information for bears captured in spring 1989 are presented in Table 1.

The results for each replicate flight are presented in Table 2. A high level of natural closure (88.9%) occurred in this study area because of natural barriers to movements (Table 2). Sightability of bears was high, marked bears were seen on 42.2% of the occasions they were present. Sightability of marked bears varied from 27.9% during replication 1 to 56.8% during replication 2 (Table 3). Average proportion of the population marked was 28%. Data on observations of marked and unmarked bears seen during each replicate are summarized in Table 3.

A minimum number of bears known to be present was calculated as the sum of marked bears present and unmarked bears seen. For bears of all ages this minimum number averaged 138.2 bears (range = 124-162) (Table 3). A density estimate based on the largest value for the minimum number of bears known to be present (162) was 2.90 mi^2/bear. This was the number of bears known to be present during replication 4.

Capture-recapture estimates were calculated in two ways. The first way was the "bear-days" estimator described by Miller et al. (1987) and the second was the mean of the daily Lincoln-Petersen estimates and confidence intervals based on the sampling variance of this mean as described by Eberhardt (in press).

Using the bear-days estimator the mean number of bears present on the study area during the search period was 234.7. The calculated 95% CI around this estimate based on the normal approximation to the binomial was 207.1 to 269.8 bears or -11.8% to +15.0% of the estimate. The corresponding density estimate was 2.0 mi^2/bear (95% CI = 1.74-2.27). Because of violation of the independent observation assumption the true 95% CI would be larger than this calculated interval (Miller in press). The number of independent bears was estimated to be 150.0 (95% CI = 128.3-179.4) (Table 4). Estimates for all bears and for independent bears based on the bear-days estimator are provided in Table 4 and illustrated in Figs. 1 and 2. The bear-days estimator is equivalent to using the means of each of the 3 Lincoln-Petersen parameters (number of marks present, number of marks seen, and total number of bears seen) and this estimator was well-behaved in simulation studies (Eberhardt in press).

The population estimate for all bears based on the mean of Lincoln-Petersen estimates obtained for each replicate was 242.7, 3.4% higher than the bear-days estimate. The 95% CI for the mean Lincoln-Petersen estimate based on the sampling variance was +/- 52.5 bears or +/-21.6% of the point estimate (Table 5). The lower limit for this estimate was 190.2 bears; this value is larger than the minimum number of bears known to have been present on one day during the search period (162 bears), so the lower limit was not truncated at this minimum value. The range of this CI encompassed 105 bears compared to 62.7 bears encompassed by the range of the 95% CI based on the bear-days estimate and the binomial approximation to the normal. The population estimate for independent bears based on the mean of Lincoln-Petersen estimates was 152.6 bears with a 95% CI of +/-27.2 bears. Changes in the estimates based on the mean of Lincoln-Petersen estimates that occurred during the course of the study period are presented in Table 5 and illustrated in Figs. 3 and 4. The confidence interval for this estimate was very broad until replication 4 (Figs. 3 and 4). This supports the suggestion by Eberhardt (in press) that at least 3 replications are necessary.

Population estimates for the population of bears aged 2.0 and older are presented in Table 4 using the bear-days estimator and in Table 5 using Eberhardt's approach. As expected, this estimate (178 bears) was intermediate between that for the whole population (243) and that for the population of independent bears (153) (Table 4).

Each of these 3 estimates for differing portions of the population has a distinct utility. The estimate of the number of independent bears (excluding dependent young) is the most valid in a statistical sense since the problem of dependent observations is reduced. For comparisons of trend within an area, this estimate has fewer problems. For many management purposes, however, the other estimates-even with their larger statistical flaws-may be more useful. Estimates of total population or population older than 2.0 may be more useful in comparisons of density between areas when age at independence is different in each area. Extrapolation of the estimate of bears older than 2.0 to obtain a population estimate of bears that can legally be hunted is desirable in some cases. The total population estimate may be most useful in cases where exploitation rate is expressed as a function of total population.

SOURCES OF BIAS AND POTENTIAL CORRECTIONS

It appears likely that the application of capture-recapture techniques to estimate bear density at Black Lake resulted in a more accurate and more precise estimate than has occurred in other applications of these procedures in Alaska. The Black Lake study benefited from high sample sizes compared to density estimates obtained in low-density populations in Game Management Units (GMUs) 13 and 23 (Miller 1988, Ballard et al. 1988). Compared to density estimates obtained in areas with high bear densities (GMUs 4 and 8) (Barnes et al. 1987 and Schoen in prep), this study had more replicates and included a larger search area with more bears, and somewhat higher sightability. An application in GMU 20 (Reynolds et al. 1987) suffered from relatively small sample size, fewer replications, and low sightability.

Capture heterogenity is a likely source of bias in all of these estimates. Females accompanied by newborn cubs may have lower capture probability and lower sightability than other bears (Miller et al. 1987, Miller and Ballard 1982). Low sightability of this group results from late emergence from dens, a tendency to remain in high elevation habitats where spotting bears is more difficult because of weather and other hazards to flying, an increased tendency to hide from spotting planes, and more sedentary behavior. These biases would result in an underestimate of population density unless females with newborn cubs had a disproportionately high number of the marks distributed in the population. Only 2 females with newborn cubs were marked in the Black Lake study area, both had been marked in 1988 during the premarking phase of this study. During the marking phase of work conducted in spring 1989, no females with newborn cubs were observed and the 2 previously-marked females with newborn cubs were still in dens. Females with newborn cubs were also apparently underrepresented in the sample of bears seen during the density estimation phase when 22 groups with newborn cubs were spotted compared to 45 and 44 groups composed of a female with yearling or offspring older than yearling, respectively (Table 6). Of 29 adult marked females (based on estimated age >5.0) that were present in the search area at least once during the density estimation phase (Table 2), 14 were without offspring. Of the remaining females only 2 (13.3%) had newborn cubs compared to 5 (33.3%) with yearlings, and 8 (53.3%) with offspring classified as "older than yearling" For 38 observations of unmarked bears accompanied by offspring, 34.2% were of groups with newborn cubs compared to 52.6% with "yearlings" and 13.2% with offspring "older" than yearlings (Table 3). These observations doubtless include repeated sightings of the same group and the quotation marks indicate that the ages of the offspring were estimated by the observer. These observations support the hypothesis that females with newborn cubs were underrepresented both in the sample of marked bears and in the sample of unmarked bears observed.

Under these circumstances it would be instructive to make separate estimates of the population size for all bears except females with newborn cubs and their cubs as proposed by Miller et al. (1987). Using the bear-days estimator, the population composed of independent bears excluding females with newborn cubs was estimated as 139.6 bears (95% CI = 119.3-167.4); the mean Lincoln-Petersen for this estimate was 141.3 bears. These estimates are only about 10 bears less that the estimate for total independent bears (150) (Table 4).

However, there were probably more than 10 females with newborn cubs in the study area. Sample sizes are too small to directly estimate number of females with newborn cubs, but it would be reasonable to assume that there were at least as many such females as there were females with yearling offspring. In fact, there would probably be more females with cubs than females with yearlings because some complete litters of newborns would be lost before reaching yearling age. An estimate of 17.1 females accompanied by yearlings was derived using the bear-days estimator and the capture recapture records listed in Table 2 (95% CI= 11.3-

32.3); an estimate of 18.9 females with yearlings was derived using the mean of the Lincoln-Petersen estimates. An estimate of the number of independent bears in the search area "corrected" for capture bias against females with newborn offspring would be 139.6 (bears excluding females with newborn cubs) plus 17.1 females with newborn cubs based on the estimated number of females with yearlings for a total of 156.7 bears. This "adjusted" estimate is only slightly higher than the original estimate for number of independent bears (150 bears) (Table 4). This suggests that the bias resulting from the suspected low sightability of females with newborn cubs may have resulted in an underestimate of only 4% in bear numbers and bear density. This is probably an underestimate of the number of females accompanied by yearlings because some yearlings were probably classified as older offspring.

During the density estimation phase of this study we obtained 607 observations of bears in groups of from 1 to 4 individuals (Table 6). More bears occurred in groups (465) than alone (142) and, including groups of 1, the mean group size was 1.94 bears (Table 6). Of 102 observations of groups composed of "adults", single bears, and sibling groups, 53 (26.2%) were groups of "adults" (Table 6), as would be expected during the breeding season when this study occurred. Treating bears in groups as independent sightings when, in fact, they were, to some degree, dependent sightings is a source of bias. Simulation studies indicate this bias results in underestimation of variance and results in a slight overestimation bias (Miller in prep.).

DENSITY CHARACTERISTICS OF STUDY AREA

The above-described density estimates pertain to a study area where spring brown bear densities ranged from very high in some portions to very low in others. At this time of year bears are concentrated in the mountains and foothills and on southerly exposures. There were relatively few bears on the flatlands between the mountains and Bristol Bay (quadrats 1-3) or on northerly aspects of the mountains (quadrat 5). Search effort in each quadrat during each replicate is provided in Table 8 and averaged 2.38 minutes/mi^2 (0.92 minutes/km^2).

In different quadrats the average search effort per independent bear seen (excludes dependent offspring) varied from 9 to 60 (Table 8). A ranking of the different quadrats by this criteria resulted in almost the same ranking as would have been obtained using the number of bears seen per mi^2 (Table 8). There was also little difference in this ranking and a ranking based on total number of bears seen, including dependent young (Table 8). Therefore, search effort per independent bear seen was used to obtain an approximation of the density of bears in each quadrat. This was done by calculating the bears seen/minute (the reciprocal of the mean number of minutes searched per bear seen in each quadrat) (x_i). These reciprocals were summed over all quadrats and the proportion of this sum for each quadrat was calculated as the value (P). Then (P)(242.7) was the estimated total number of bears in each quadrat where 242.7 is the estimated number of bears in the whole search area derived from the mean of the Lincoln-Petersen estimates. This was converted to a density figure using the area of each quadrat (Table 9). On this basis it was calculated that the highest density was in quadrat 10 (0.85 mi^2/bear) and the lowest density was in quadrat 2 (7.17 mi^2/bear) (Table 9). The 2 lowest density quadrats based on these calculations represented 24.4% of the search area and together had a density of 5.39 mi^2/bear (Table 9).

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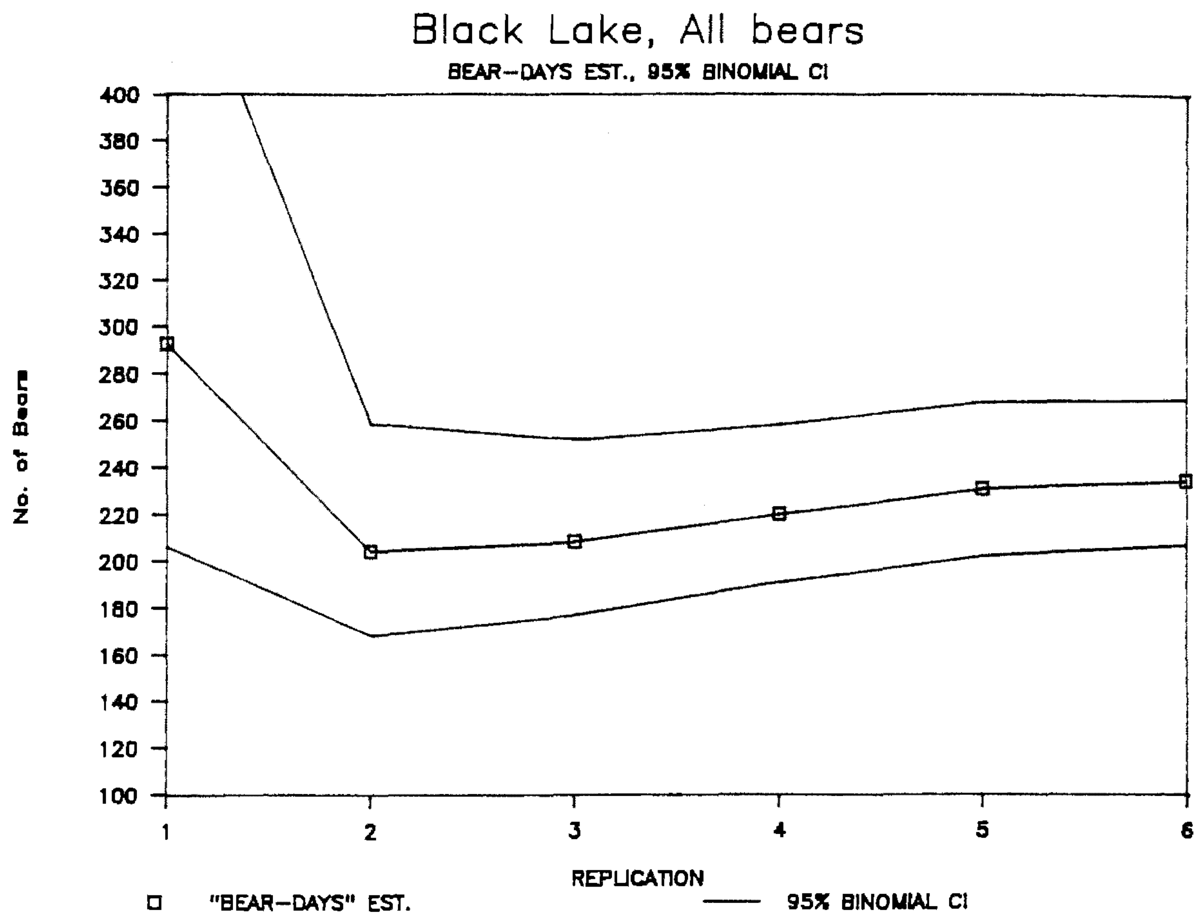
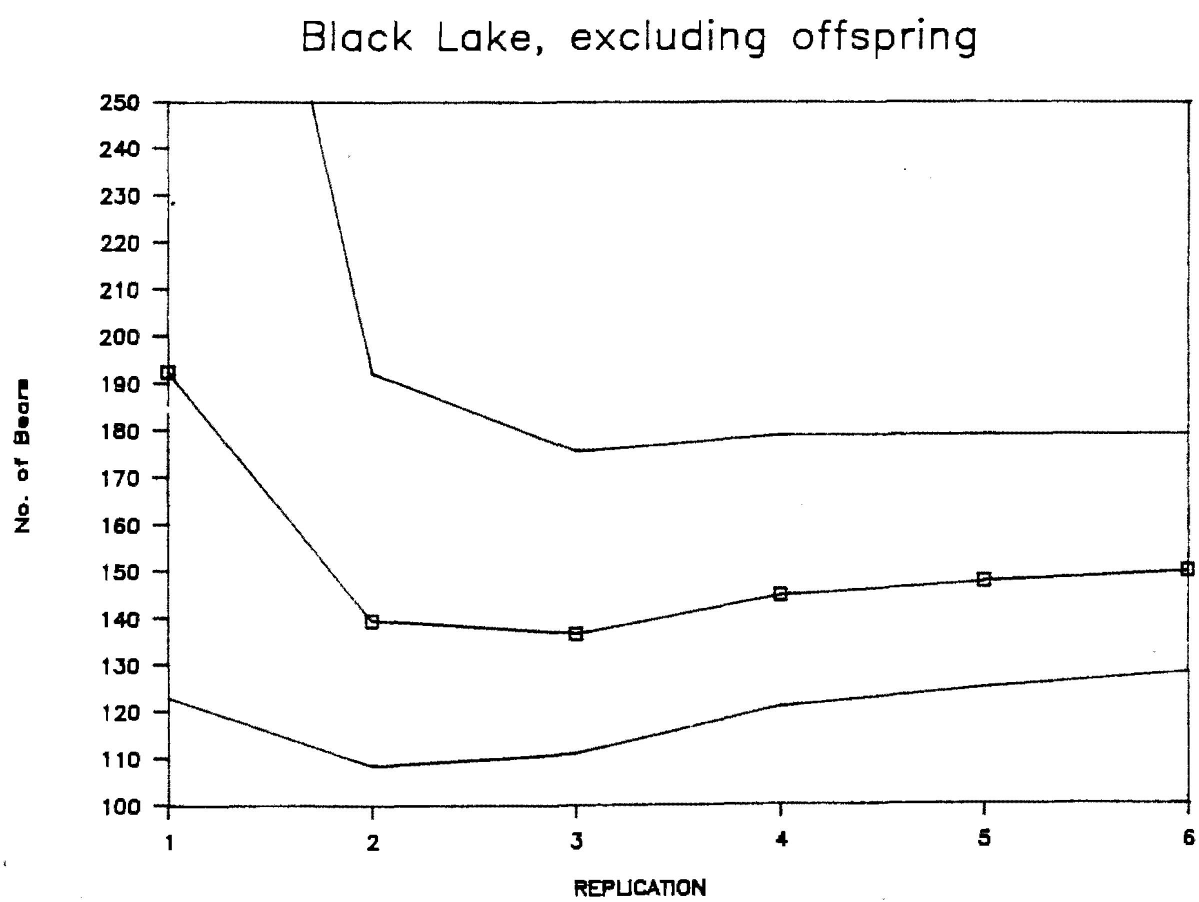
Figure 1. Trend in bear density estimate and 95% binomial CI using the bear-days estimator of Miller et al. (1987). Estimate includes dependent offspring assumed to have been sighted independently of their mothers.

Figure 2. Trend in bear density estimate and 95% binomial CI using the bear-days estimator of Miller et al. (1987). Estimate is for number of independent bears, excluding dependent offspring.



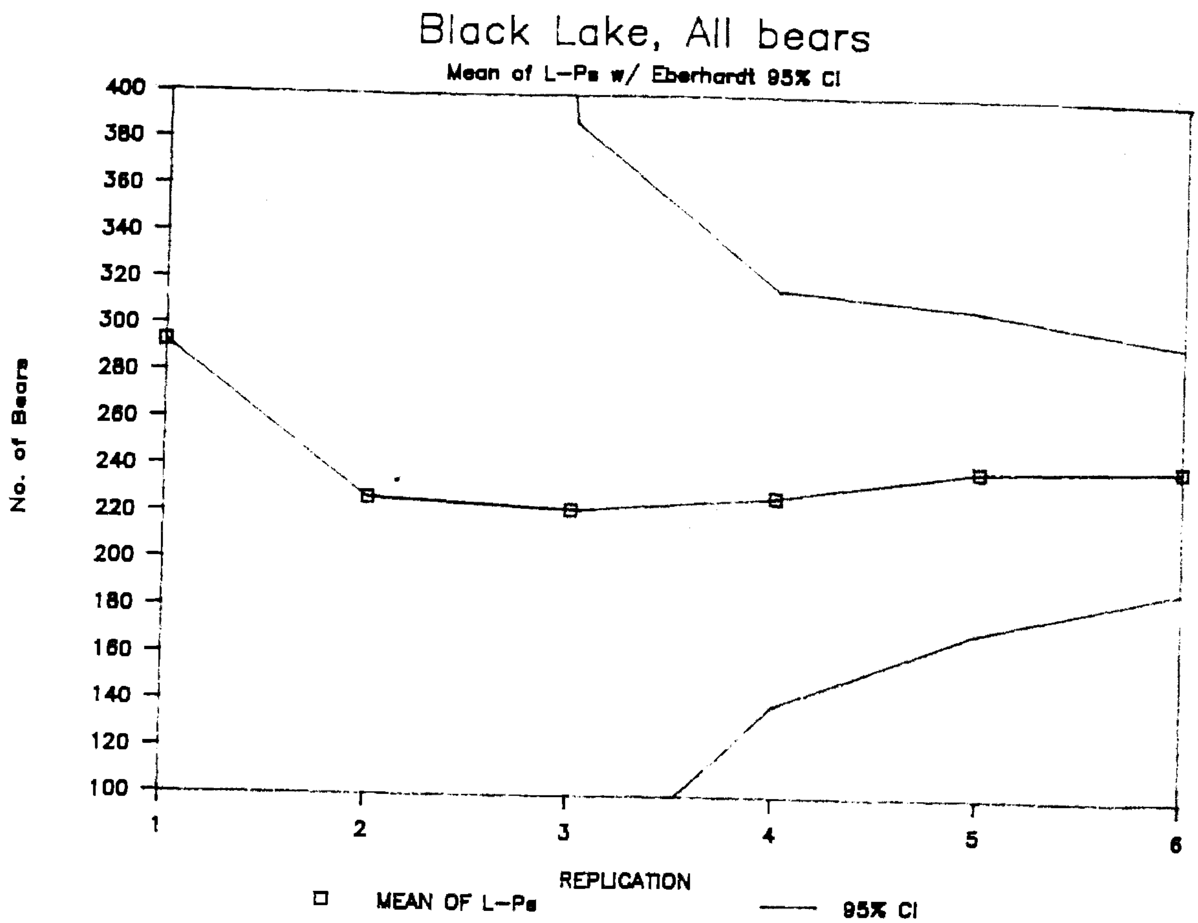
Black Lake, All bears
BEAR–DAYS EST., 95% BINOMIAL CI
No. of Bears
REPLICATION
"BEAR–DAYS" EST.
95% BINOMIAL CI



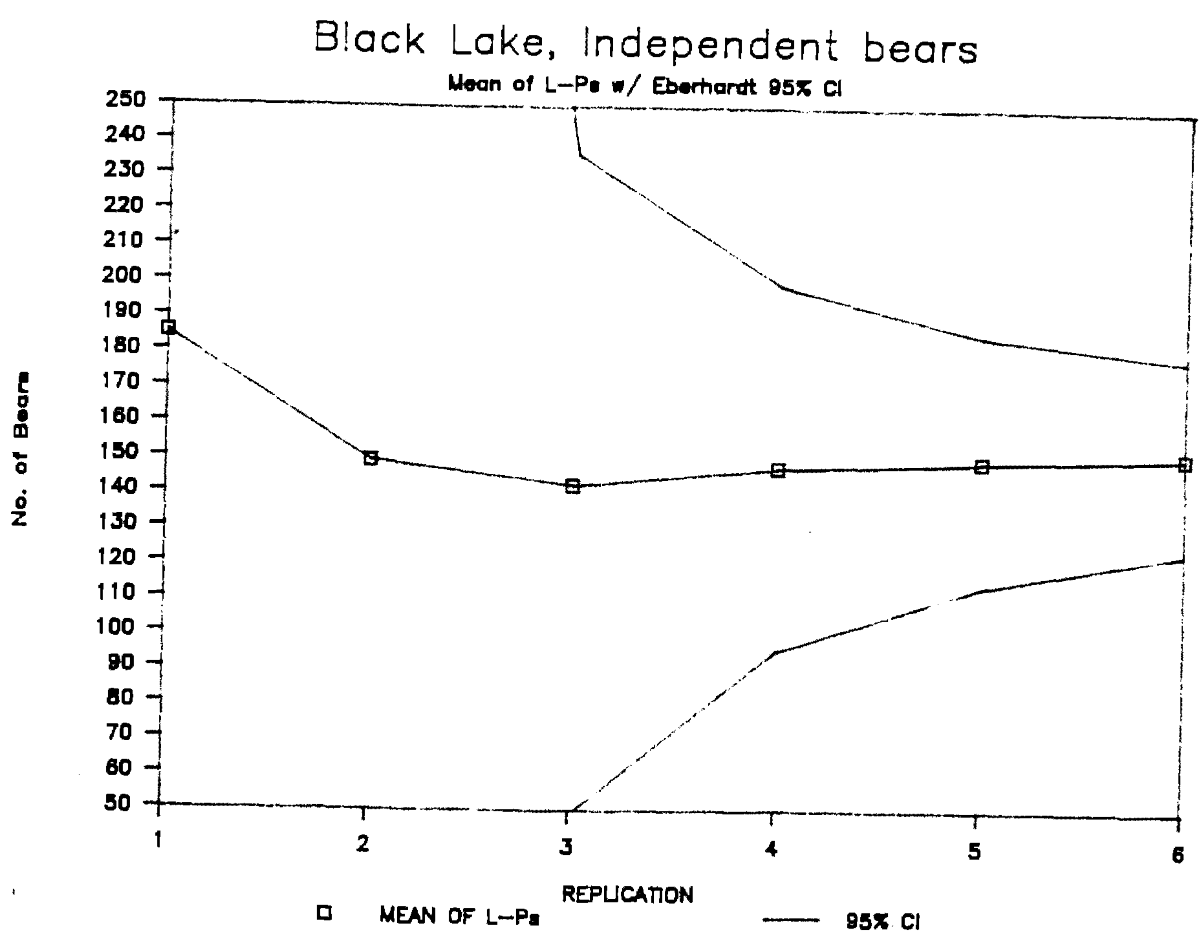
Black Lake, excluding offspring
No. of Bears
REPLICATION

Figure 3. Trend in bear density estimate using the mean of Lincoln Petersen estimates and confidence interval based on sample variance of this mean (Eberhardt in press). Estimate includes dependent offspring who were assumed to have been sighted independently of their mothers.

Figure 4. Trend in bear density estimate using the mean of Lincoln Petersen estimates and confidence interval based on the sampling variance of this mean (Eberhardt in press). Estimate excludes dependent offspring still associated with their mothers.



Black Lake, All bears
Mean of L-Ps w/ Eberhardt 95% CI
No. of Bears
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
1
2
3
4
5
6
REPLICATION
MEAN OF L-Ps
95% CI



Black Lake, Independent bears
Mean of L-Ps w/ Eberhardt 95% CI
No. of Bears
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
1
2
3
4
5
6
REPLICATION
MEAN OF L-Ps
95% CI

Table 1. Brown bears captured in Black Lake Study area during spring 1989.

ID	SEX	ESTAGE	WT. (LBS)	CAPTURE DATE	EARTAGS LEFT	EARTAGS RIGHT	RADIO S. N.	RADIO TYPE	FLAGS		SKULL LENGTH	SIZE WIDTH	COMMENTS
59	F		450*	5/21/89	3047	3037	29723		W	CF	377	207	
5	M	15	800*	5/21/89			32235	glue-on	O	HUMP	437	268	
58	F		400*	5/21/89	093	094			W	CF			W/2@2,OLD COLLAR
51	F		375*	5/21/89	056	055			W	CF			OLD COLLAR
60	F	10	450*	5/21/89	3060	3091	34069		W	CF	388	220	
61	F	2	200*	5/21/89	3024	3083	32234	glue-on			306	175	
62	M	2	170*	5/21/89	--	--	---						CAPTURE MORTALITY
49	M	10	850*	5/21/89	011	012	32236	glue-on	G	BACK	401	269	
64	M	10	1200*	5/22/89	2642	2627	34071	glue-on			433	270	
65	F	9	450*	5/22/89	3077	3084	34065		W	CF	391	236	W/1@2 (#66)
66	M	2	195	5/22/89	2666	2647	34073	glue-on					W/#65
67	F	3	175*	5/22/89	3005	3062	34060		W	CF	357	189	
68	M	6	450*	5/22/89	2508	2672	29751		R	CF	389	221	
42	M	5	450*	5/22/89	025	026	34070	glue-on	Blk	BACK	417	234	
71	M	10	720	5/22/89	89	14	29744	w/spacer	R	CF	435	269	
69	F	15	390	5/22/89	3299	3295	29725		W	CF	362	237	W/3@1
70	F	6	375*	5/22/89	3055	3095	34068		W	CF	384	225	W/2@1
72	M	8	775*	5/23/89	052	092	34075	glue-on			392	229	
31	M	3		5/23/89	100	099	6306	surg.tube	G	CF	235	171	LAST YR'S MARKS
73	M	3	250*	5/23/89	2636	2650	32237	glue-on			347	191	
74	M	3	275*	5/23/89	045	064			Y	BACK	336	192	NO RADIO
75	F	4	300*	5/23/89	3065	3054	34061		W	CF	348	196	
76	F	14	560	5/23/89	3092	3010	34064		W	CF	403	249	W/1@3 (#77)
77	F	3	310	5/23/89	3012	3013	32233	glue-on			373	208	W/mom #76
78	M	5	450*	5/23/89	2663	2682	15276	w/spacer	R	CF	385	205	

Continued....

Table 1. Continued.

ID	SEX	ESTAGE	WT. (LBS)	CAPTURE DATE	EARTAGS LEFT	EARTAGS RIGHT	RADIO S. N.	RADIO TYPE	FLAGS		SKULL LENGTH	SIZE WIDTH	COMMENTS
79	M	12	1050	5/23/89	078	009	34074	glue-on			472	299	
80	F	13	566	5/23/89	3207	3216	34066		Y	CF	420	250	
81	M	3	340	5/23/89	2519	2501	14885	w/spacer	O	CF	356	188	s/n maybe 14985
82	F	15	450*	5/23/89	3085	3074	34062		W	CF	387	250	W/2@2 and #83
83	M	5	496	5/23/89	2639	2518	29726	w/spacer	R	CF	407	235	W/#082
84	M	3	310	5/24/89	65	62	32238	glue-on			353	207	
85	M	10	1000*	5/24/89	2652	2693	34072	glue-on			445	284	
86	M	5	460	5/24/89	74	73	29729	surg.tube	R	CF	393	220	
87	F	8	450*	5/24/89	003	004	34063		W	CF	382	236	W/3@1
13	F	3	185	5/24/89	83	84	29751	surg.tube	W	CF	320	170	
88	F	15	600*	5/24/89	037	087	6315		W	CF	391	243	W/ male #89
89	M	14	900*	5/24/89	090	013	34071	glue-on			444	272	W/female #88
90	F	18	500*	5/24/89	3201	3006	34067		W	CF	395	241	W/1@1
91	M	3	350*	5/24/89	077	010	29721	w/spacer	R	CF	366	207	
92	F	2	150*	5/24/89	3072	3100	29756	w/spacer	W	CF	308	163	

* Estimated weight

Table 2. Status of marked brown bears during density estimation study at Black Lake during spring 1989. Data for each replication are summarized in Table 2.

		Young			REP.1 (5/28)			REP.2 (5/30)			REP.3 (5/31 am)			REP.4 (5/31 pm)		
ID	Sex	Est. Age	Initial No.	Est. Age	Stat.	Group Size	Seen?	Stat.	Group Size	Seen?	Stat.	Group Size	Seen?	Stat.	Group Size	Seen?
67	F	3			in	1	yes	in	1	yes	in	1		in	1	yes
31	M	3			in	1		in	1		in	1	yes	in	1	yes
75	F	4			out			out			out			out		
37	F	8	1	2	in	2		in	2	yes	in	1	yes	in	1	yes
82	F	15	2	2	in	1		in	1		in	1		in	1	
88	F	15			in	1		in	1	yes	in	1		in	1	
87	F	8	3	1	in	4		in	4	yes	in	4		in	4	yes
48	M	4			in	1		in	1	yes	in	1		in	1	yes
91	M	3			in	1		in	1		in	1		in	1	
46	F	16			in	1		in	1		in	1		in	1	
59	F	A			in	1		in	1	yes	in	1	yes	in	1	yes
30	F	12			in	1		in	1	yes	in	1	yes	in	1	yes
69	F	15	3	1	in	4		in	4	yes	in	4	yes	in	4	
83	M	5			in	1		in	1		in	1		in	1	yes
76	F	14	2	3	in	3	yes	in	1	yes	in	1	yes	in	1	
78	M	5			in	1	yes	in	1	yes	in	1	yes	in	1	
53	F	3			in	1	yes	in	1	yes	in	1	yes	in	1	yes
34	F	17	3	1	in	4		in	4		in	4		in	4	yes
86	M	5			in	1		in	1	yes	in	1	yes	in	1	yes
65*	F	9	1	2	in	2	yes	in	1	yes	in	2	yes	out	2	
50	F	8			out	1		out			out			out		
8	F	3			out	1		out			out			out		
18	F	15			in	1		in	1		in	1		in	1	
16	F	4			in	1		in	1	yes	in	1	yes	in	1	
12	F	9	2	0	in	3		in	3	yes	in	3	yes	in	3	yes
11	F	22			in	1		in	1		in	1		in	1	yes
38	F	16	2	0	in	3		in	3		in	3		in	3	
1	F	17	1	2	in	2	yes	in	2	yes	in	2	yes	in	2	yes
51	F	14	3	2	in	3	yes	in	3		in	2		in	2	
81	M	3			in	1		in	1	yes	in	1	yes	in	1	yes
71	M	10			in	1	yes	in	1		in	1		in	1	
17	F	19			in	1	yes	in	1		in	1		in	1	yes
26	F	13			in	1		in	1		in	1		in	1	
55	F	8			in	1		in	1	yes	in	1		in	1	
57	F	7			in	1		in	1		in	1		in	1	
43	F	5			in	1		in	1		in	1		in	1	
13	F	3			in	1		in	1		in	1		in	1	yes
52	F	4			out			out			out			out		
80	F	13			out			out			out			out		
23	F	17	2	2	in	3		in	3	yes	in	3		in	3	yes
58	F	15	2	2	in	3	yes	in	3	yes	in	3	yes	in	3	
92	F	2			in	1		in	1		in	1		in	1	
40	F	6			in	1		in	1		in	1		in	1	
77	F	3			in	1	yes	in	1	yes	in	1	yes	in	1	
61	F	2			shed											
5	M	A			shed											
90	F	18	1	1	in	2		in	2		in	2		in	2	
70	F	6	2	1	in	3		in	3	yes	in	3	yes	in	3	yes
49	M	10			shed											
73	M	3			shed											
84	M	3			in	1		in	1	yes	in	1	yes	in	1	
60	F	10			in	1	yes	in	1	yes	in	1	yes	in	1	yes
85	M	10			shed											
66*	M	2			w/65			in	1	yes	w/65			w/65		
79	M	12			shed											
89	M	14			shed											

* Bear #66, a collared 2 year-old with #65, is treated as an independent bear when not with #65 (replication 2).

Continued...

Table 2. Continued.

ID	Sex	REP.5 (6/1-3) Stat.	REP.5 Group Size	REP.5 Seen?	REP.6 (6/4) Stat.	REP.6 Group Size	REP.6 Seen?	No. Young	Summary No. out	Summary No. in	Summary No. seen	Summary % in	Summary % seen
67	F	in	1	yes	in	1			0	6	4	100	66.7
31	M	in	1	yes	in	1			0	6	3	100	50.0
75	F	out			out				0	0	-	--	--
37	F	in	1	yes	in	1	yes		0	6	5	100	83.3
82	F	in	1	yes	in	1			0	6	1	100	16.7
88	F	in	1		in	1			0	6	1	100	16.7
87	F	in	4	yes	in	4			0	6	3	100	50.0
48	M	in	1		in	1	yes		0	6	3	100	50.0
91	M	in	1	yes	in	1			0	6	1	100	16.7
46	F	in	1	yes	in	1			0	6	1	100	16.7
59	F	in	1		in	1	yes		0	6	4	100	66.7
30	F	in	1	yes	in	1	yes		0	6	5	100	83.3
69	F	in	4		in	4	yes	3	0	6	3	100	50.0
83	M	in	1		in	1	yes		0	6	2	100	33.3
76	F	in	1	yes	in	1	yes		0	6	5	100	83.3
78	M	in	1		in	1			0	6	3	100	50.0
53	F	in	1		in	1			0	6	4	100	66.7
34	F	in	4		in	4	yes	3	0	6	2	100	33.3
86	M	in	1		out	1			1	5	3	83.3	60.0
65	F	out			out	2			3	3	3	50	100.0
50	F	out			out				6	0	-	0	--
8	F	out			out				6	0	-	0	--
18	F	in	1		in	1	yes		0	6	1	100	16.7
16	F	in	1		in	1			0	6	2	100	33.3
12	F	in	3		in	3			0	6	3	100	50.0
11	F	in	1	yes	in	1	yes		0	6	3	100	50.0
38	F	in	3		in	3			0	6	0	100	0.0
1	F	in	2		in	2			0	6	4	100	66.7
51	F	in	4	yes	in	4			0	6	2	100	33.3
81	M	in	1		in	1	yes		0	6	4	100	66.7
71	M	in	1	yes	in	1	yes		0	6	3	100	50.0
17	F	in	1		in	1	yes		0	6	3	100	50.0
26	F	in	1		in	1			0	6	0	100	0.0
55	F	in	1		in	1			0	6	1	100	16.7
57	F	in	1	yes	in	1			0	6	1	100	16.7
43	F	in	1		in	1			0	6	0	100	0.0
13	F	in	1	yes	in	1			0	6	2	100	33.3
52	F	out			out				6	0	-	0	--
80	F	out			out				6	0	-	0	--
23	F	in	3		in	3			0	6	2	100	33.3
58	F	in	1	yes	in	1			0	6	4	100	66.7
92	F	in	1		in	1			0	6	0	100	0.0
40	F	in	1		out	1			1	5	0	83.3	0.0
77	F	in	1		in				0	6	3	100	50.0
61	F								-	-	-	--	--
5	M								-	-	-	--	--
90	F	in	2		in	2			0	6	0	100	0.0
70	F	in	3		in	3	yes	2	0	6	4	100	66.7
49	M								-	-	-	--	--
73	M								-	-	-	--	--
84	M	fail?	1		fail?	1			0	4	2	100	50.0
60	F	out	1		out	1			2	4	4	66.6	100.0
85	M								-	-	-	--	--
66	M	w/65			w/65				-	1	1	--	100.0
79	M								-	-	-	--	--
89	M								-	-	-	--	--
TOTALS									31	250	105	88.9	42.2

Table 3. Summary of observations of brown bears during spring 1989 brown bear density estimate at Black Lake, Alaska. "Independent" bears excludes offspring, of whatever age, still with their mother.

	REP. 1	REP. 2	REP. 3	REP. 4	REP. 5	REP. 6	MEAN	MIN.	MAX.
Marked bears present, all ages =	70	68	66	64	62	60	65.0	60	70
Marked bears seen, all ages =	20	41	30	34	21	22	28.0	20	41
Unmarked bears seen, all ages =	64	56	68	98	79	74	73.2	56	98
No. cubs-of-year =	4	4	13	10	1	3	5.8	1	13
No. "yearlings" =	10	2	3	13	20	19	11.2	2	20
No. "older" than yearling =	8	10	13	13	12	5	10.2	13	5
Total marked present + unmarked seen =	134	124	134	162	141	134	138.2	124	162
Marked bears present, independent =	43	44	43	42	40	38	41.7	38	44
Marked bears seen, independent =	12	25	19	21	15	14	17.7	12	25
Unmarked bears seen, independent =	42	40	39	62	46	47	46.0	39	62
Independent marked present + unmarked seen =	85	84	82	104	86	85	87.7	82	104
Sightability, independent									
No. in	43	44	43	42	40	38	41.7	38	44
No. seen	12	25	19	20	15	14	17.5	12	25
% seen	27.9	56.8	44.2	47.6	37.5	36.8	42.0	27.9	56.

Table 4. Bear population and density estimate in a 469.31 mi^2 study area at at Black Lake, Alaska based on bear-days estimator of Miller et al. (1987). "L-P" is the Lincoln-Petersen estimate.

BEARS OF ALL AGES, DEPENDENT YOUNG TREATED AS INDEPENDENT SIGHTINGS:

REP.	DATE	n^1 (marks present)	m^2 (marks seen)	n^2 (total seen)	DAILY L-P	SIGHT-ABILITY	N^* (BEAR-DAYS EST.)	EST. DENSITY sq.mi/bear	95% BINOMIAL CI FOR NO. BEARS lower	upper	95% BINOMIAL CI FOR MI^2/BEAR lower	upper	80% BINOMIAL CI FOR NO. BEARS lower	upper	80% BINOMIAL CI FOR MI^2/BEAR lower	upper
1	5/28	69	19	83	293.0	0.28	293.00	1.60	206.46	479.83	0.98	2.27	231.00	407.32	1.15	2.03
2	5/30	68	41	97	160.0	0.60	204.24	2.30	168.18	258.49	1.82	2.79	179.13	238.59	1.97	2.62
3	5/31	66	30	98	213.0	0.45	208.15	2.25	177.05	251.46	1.87	2.65	186.72	235.77	1.99	2.51
4	5/31	64	34	132	246.0	0.53	220.05	2.13	191.04	258.42	1.82	2.46	200.21	244.60	1.92	2.34
5	6/1-3	62	21	100	288.2	0.34	230.80	2.03	202.09	268.02	1.75	2.32	211.24	254.64	1.84	2.22
6	6/4	60	22	96	256.3	0.37	234.68	2.00	207.14	269.80	1.74	2.27	215.97	257.17	1.82	2.17
			cumulative % =			42.93										
			mean daily L-P=		242.74			1.93								
			SE=		18.65											

INDEPENDENT BEARS ONLY, DEPENDENT YOUNG NOT INCLUDED IN ESTIMATE:

REP.	DATE	n^1 (marks present)	m^2 (marks seen)	n^2 (total seen)	DAILY L-P	SIGHT-ABILITY	N* (BEAR-DAYS EST.)	EST. DENSITY sq.mi/bear	95% BINOMIAL CI FOR NO. BEARS lower	upper	95% BINOMIAL CI FOR MI^2/BEAR lower	upper	80% BINOMIAL CI FOR NO. BEARS lower	upper	80% BINOMIAL CI FOR MI^2/BEAR lower	upper
1	5/28	42	11	53	192.5	0.26	192.50	2.44	123.13	387.45	1.21	3.81	141.70	307.69	1.53	3.31
2	5/30	44	25	65	113.2	0.57	139.41	3.37	108.42	192.22	2.44	4.33	117.52	172.41	2.72	3.99
3	5/31	43	19	58	128.8	0.44	136.63	3.43	111.23	175.58	2.67	4.22	118.92	161.23	2.91	3.95
4	5/31	42	21	83	163.2	0.50	144.94	3.24	121.10	179.10	2.62	3.88	128.49	166.67	2.82	3.65
5	6/1-3	40	15	61	157.9	0.38	147.74	3.18	125.15	179.12	2.62	3.75	132.21	167.73	2.80	3.55
6	6/4	38	14	61	160.2	0.37	149.99	3.13	128.32	179.42	2.62	3.66	135.14	168.77	2.78	3.47
			cumulative % =			42.17										
			mean daily L-P=		152.63	42.17		3.07								
			SE=		10.42											

Continued....

Table 4. Continued.

BEARS OLDER THAN 2.0 ONLY:

									95% BINOMIAL CI FOR NO. BEARS		95% BINOMIAL CI FOR MI²/BEAR		80% BINOMIAL CI FOR NO. BEARS		80% BINOMIAL CI FOR MI²/BEAR	
REP.	DATE	n[1] (marks present)	m² (marks seen)	n² (total seen)	DAILY L-P	SIGHT-ABILITY	N* (BEAR-DAYS EST.)	EST. DENSITY sq.mi/bear	lower	upper	lower	upper	lower	upper	lower	upper
1	5/28	53	19	69	188.0	0.36	188.00	2.50	133.77	304.07	1.54	3.51	148.88	258.41	1.82	3.15
2	5/30	52	31	81	134.8	0.60	156.42	3.00	126.57	203.00	2.31	3.71	135.48	185.77	2.53	3.46
3	5/31	50	23	75	160.5	0.40	158.48	2.96	132.51	195.93	2.40	3.54	140.51	182.25	2.58	3.34
4	5/31	48	24	99	195.0	0.50	168.88	2.78	143.97	203.00	2.31	3.26	151.76	190.65	2.46	3.09
5	6/1-3	46	18	76	189.5	0.39	172.64	2.72	148.83	204.43	2.30	3.15	156.36	192.95	2.43	3.00
6	6/4	44	14	66	200.0	0.32	175.86	2.67	152.65	206.31	2.27	3.07	160.06	195.41	2.40	2.93
			cumulative % =			44.03										
			mean daily L-P=		177.96			2.64								
			SE=		9.392739											

Table 5. Brown bear population, density, and bias correction estimates at Black Lake, Alaska using estimator and 95% CI proposed by Eberhardt (in press). Data used in making estimates are presented in Table 3.

ESTIMATE FOR BEARS OF ALL AGES, DEPENDENT YOUNG TREATED AS INDEPENDENT SIGHTINGS:

(k) REP.	MEAN L-P for (k) Reps	DENSITY (mi^2/bear)	CUMULATIVE MEAN NO. MARKS SEEN	DENOMINATOR FOR BIAS CORRECTION FACTOR (eq. 13)	SAMPLE VARIANCE (eq. 2)	FOR 95% t w/ (k-1) d.f	95% CI FOR EST. NO. BEARS upper	95% CI FOR EST. NO. BEARS lower	95% CI FOR MI^2/BEAR upper	95% CI FOR MI^2/BEAR lower	FOR 80% t w/ (k-1) d.f	80% CI FOR EST. NO. BEARS upper	80% CI FOR EST. NO. BEARS lower	80% CI FOR MI^2/BEAR upper	80% CI FOR MI^2/BEAR lower
1	293.0	1.6	19.00	1											
2	226.5	2.9	30.00	1	8844.50	12.706	1071.4	-618.4	0.44	-0.76	3.078	431.2	21.8	1.09	21.52
3	222.0	2.2	30.00	1	4483.29	4.303	388.3	55.6	1.21	8.43	1.886	294.9	149.1	1.59	3.15
4	228.0	1.9	31.00	1	3132.99	3.182	317.0	138.9	1.48	3.38	1.638	273.8	182.1	1.71	2.58
5	240.0	1.6	29.00	1	3075.40	2.776	308.9	171.2	1.52	2.74	1.533	278.1	202.0	1.69	2.32
6	242.7	1.8	27.83	1	2504.18	2.571	295.3	190.2	1.59	2.47	1.440	272.2	213.3	1.72	2.20
all		1.93													

ESTIMATE FOR INDEPENDENT BEARS ONLY, DEPENDENT OFFSPRING ARE NOT INCLUDED:

(k) REP.	L-P for (k) Reps	DENSITY (mi^2/bear)	CUMULATIVE MEAN NO. MARKS SEEN	DENOMINATOR FOR BIAS CORRECTION FACTOR(eq. 13)	SAMPLE VARIANCE (eq. 2)	FOR 95% t w/ (k-1) d.f	95% CI FOR EST. NO. BEARS upper	95% CI FOR EST. NO. BEARS lower	95% CI FOR MI2/BEAR upper	95% CI FOR MI2/BEAR lower	FOR 80% t w/ (k-1) d.f	80% CI FOR EST. NO. BEARS upper	80% CI FOR EST. NO. BEARS lower	80% CI FOR MI2/BEAR upper	80% CI FOR MI2/BEAR lower
1	185.2	2.5	12.00	1											
2	199.2	4.1	18.50	1	2586.46	12.706	606.1	-307.7	0.77	-1.53	3.078	259.9	38.5	1.81	12.19
3	142.4	3.6	18.67	1	1431.85	4.303	236.4	48.4	1.99	9.70	1.886	183.6	101.2	2.56	4.64
4	147.6	2.9	19.25	1	1062.59	3.182	199.5	95.7	2.35	4.90	1.638	174.3	120.9	2.69	3.88
5	149.6	3.0	18.40	1	818.09	2.776	185.2	114.1	2.53	4.11	1.533	169.3	130.0	2.77	3.61
6	151.4	2.9	17.67	1	673.03	2.571	178.6	124.2	2.63	3.78	1.440	166.7	136.2	2.82	3.45
all		3.07													

Continued....

Table 5. Continued.

ESTIMATE FOR BEARS OLDER THAN 2.0 ONLY, INCLUDES SOME DEPENDENCE OF 2- AND 3- YEAR OLDS:

(k) REP.	MEAN L-P for (k) Reps	DENSITY (mi^2/bear)	CUMULATIVE MEAN NO. MARKS SEEN	DENOMINATOR FOR BIAS CORRECTION FACTOR (eq. 13)	SAMPLE VARIANCE (eq. 2)	FOR 95% t w/ (k-1) d.f	95% CI FOR EST. NO. BEARS upper	lower	95% CI FOR MI^2/BEAR upper	lower	FOR 80% t w/ (k-1) d.f	80% CI FOR EST. NO. BEARS upper	lower	80% CI FOR MI^2/BEAR upper	lower
1	188.0	2.5	19.00	1											
2	161.4	3.5	25.00	1	4000.92	12.706	729.7	-406.9	0.64	-1.15	3.078	299.1	23.7	0.54	6.80
3	161.4	2.9	24.33	1	2139.35	4.303	276.0	46.2	1.70	10.16	1.886	211.5	110.7	0.76	1.45
4	169.6	2.4	24.25	1	1821.49	3.182	237.5	101.7	1.98	4.62	1.638	204.5	134.6	0.83	1.26
5	173.6	2.5	23.00	1	1466.43	2.776	221.1	126.0	2.12	3.72	1.533	199.8	147.3	0.87	1.18
6	178.0	2.3	21.50	1	1308.24	2.571	215.9	140.0	2.17	3.35	1.440	199.2	156.7	0.89	1.14
all		2.64													

Table 6. Number of groups of brown bears seen during density estimation at Black Lake, Alaska during May 28-June 4, 1989. Note that many sightings are resightings of the same group(s).

Classification	Group Size 1	2	3	4	No. of groups	Mean size
Females with coy	0	8	9	5	22	2.86
Females with "yearlings"	0	4	26	15	45	3.24
Females with "> yearlings"	0	12	24	8	44	2.91
Groups of "adults"*	0	47	4	2	53	2.15
Single bears	142	0	0	0	142	1.00
Groups of "siblings"**	0	7	0	0	7	2.00
No. of groups	142	78	63	30	313	1.94
Percent	45.3	24.9	20.1	9.6	100	

* Includes groups of adults (mostly breeding pairs, some with offspring hanging around), and some sibling groups.

** A consistent effort was not made to identify sibling groups, most are included along with groups of "adults".

Table 7. Search effort and allocation of search effort during brown bear density estimate at Black Lake, Alaska.

QUAD. NO.	AREA (mi^2)	SEARCH EFFORT (MINUTES) Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	MEAN SEARCH TIME	MEAN MIN./MI^2	TARGET MIN/MI^2	SEARCH TEAM* Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6
1	42.65	64	87	70	53	80	75	71.5	1.68	2	1	2	1	5	4	1
2	78.25	100	147	90	134	106	143	120.0	1.53	2	1	2	1	5	4	2
3	20.59	32	47	49	45	37	29	39.8	1.93	2	1	2	4	5	1	1
4	49.03	106	125	108	77	96	90	100.3	2.05	3	4	5	4	1	5	5
5	36.38	75	75	60	78	70	63	70.2	1.93	3	4	5	4	1	1	2
6	35.75	154	127	147	103	112	93	122.7	3.43	3	4	3	5	2	2	5
7	47.98	89	149	148	164	221	136	151.2	3.35	3	5	3	2	4	5	4
8	51.35	112	116	180	119	173	119	136.5	2.66	3	5	3	2	4	2	4
9	39.96	85	103	99	78	82	107	92.3	2.31	3	5	1	5	1	4	1
10	27.82	103	90	73	85	92	61	84.0	3.02	3	2	5	2	4	1	4
11	39.55	136	116	130	100	103	177	127.0	3.21	3	2	1	5	2	4	5
TOTAL	469.31	1056	1182	1154	1036	1172	1093	1115.5	2.38	2.70						
MIN/MI^2		2.25	2.51	2.45	2.20	2.49	2.33	2.38								

* 1 = DM/JC, 2 = SM/JL, 3 = KT/HM, 4 = LV/HM, 5 = BT/CM

Table 8. Number of bears seen during brown bear density estimate at Black Lake sorted in order of increasing number of independent bears seen/minute of search effort(**).

QUAD. NO.	MEAN EFFORT MIN./MI² *	NUMBER INDEP. BEARS SEEN Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	MEAN NO.	** MEAN MIN./BEAR	*** MI²/ MEAN NO.	TOTAL NO.BEARS SEEN, ALL AGES Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	MEAN NO.	MEAN MIN./BEAR	*** MI²/ MEAN NO.
7	3.15	11	15	11	26	21	18	17.0	8.89	2.82	21	28	26	46	40	31	32.0	4.72	1.50
10	3.02	7	8	5	10	6	2	6.3	13.26	4.39	11	14	11	14	8	6	10.7	7.88	2.61
11	3.21	8	4	9	10	6	11	8.0	15.88	4.94	14	4	12	10	11	12	10.5	12.10	3.77
8	2.66	4	9	10	9	7	10	8.2	16.71	6.29	10	14	16	19	14	17	15.0	9.10	3.42
6	3.43	12	9	5	6	5	3	6.7	18.40	5.36	14	13	7	11	9	11	10.8	11.32	3.30
4	2.05	2	7	5	8	5	3	5.0	20.07	9.81	3	9	8	9	5	4	6.3	15.84	7.74
1	1.68	1	2	4	3	2	5	2.8	25.24	15.05	1	2	5	4	3	5	3.3	21.45	12.79
9	2.31	0	4	3	5	3	5	3.3	27.70	11.99	0	4	8	10	3	7	5.3	17.31	7.49
2	1.53	0	4	5	4	3	2	3.0	40.00	26.08	0	5	6	6	3	5	4.2	28.80	18.78
5	1.93	5	1	0	1	3	0	1.7	42.10	21.83	7	1	0	1	4	0	2.2	32.38	16.79
3	1.93	1	1	0	0	1	1	0.7	59.75	30.89	2	2	0	0	1	1	1.0	39.83	20.59
TOTAL	2.38	51	64	57	82	62	60	62.7	17.80	7.49	83	96	99	130	101	99	101.3	11.01	4.63

* From Table 6.

** Data are sorted from lowest to highest value of search minutes/bear seen.

*** Area of quadrat/mean number of bears seen.

Table 9. Estimated density in each quadrat of search area based on total estimated population size using the mean of the daily Lincoln-Petersen estimates (242.74 bears) and a constant calculated from mean number of minutes search to find a bear in each quadrat.

				IN EACH QUAD.						
Quad.	MEAN MIN./BEAR (xi)	BEARS/ MIN. [1/(xi)]	(P)= PROPORTION OF 0.56	ESTIMATED NO. BEARS (242.7)(P)	AREA (mi^2)	ESTIMATED DENSITY (mi^2/bear)	CUMULATIVE DENSITY (down)	CUMULATIVE AREA (%) (down)	CUMULATIVE DENSITY (up)	CUMULATIVE AREA (%) (up)
10	13.26	0.08	0.136	32.91	27.82	0.85	0.85	5.9	1.93	100.0
7	8.89	0.11	0.202	49.08	47.98	0.98	0.92	16.2	2.10	94.1
11	15.88	0.06	0.113	27.49	39.55	1.44	1.05	24.6	2.45	83.8
6	18.40	0.05	0.098	23.72	35.75	1.51	1.13	32.2	2.66	75.4
8	16.71	0.06	0.108	26.11	51.35	1.97	1.27	43.1	2.91	67.8
4	20.07	0.05	0.090	21.75	49.03	2.25	1.39	53.6	3.20	56.9
1	25.24	0.04	0.071	17.30	42.65	2.47	1.48	62.7	3.53	46.4
9	27.70	0.04	0.065	15.76	39.96	2.54	1.56	71.2	3.95	37.3
3	59.75	0.02	0.030	7.30	20.59	2.82	1.60	75.6	4.73	28.8
5	42.10	0.02	0.043	10.37	36.38	3.51	1.69	83.3	5.39	24.4
2	40.00	0.03	0.045	10.91	78.25	7.17	1.93	100.0	7.17	16.7
SUM =		0.56	1.000	242.7	469.31	1.93				