Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report

Development and Improvement of Bear Management Techniques and Procedures in Southcentral Alaska

by

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RESEARCH PROGRESS REPORT

State: Alaska

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Project Title: Wildlife Research and Management

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SUMMARY

Premarking was accomplished for 2 brown bear density estimates. We used capture-mark-resight (CMR) techniques for an estimate scheduled to be done in 1995. One estimate will be done by Alaska Department of Fish and Game (ADF&G) in Unit 13 and the other will be done in Unit 18 by the U.S. Fish and Wildlife Service (USFWS) with technical assistance from ADF&G. An evaluation of trends in harvest data in Subunit 13E, where bear numbers are thought to be declining as a consequence of intentional harvests in excess of sustainable levels, illustrated clear trends in some parameters (especially sex ratio in kill). These trends have reversed in recent years even though harvest levels remained high. This analysis illustrated the problems associated with reliance on sex and age composition of harvest data to identify critical thresholds in harvested bear populations. A manuscript on "Brown Bears in Alaska" was prepared and submitted as a chapter in the *Bear Action Plan* under preparation by the International Union for the Conservation of Nature and Natural Resources. An estimate of brown bear abundance in each Alaskan Game Management Unit was compiled with the assistance of ADF&G area and research biologists. The estimated number of brown bears in Alaska (all ages) was 31,700 (25,000-39,100).

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BACKGROUND

Management of bears is frequently more challenging than management of other species of hunted wildlife. Compared to other species, bears are difficult to count and available indices of abundance are not precise (Harris 1986). Bears typically occur at low densities and can sustain only low harvest rates without population declines. Bears cannot be restricted to one sex hunting, because sexes are difficult to identify, and they have different vulnerabilities to different kinds of hunting based on sex and age characteristics (Miller 1990a, Miller and Miller 1988). Bears may also become nuisances or threaten humans; this leads to killings which may be both significant in number and underreported (Miller and Chihuly 1987). In some regions of the state, bears are considered undesired competitors with humans for preferred ungulate species. In these areas there is little support for management of bears for high sustained yields. In some rural portions of the state, compliance with harvest reporting requirements is low. Complicating management further in some areas, is a reluctance to adopt restrictions on bear hunting until there is unequivocal evidence of population declines. With currently available technology, such evidence is seldom available or lags far behind significant changes in population status (Harris 1984, Harris and Metzgar 1987a,b, Miller and Miller 1988, 1990).

Responsible management of exploited bear populations requires continuous effort on the part of managers to improve understanding of the significance and utility of the

information sources available to them. We also need to develop improved indices of bear population status. The general objective of this project is to improve our ability to manage bear populations through studies designed to better understand currently available information and develop improved information sources.

Management of exploited bear populations requires information on status of populations. Information on status of populations may be obtained through study of the population directly (e.g. Miller et al. 1987, Miller 1990b,c) or through analysis of harvests (Miller and Miller 1988, 1990, Miller 1989). Better information is usually obtained from direct studies but because of the expense of such studies, in most areas population status evaluations are based on indirect evidence obtained from harvested animals.

Information on the number of bears harvested is clearly useful. Information on the sex and age composition of harvested animals is more difficult to interpret. Although some approaches have been proposed for interpretations of sex and age composition of bear harvest data (Frazer et al. 1982, Tait 1983), most studies have not demonstrated the capability of such data to reveal changes in population trends in a timely manner (Caughley 1974, Harris 1984, Harris and Metzgar 1987, Miller and Miller 1990).

STUDY OBJECTIVES

1. Improve understanding of the utility of information collected from harvest monitoring programs.

2. Investigate new procedures to monitor status of exploited bear populations using both direct and indirect means.

3. Develop and refine procedures to estimate appropriate harvest levels for bear populations.

RESULTS

Job 1. Mark-resight Density Estimation Technique Applications and Refinement

The objective of this job is to apply and further evaluate the mark-resight density estimation technique described by Miller et al. (1987) in order to develop methods to reduce bias and increase precision. Progress under this job is listed below.

1. During spring 1993, we completed the first year of premarking for a replicate density estimate in the 1985 Su-hydro study area. These results will be reported under a related project (Study 4.26, "Impacts of heavy hunting pressure on the density and demographics

of brown bear populations in southcentral Alaska"). The density estimate will be conducted in 1995.

2. During spring 1993, we completed the first year of premarking for a density estimate in the Kilbuck Mountains south of Bethel in Unit 18. This project is funded by the U.S. Fish and Wildlife Service (USFWS) with ADF&G staff providing technical support. The density estimate will be conducted in 1995.

3. CMR density estimates that were independent of this project were also conducted. One was completed in the 1987 and 1988 Admiralty Island study area during July 1993 by K. Titus and V. Beier (ADF&G) in cooperation with the U.S. Forest Service. Another CMR density estimate was conducted in southern Kodiak Island by Vic Barnes (FWS) and Roger Smith (ADF&G) with partial funding from the Terror Lake Trust Fund. Results of these studies will improve understanding of the utility of CMR density estimates.

4. Premarking prior to a potential CMR density estimate is underway in Denali National Park. The principal investigator of this project, J. Keay, participated in the marking effort in Unit 13 during spring 1993. An effort will be made to coordinate the results from Unit 13 and Denali Park studies to obtain comparisons between hunted and unhunted populations in a manner similar to the ongoing study on the Alaska Peninsula (Sellers and Miller 1993).

Job 2. Bear Survey Technique Evaluation

The objective of this job is to explore techniques for directly estimating bear numbers or changes in bear numbers. Little progress was made on this job during this report period. Information on bears/hour seen during the 1995 density estimate in Unit 13 compared to that found in the same area in 1985 will permit evaluation of the bears/hour statistic to reflect changes in density estimates in CMR study areas. This procedure replicates the search portion of CMR density estimation procedures to obtain data on bears/hour seen in replicated searches. It may be possible to extrapolate such data to obtain estimates of relative density in areas with similar sightability characteristics. If so, this would improve the accuracy of population estimates obtained by subjective extrapolation from CMR study areas.

Similar comparisons were incorporated into the Unit 18 brown bear study plan by the USFWS.

Job 3. Productivity and Survival Assessments

The objective of this job is to improve the precision of estimates of productivity and survival in order to permit more accurate estimates of sustainable levels of harvest. The new study initiated in Unit 13 will refine estimated productivity and survival rates in that area and will be reported under Study 4.26.

Job 4. Harvest Data Interpretation

The objective of this job is to explore methods to improve the utility of data collected from harvested bears to reflect changes in status of bear populations. There are 2 areas in Alaska were declines in brown bear density have been documented with field studies during the period 1980-1992: Subunit 13E (Miller 1993) and Subunit 20A (Reynolds 1993). We examined the harvest data from Subunit 13E to determine whether criteria in the harvest data could be identified that would provide benchmarks suggesting the level of reduction. This was done in response to a request from Regional Supervisor Ken Pitcher and results are presented in Appendix A.

Job 5. Evaluate Responses of Bear Populations to Harvest

The objective of this job is to evaluate how bear populations respond to different levels of hunting pressure. Results of this job will be reported under study 4.26 ("Impacts of heavy hunting pressure on the density and demographics of brown bear populations in southcentral Alaska") which will begin in July 1993.

Job 6. Prepare Reports and Publications

Progress was made on the following reports and publications during this report period.

1. The second draft of a wildlife monograph was completed: "Grizzly and black bear density estimation in Alaska using radio-telemetry and replicated capture-mark-resight techniques" (Miller et al. in prep.). This monograph describes results of 18 CMR density applications for brown and black bears in Alaska. I expect to complete and submit this manuscript during 1993.

2. Final revisions were completed for the manuscript "Black bear reproduction and cub survivorship in southcentral Alaska" presented at the 9th International Conference of Bear Research and Management in Missoula, Montana (February 1992).

3. The first draft was completed of a manuscript describing the relationship between grizzly bear density and productivity (Miller and Sellers in prep.).

4. A chapter on brown bears in Alaska was prepared for the Bear Conservation Action Plan being prepared by the IUCN bear specialists group (Miller and Schoen, in prep.). This manuscript is presented in Appendix B. The action plan will present chapters on all of the world's bear species with additional chapters on bears in significant areas such as Alaska.

5. A statewide brown bear management report was prepared for possible publication along with the brown bear management reports for each Game Management Unit

in Alaska. This report could serve as a vehicle to document a new estimate of the number of brown bears in Alaska. This estimate was obtained with the cooperation of brown bear managers and researchers working in all regions of the state. The executive summary and Table 1 from this report is presented in Appendix C.

ACKNOWLEDGEMENTS

Karl Schneider was instrumental in initiation of this project. Dave Anderson read and offered helpful comments on an earlier version of this report. Many ADF&G staff assisted in the development of the statewide brown bear population estimate, they are listed in Appendices B and in Table C1 (Appendix C).

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APPENDIX A. Analysis of trends in brown bear harvest data in Alaska's Unit 13 as a means towards identifying benchmarks in harvest data that are useful in helping to decide when to recommend reducing the take of bears.

SUMMARY. To determine if harvest data benchmarks could be identified that would be useful in determining when bear population reduction efforts in GMU 13 should be curtailed, the sex and age composition of harvest data in GMU 13E was examined. GMU 13E is an area where populations are believed to be declining as a consequence of intentional harvesting in excess of sustainable levels. No reliable benchmarks were identified. The most likely statistic to be useful in such determinations was sex composition in fall harvests. This statistic showed a clear trend during 1980-1989 towards increasing females in the harvest. However, this trend has reversed in recent years in spite of a continuing trend in increased numbers of bears shot by hunters. Contradictory explanations for the reversal in trend in these statistics have been offered and are conceivable given the absence of a mandate for conservative management of harvests from this population. I recommend the sustainable harvest model presented in Miller (1993) as a mechanism for setting target levels of reduction for the GMU 13 bear population.

MEMO TO:	Ken Pitcher Regional Supervisor DWC-Anchorage	**DATE:** **PHONE:**	March 18, 1993 (revised 7/93) 267-2203
FROM:	Sterling Miller Div. Wildl. Conserv. Anchorage	**SUBJECT:**	Unit 13 bear harvest benchmarks

Per your request, the following are some thoughts on bear harvest benchmarks for use in deciding when to curtail reductions in bear numbers in GMU 13.

Since the revised management objective for reducing bears is to benefit moose populations and hunters, the decision should be based on when this benefit is realized. However, I have a strong suspicion that we'll never realize elevated moose recruitment in GMU 13 through the mechanism of still further hunter-induced bear reductions unless moose density gets very low or as part of a program that includes wolf control and changes in moose harvest patterns. This conclusion is based on the lack of a favorable response so far in GMU 13E (Miller and Ballard 1992).

If this interpretation is correct, then in a management context, the question could be rephrased as either:

1.) When will bear numbers be so unequivocally low that it becomes completely evident that further bear reductions are unlikely to achieve any beneficial result?, or

2. What can we use as a benchmark that will indicate to the satisfaction of most biologists and the Board of Game that further reductions are unlikely to be beneficial in terms of moose? We all agree that this point must be short of the point where viability of the GMU 13 bear populations is threatened.

I believe it will be instructive to look at the data from 13E to see what potential benchmarks are evident. The 13E data are instructive because, regardless of where bear numbers currently are here, we'll all agree we're further down the road toward reduced populations in 13E than elsewhere in the state. This analysis is similar to what I've done in my final report for GMU 13 (excluding 13D) (Miller 1993).

Effort data. Ultimately, there should be an increase in effort per successful hunter but we haven't seen it yet (Miller 1993). Effort data are also difficult to interpret when hunters are not specifically hunting for bears (as during fall seasons in GMU 13) or when technology is improving (as during spring seasons with the new snowmachines). Clearly effort data would be more worthwhile if we had it for unsuccessful hunters too, but I suspect it would still be very noisy because of different transportation types and annual variations in hunting conditions. In GMU 16B, a non-significant 10 year trend towards increasing effort/successful hunter was initially interpreted as "consistent" with declining bear availability" (Griese 1991). More recent effort data, however, have not been consistent with this conclusion (Griese in press).

Number killed. Even with no change in effort/successful hunter, ultimately there will be so few bears left that the number killed will decline. One problem is that this can be masked by changes in regulations that are independent of bear population trend. For example, kill numbers went down when bag limits changed from 1/year to 1/4 years and went up last year, perhaps because of the increase in number of caribou permits. In 13E, spring kill has been generally increasing over the last decade while fall kills, excluding the period with increased bag, have been generally stable (Fig. 1). When an increasing trend in kill numbers begins to reverse without explanation based on regulation changes, it would be reasonable to conclude that hunters are having a harder time finding bears. It is hard to say how much of a reduction will have occurred when this happens and how many years are necessary to clearly identify such a trend.

Harvest sex ratio. Changes in sex ratio in kill are widely thought to be indicative of increasing harvest. An increasing proportion of females is thought to reflect increasing harvest rates. These changes are the basis of exploitation models suggested by Fraser et al. (1982) and Tait (1983), both of which require effort information. Even with effort information, however, the Fraser model doesn't work very well (Harris 1984, Harris and Metzgar 1987). One of the reasons it doesn't work very well is that harvest sex ratio reflects, primarily, the relative vulnerability of each sex to hunting. Regardless of population trend, the relative vulnerability of bears and sex ratio in kill changes when seasons, regulations, hunter motivations, transportation types, and other factors are changed.

The harvest sex ratio will mirror sex ratio at recruitment if all bears are harvested. If your decision benchmark is set at ≥ 51% males (all ages and seasons), you'll never reach it if recruitment sex ratio is 50:50 and all bears are harvested. The harvest sex ratio statistic will look even more rosy (more males) in cases where immigrant males are being shot or in cases where more females are surviving to die of old age than males. In both cases, the proportion of males in the harvest will exceed the sex ratio at age of recruitment.

The weird things that can happen with harvest sex ratio are illustrated in data from 13E. Percent females in spring kills increased during 1982-1990 followed by a decline and during fall seasons it increased during 1977-1987 followed by a decline (Fig. 2). The increases in this statistic are in line with the expectation based on increasing harvest rate but the recent declines are not. Where did these males come from in recent years? Could we be mining formerly little hunted areas, are they immigrants, or what? Based on a benchmark of no more than 50% females in the 3 year running average for fall hunts we'd have shut the season down during 1984-1988. We apparently "saved the day" just by waiting until this statistic improved itself (Fig. 2). The same trend is evident when spring and fall seasons are combined (Fig. 3). There was a clearly ominous trend toward increasing females in kill until it almost hit 50% in 1988 at which point males apparently started beaming down into the harvest from somewhere. Some have found this recent "improvement" in the harvest statistics to be an encouraging indication that harvests are not excessive (Tobey 1993). I disagree with this interpretation. This difference in interpretation makes it clear that statistics on sex ratio of kills, alone, will not provide the unequivocal benchmark you are looking for.

The observed recent decline in percent females killed could reflect either increased numbers of males or decreased numbers of females in kills. Numbers of males killed in spring seasons have increased in recent years especially older males (Fig. 4); no trend in males was evident in fall seasons (Fig. 5). Too few females are killed in spring seasons to detect trends (Fig. 6). In recent years, however, it appears that numbers of both young and old females have declined in fall seasons (Fig. 7). It appears that the recent "improvement" in sex ratio of kills resulted from increased kills of older males during spring and declining kills of females during fall. One reasonable explanation for this result is that resident females have been depleted by overharvest and there has been an increase in harvest of immigrant males. If this explanation is correct, it provides little basis for optimism from the perspective of the bear hunter.

During spring seasons, there was an increase in the percent females in harvests of young bears followed by a decline in recent years (Fig. 8). This is consistent with the above explanation as the increased harvest of young females may have reduced recruitment into adult female age classes. There was no change for old bears (Fig. 8).

I believe that managers should concentrate on the components of their harvest data that will show the least noise and is most likely to reflect population status rather than vulnerability based on differences in hunting conditions. For bears, this means that the fall

data will be better adapted for an index than the spring data. In GMU 13E fall seasons, there was an increase in percent females followed by a decline in recent years for both young and old bears (Fig. 9). The 3 year running average for percent females for adults killed in fall has been over 50% since 1980--except for last year (Fig. 9). This is an amazing result given that adult females with cubs are protected. The same pattern, though less extreme, is evident when spring and fall data are lumped (Fig. 10). Again, this suggests that sex ratio in the kill showed a clearly unfavorable trends towards declining males which has magically reversed itself without the need for any decline in kill numbers. This does not bode well for finding an acceptable overharvest benchmark in sex ratio of bear kill data.

These same patterns were evident in the GMU 13 (except 13D) analysis presented in Miller (1993) perhaps because the 13E kill, which is about half of the harvest for this area, swamps data from the other subunits. Although it is interesting, I am not suggesting that a switch in direction from increasing to declining percent females in harvest as a benchmark, at least until we better understand why it occurred.

I think this analysis demonstrates why sex ratio of harvest may be misleading. It is true that some of the "improvement" in this ratio (more males or fewer females) may result from the later fall opening that started in 1990 that was designed to protect more females from hunters but, if so, this just demonstrates my main point that sex ratio in kill best reflects changes in vulnerability, not population trend.

I suspect that, under conditions for relative vulnerability that exist in GMU 13, bear populations will be pretty far reduced when the cumulative 3-year sex ratio in fall harvests exceeds 50% for several years. It is most conservative to calculate this for old bears in fall harvests, less conservative to calculate it for old bears lumping spring and fall, and, apparently, not conservative to calculate it for young bears during the whole year or old bears during spring. This suspicion is not, so far supported by the recent results discussed above in GMU 13E.

Even if trends in sex ratio of kill reflect trend in population number, it can't indicate degree of change. As a benchmark, you want to be able to say we'll stop when we've achieved a reduction of x percent. I can think of 2 ways to accomplish this.

1. As per my memo of last year and my final report you can mathematically reconstruct population numbers from an estimated population size, estimated sustainable exploitation rate, and harvest numbers. You will overestimate the degree of decline if you underestimate initial population size, underestimate sustainable harvest rates, have significant harvests of immigrant animals, have bootlegging of kills into the area, or have compensatory increases in productivity associated with populations decline. You will underestimate the degree of decline if you overestimate initial population size, overestimate harvest rate, have compensatory declines in productivity, or have many unreported kills or wounding losses. This is cheapest way I know of to establish a

benchmark for a targeted percent reduction in population size. You must decide in which direction it is most acceptable to error (under-or overestimation of decline) and make the corresponding conservative or liberal assumptions relative to these sources of potential error.

2. You can use the 1995 density estimate we'll get in the Su-hydro area to set a benchmark. If you decide that you don't want to reduce populations in this remote area by more than x%, then you'll change your bear management regulations if this density is less than (1-x)(29.1 bears/1,000 km^2). Note that I doubt if the CMR technique can be used to measure densities much less than 10 bears/1,000 km^2 which would be about a 70% reduction from the 1985 density of 29.1 bears of all ages/1,000 km^2).

I am aware that you are concerned about extrapolating from these density estimates to other areas. However, the population reconstruction model can be refined if the measured reduction doesn't match the predicted reduction and the refined version used to adjust the reconstructions for other areas. As noted above, I am concerned, however, that the reconstruction for 13E may exaggerate the rate of decline because of immigration.

In evaluating this possible benchmark you should be aware that the 1992 CMR density estimate in the northcentral Alaska range 20A study area indicated no significant change in density since the 1986 estimate even though a home range technique for a much larger study area indicated there had been a 28% decline in recent years (Reynolds 1993).

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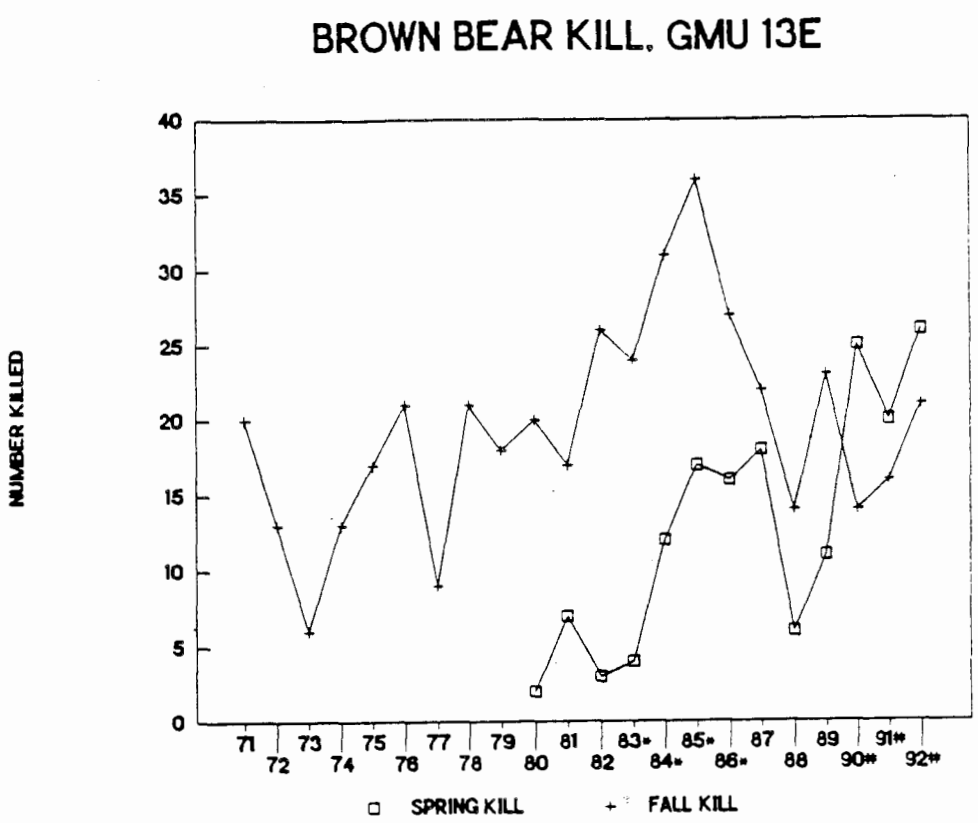

Figure 1. Number of brown bears reported killed annually during spring and fall seasons in Alaska's GMU 13E. Bag limit was changed from 1/4years to 1/year during 1982-1986; fall season opening was changed from September 1 to September 10 during 1990-1992.

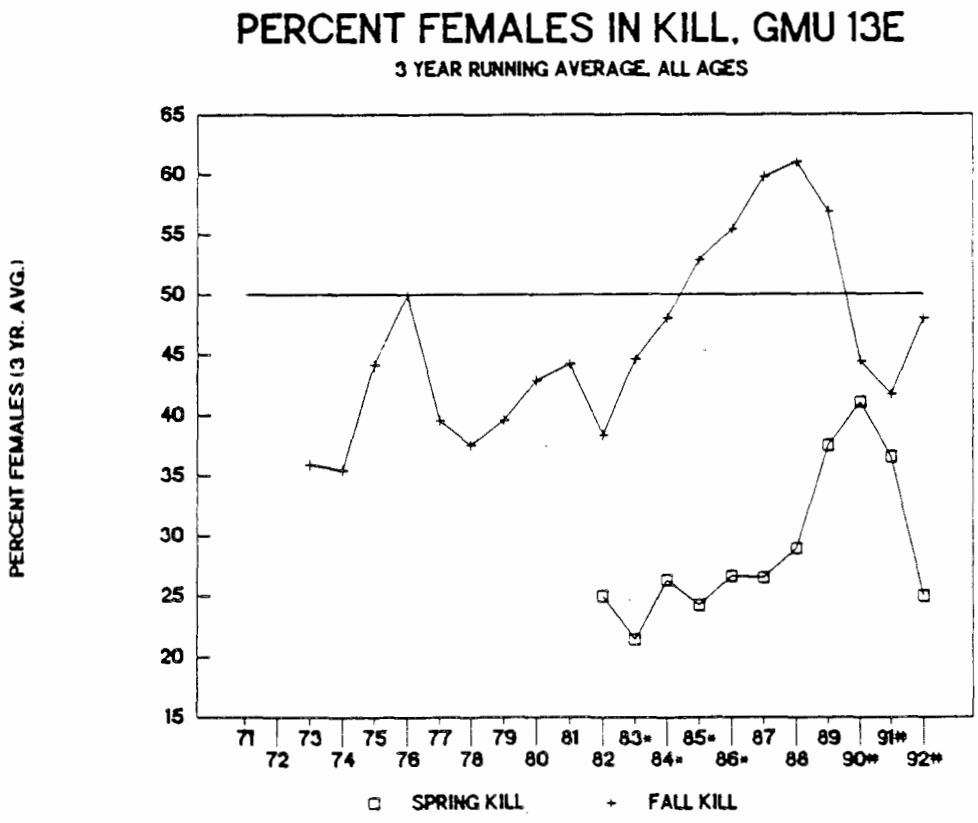

Figure 2. Three year running average of percent females in kill during spring and fall seasons in Alaska's GMU 13E.

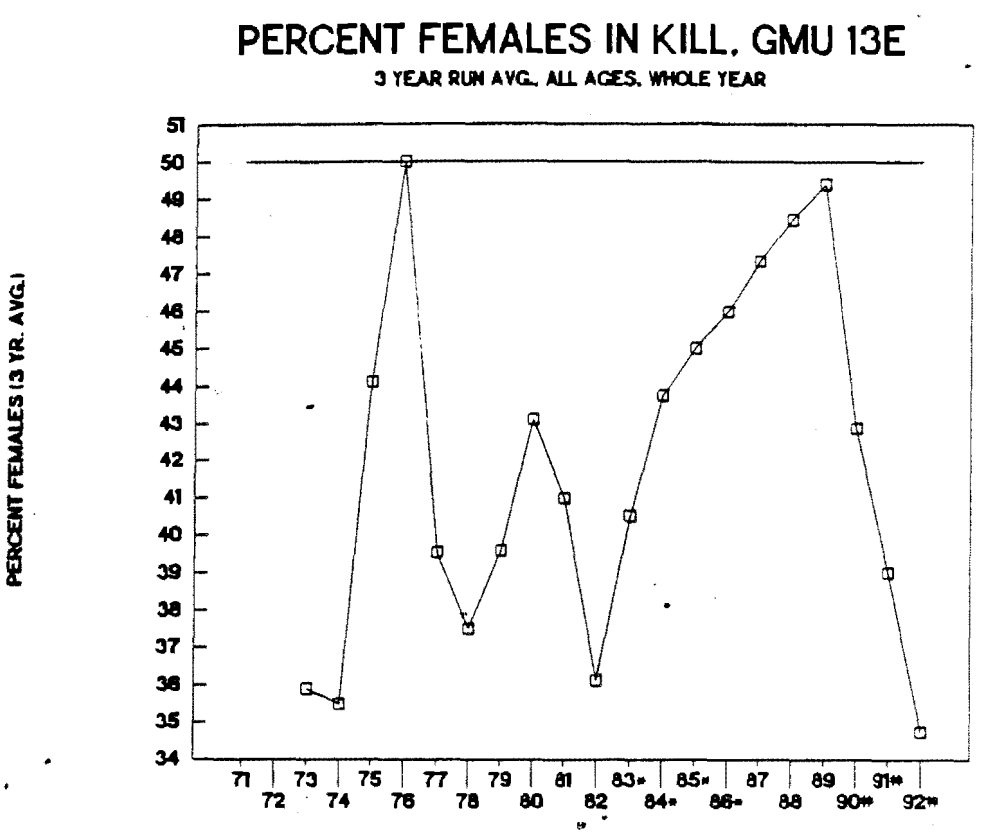

Figure 3. Three year running average of percent females in kill in Alaska's GMU 13E with spring and fall seasons combined. Bag limit was changed from 1/4years to 1/year during 1982-1986; fall season opening was changed from September 1 to September 10 during 1990-1992.

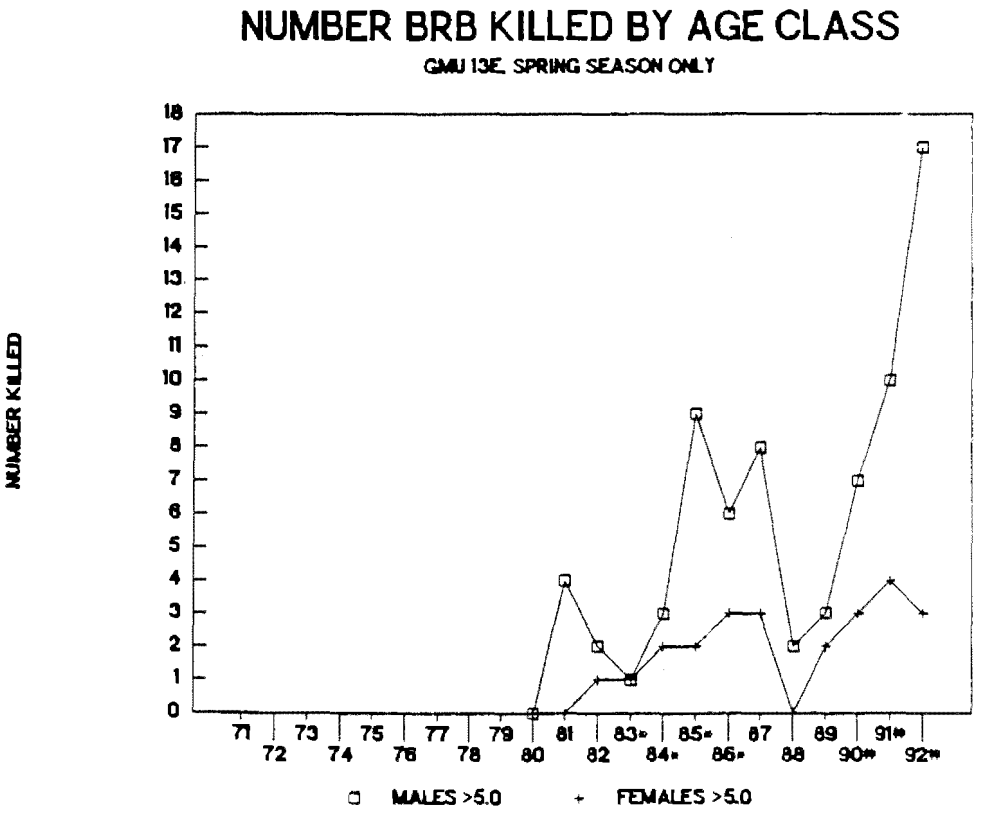

Figure 4. Number of brown bear males killed by age class during spring seasons in Alaska's GMU 13E.

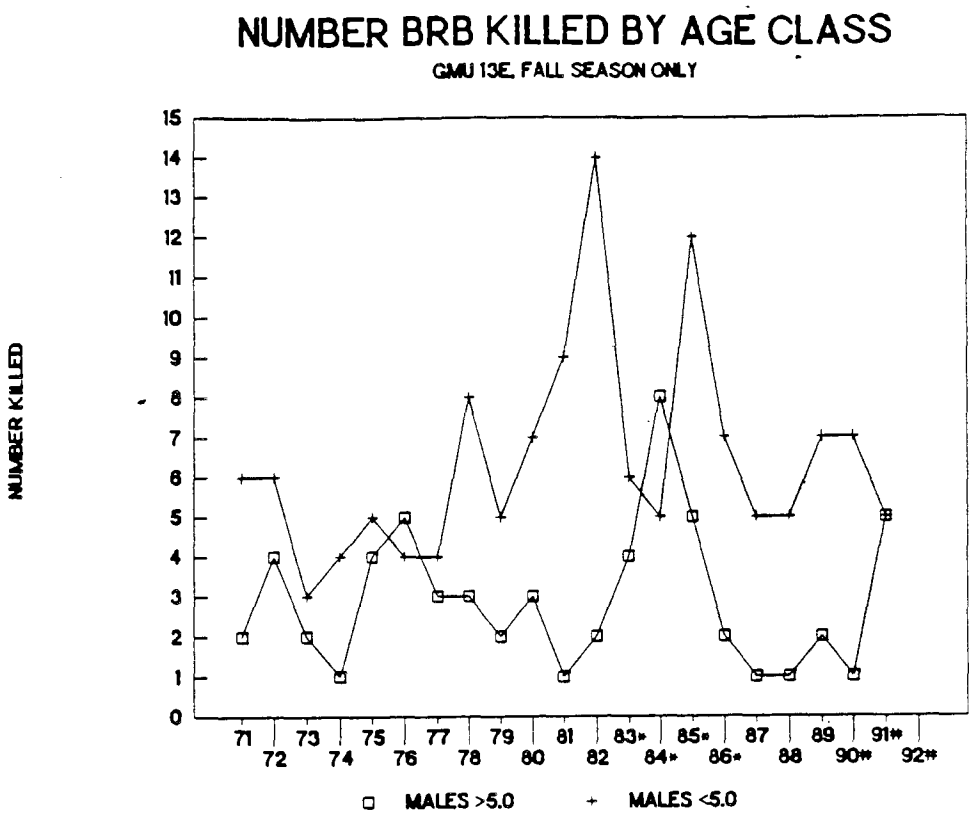

Figure 5. Number of brown bear males killed by age class during fall seasons in Alaska's GMU 13E. Bag limit was changed from 1/4years to 1/year during 1982-1986; fall season opening was changed from September 1 to September 10 during 1990-1992.

Figure 6. Number of brown bear females killed by age class during spring seasons in Alaska's GMU 13E.

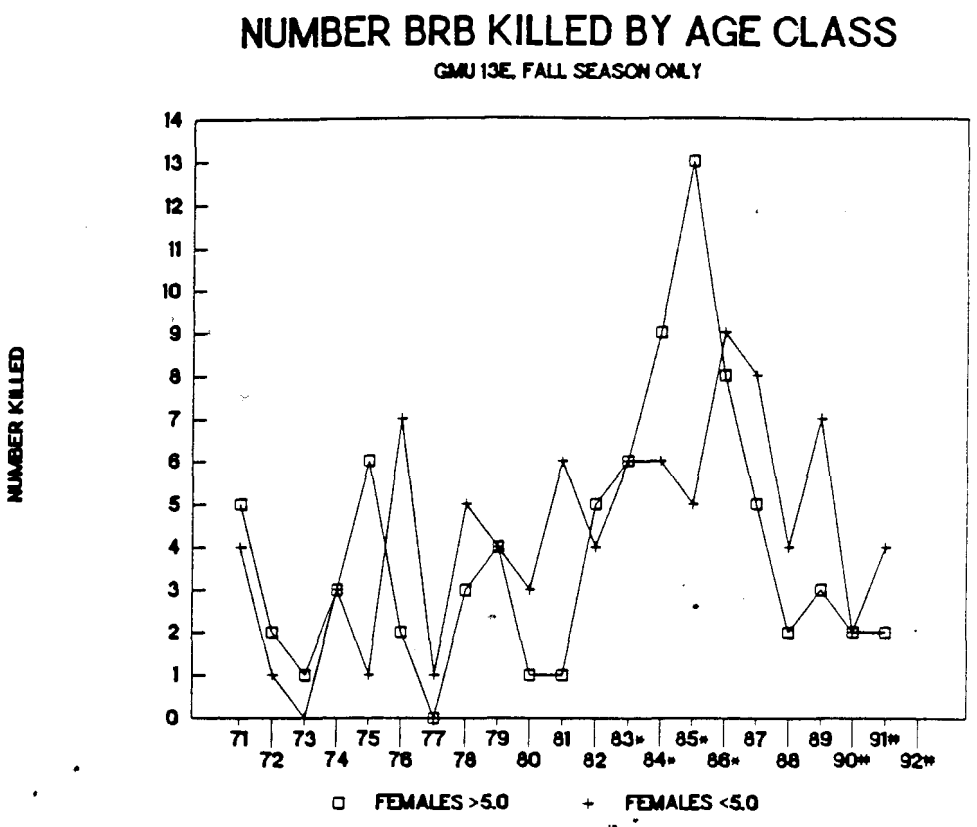

Figure 7. Number of brown bear females killed by age class during fall seasons in Alaska's GMU 13E. Bag limit was changed from 1/4years to 1/year during 1982-1986; fall season opening was changed from September 1 to September 10 during 1990-1992.

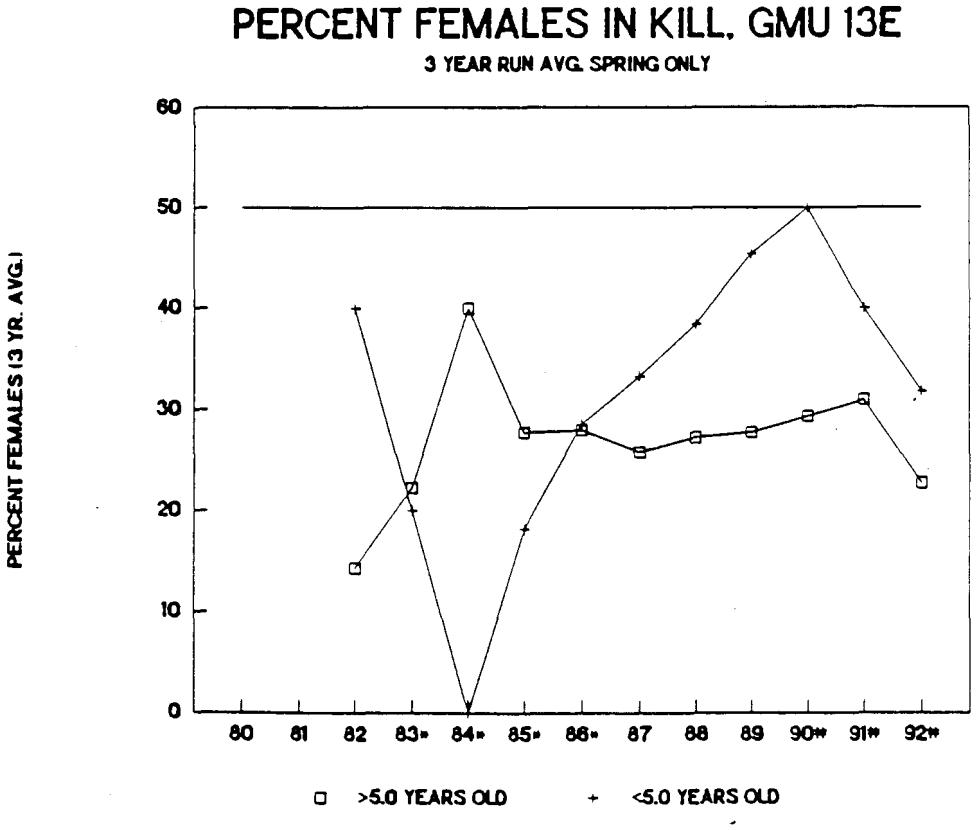

Figure 8. Three year running average of percent females in kill by age class during spring seasons in Alaska's GMU 13E.

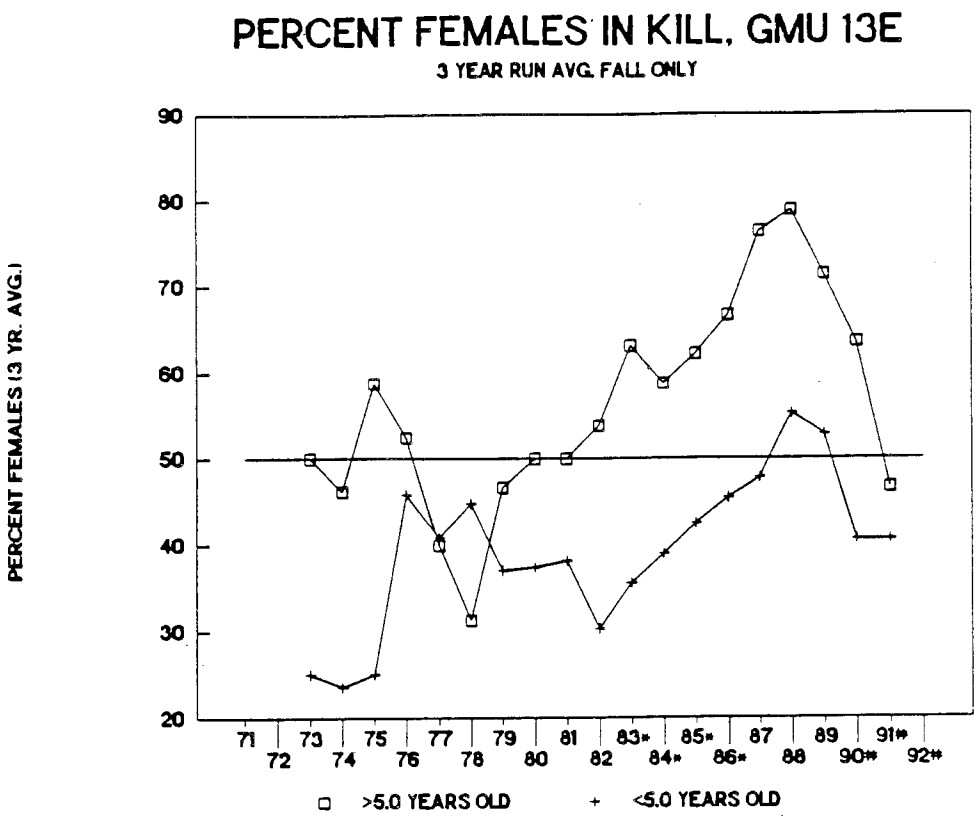

Figure 9. Three year running average of percent females in kill by age class during fall seasons in Alaska's GMU 13E. Bag limit was changed from 1/4years to 1/year during 1982-1986; fall season opening was changed from September 1 to September 10 during 1990-1992.

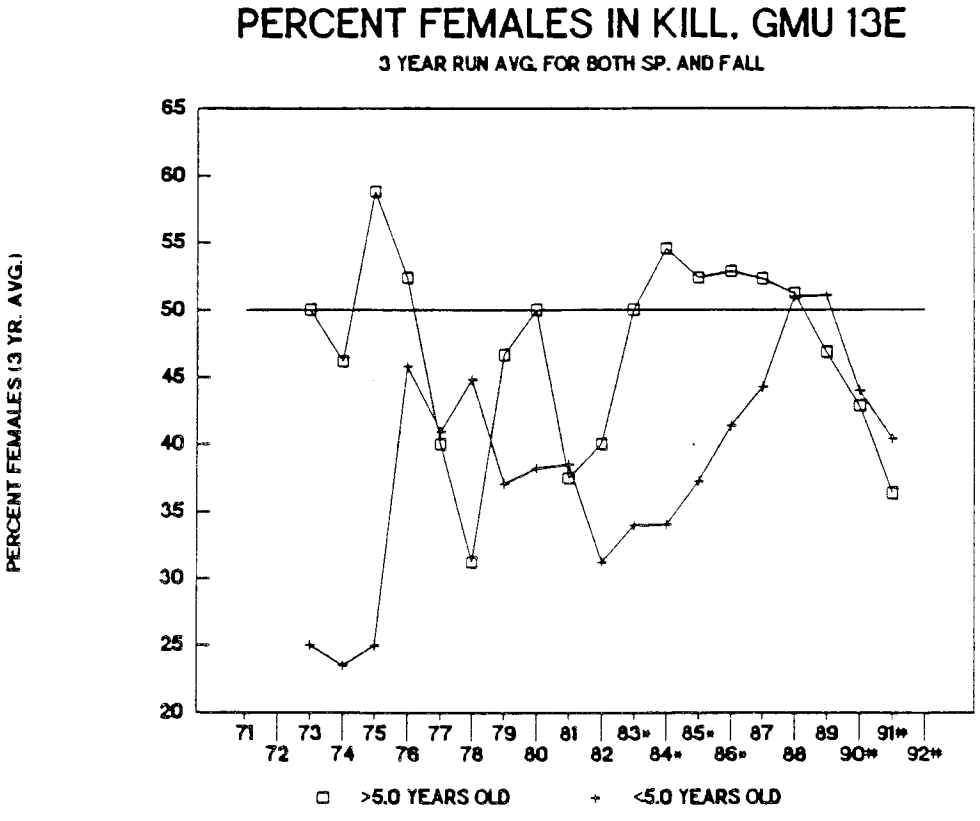

Figure 10. Three year running average of percent females in kill by age class in Alaska's GMU 13E with spring and fall seasons combined.

Appendix B. *The Brown Bear in Alaska*

Draft date: July 26, 1993

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Area: 1,530,700 km^2

Human population: 570,000 (1991)

Status of the Brown Bear in Alaska

Alaska has the largest population of brown and grizzly bears (hereafter termed brown bears) of any state or province in North America. Internationally, larger populations occur only in the former USSR (Chestin et al. 1992). Brown bears in Alaska currently occupy all their historic range. In some portions of their range in Alaska, habitat destruction, hunting, and disturbance associated with development have reduced bear densities. Both North American subspecies are found in Alaska. *U. arctos middendorfi* occurs on Kodiak and Afognak Islands and *U. a. horribilis* occurs in the rest of Alaska and North America (Rausch 1963). Bears in coastal portions of southcentral and southeastern Alaska (including both subspecies) are commonly referred to as "brown" bears while those occupying northern and interior habitats are called "grizzly" bears. These distinctions have no taxonomic validity and, in this report, both are termed brown bears.

Brown bear populations throughout most of Alaska are stable. There are concerns, however, because Alaskan brown bears face many of the same intolerant attitudes and threats that have led to extirpation of the species throughout most of their historic range in the lower 48 states and Mexico. Advances during the 20th century in ecological consciousness, legal protections, wildlife management, and the existence of large reserves of public lands in Alaska, however, appear adequate to assure the survival of both subspecies in Alaska through the 21st century. Reductions in population density and extirpation in some localized areas will likely occur in portions of Alaska during this period.

Distribution and Density of Brown Bear in Alaska

Most of Alaska from sea level to approximately 1,500m elevation is occupied brown bear habitat (Fig. 1). The subspecies *horribilis* occurs from Unimak Island, on the Aleutian chain, throughout mainland Alaska, to Alaska's north slope bordering the Arctic Ocean.

Brown bears occur in the riparian corridors along the lower Yukon and Kuskokwim Rivers and a few wandering bears are occasionally found in the wetland delta habitat between these rivers (Fig. 1). In Prince William Sound, they occur on Montague, Hinchinbrook, Hawkins, and Kayak Islands.

In southeastern Alaska, brown bears are abundant on Admiralty, Chichagof, Baranof, and Kruzof islands but are absent from the more southern islands of Prince of Wales, Kupreanof, Etolin, and adjacent islands; a few wandering brown bears are occasionally found on Mitkof and Wrangell islands which are close to the mainland. In southeastern Alaska, black bears (*Ursus americanus*) and wolves (*Canis lupus*) occur on the large southern islands not occupied by brown bears (including Mitkof and Wrangell) but not on the northern islands occupied by brown bears. This distribution may reflect post glacial dispersal of brown bears from the north and by black bears from the south following retreat of Pleistocene glaciers (Klein 1963). Black bears, wolves, and brown bears are sympatric in many portions of interior Alaska.

The subspecies *middendorfi* occurs on Kodiak, Afognak, and other adjacent Islands. The distribution of brown bears in Alaska appears to have remained relatively unchanged since European and Russian exploration during the mid-1700s (Fig. 1).

Brown bear densities vary greatly in different regions of Alaska. Density estimates conducted using standardized techniques (Miller et al. 1987) throughout Alaska reveal densities >175 bears/1,000 km^2 in the coastal populations of the Alaska Peninsula, Kodiak and Afognak Islands, and the northern islands of southeastern Alaska (Fig. 1) (Miller et al. in prep.). Approximately 50% of Alaska's brown bear population occurs in these high density populations which represents about 8.5% of the brown bear habitat in the state (Fig. 1). It appears likely that these high densities are supported in large part by abundant runs of up to 5 species of Pacific salmon (*Oncorhynchus* spp.) and lush plant and fruit resources found in these warmer maritime environments. Bears in these high density portions of the Alaskan coast are larger and generally darker than bears from interior and arctic regions of Alaska. These size and color differences have resulted in coastal bears being commonly called "brown" bears while the more smaller and usually more lighter-colored interior bears are usually called "grizzlies".

Densities <40 bears/1,000 km^2 have been reliably estimated in the portions of interior Alaska without access to abundant salmon runs (Fig. 1) (Miller et al. in prep.). These estimates range from 6.8/1,000 km^2 on the coastal flatlands and adjacent foothills of the northeastern Brooks Range (Reynolds and Garner 1987) to 34 bears/1,000 km^2 in Denali National Park (Dean 1987). These low density habitats represent about 84% of the brown bear's distribution in Alaska (Fig. 1). Approximately 41% of Alaska's brown bear population lives in these low density habitats.

Intermediate densities of 40-175 bears/1,000 km^2 are thought to occur in small areas of south-central Alaska near the coast and on the mainland in southeastern Alaska. These

areas represent approximately 7.5% of Alaska's bear habitat and contain about 9% of the population (Fig. 1). The classification of these areas as intermediate in density is based on subjective impressions; bear densities have not been directly measured in any of these areas.

Number of Alaskan Brown Bears

There is no precise estimate on the number of brown bears in Alaska. During the period 1985-1992, however, information on brown bear density was estimated in 15 Alaskan study areas using standardized capture-mark-recapture techniques (Miller et al. in press). Density estimates using other techniques were available in 4 other areas (Miller et al. in press). In 1993, biologists from the Alaska Department of Fish and Game were asked to extrapolate from these density estimates to obtain population estimates for each of the 26 game management units in Alaska. This resulted in an estimate of 31,200 bears in Alaska with a lower limit of 24,600 and an upper limit of 38,700. This estimate is lower than previous estimates for Alaska (Peek et al. 1987) not because bear populations have declined, but because of improved information on bear densities.

Legal Status

State law (Alaska Administrative Code 5AAC 92.990) classifies brown bears as "big game." Under this classification brown bears may be legally killed by resident, non-resident, and subsistence hunters with the appropriate licenses and tags during specified seasons. In most of the state, hunters are not permitted to take a brown bear more frequently than once every 4 years. Hunters are not allowed to kill newborn or yearling cubs or female bears accompanied by cubs younger than 2 years old.

In addition to sport hunting, brown bears may also be legally killed in defense of life or property. Persons killing bears under such circumstances are required to file a report with a state wildlife protection officer and to surrender the hide and skull to the state.

Alaskan brown bears are on Appendix IIB of the Convention on International Trade in Endangered Species (CITES). This listing is designed to protect threatened populations elsewhere in North America; the brown bear population status in Alaska is secure. Under this listing, a federal wildlife export permit is required before the hides or skulls of brown bears may be shipped out of the United States or transported through Canada.

Until recently, the State of Alaska has had almost exclusive management authority for brown bears and other species of non-endangered resident wildlife in Alaska. However, under the subsistence provisions of the 1980 Alaska National Interest Lands Act (ANILCA), the US federal government in 1990 assumed management authority for subsistence uses of wildlife, including bears, for rural Alaskan residents on most federal public lands in Alaska (about 62% of the state). Uncertainties associated with the recent mixture of state and federal management authority have created administrative and legal

problems that have and will continue to complicate efforts to manage harvests of bears and other species in Alaska.

Population Threats

Humans represent the most significant source of mortality on adult brown bears in Alaska. Humans kill bears for sport or subsistence, in defense of human life and property, and illegally for a variety of reasons.

Most hunting is for trophies but a small and under-documented proportion of the statewide hunting kill is for subsistence use by residents in rural villages. An unknown, but perhaps significant, amount of illegal killing also occurs throughout Alaska. Illegal kills occur in National Parks and other closed areas as well as in areas open to legal hunting. Although sale of bear parts is illegal in Alaska, the increasing value of these parts in overseas markets has doubtless resulted in an increased number of illegal kills. Throughout most of the state, the legal sport harvest is closely and accurately monitored and seasons and bag limits are adjusted to maintain harvests within levels thought to be sustainable.

In a few management areas in southcentral and eastcentral Alaska, brown bear populations have been reduced through liberalized hunting regulations designed to cause a reduction in bear numbers. Such reductions are desired to increase moose (*Alces alces*) populations. Brown bears are known to be effective predators on newborn moose (Ballard et al. 1981, Ballard and Larsen 1987, Ballard et al. 1990), but it has not been demonstrated that these bear reductions have been successful in improving moose calf survivorship (Miller and Ballard 1992). The current areas where bears are being intentionally reduced are small and the management objectives for these areas require maintenance of "viable" bear populations. There is, however, widespread and vocal support for proposals designed to reduce bear numbers in many additional portions of Alaska (Miller and Ballard 1992). These proposals reflect a willingness to reduce bear populations thought to be too high for maximum moose production or from other human perspectives including fear of or damage by bears. The intolerant attitude toward brown bears reflected in some of these proposals is similar to the attitudes that resulted in the extirpation of bears throughout much of their historic range in the United States (McNamee 1984, Brown 1985). Although, the bear reduction efforts ongoing in Alaska are geographically restricted and do not represent a threat to the species survival, they are a cause for concern.

Unintended declines in bear populations as a result of sport hunting can best be avoided by establishment of conservative harvest quotas (Miller 1990). Even with conservative quotas, legal sport kills combined with inadequately documented kills in defense of life or property, subsistence kills, and illegal kills may significantly deplete populations. Declines from this combination of factors may be gradual and go undetected for long periods because available methods for direct monitoring of bear population trends are imprecise and expensive (Harris 1986, Miller 1990, Miller et al. in prep.).

As human presence increases in once lightly occupied areas of bear habitat and in urban areas, killing of bears in defense of life or property has increased in Alaska (Miller and Chihuly 1987). Around urban centers and in heavily populated rural areas such as on the Kenai Peninsula, such kills are sufficiently frequent that they have depleted local bear populations. The occasional human injury or death from bear attacks in Alaska increases fear of bears and these instances are usually followed by increased numbers of bears killed by persons who perceive bears as threats. Increased human presence and the commonly associated problem of bears being attracted to human foods and garbage increases the likelihood of damage to property or injury to people by bears (Herrero 1985). This pattern can initiate a cycle that may create population-level threats in large areas (Knight and Eberhardt 1988). With proper human behavior, education, and training, this cycle is not inevitable (Walker and Aumiller 1993, Aumiller and Matt in press). The number of areas in Alaska where bears killed in defense of life or property circumstances will become significant sources of mortality and increase through the next century. This will lead to population reductions in additional areas and may reduce bear populations more widely in portions of Alaska.

Habitat Threats

Alaska is unique among the 50 states in the U.S. because its major ecosystems are still relatively intact and they include healthy populations of all the large carnivores that existed prior to 1800. The vast tracts of undeveloped wildlands that still exist in Alaska bodes well for the future of brown bears in Alaska. For many of these lands, development is not imminent. However, some threats to brown bear habitat do exist.

Throughout the coastal rain forests of southeastern Alaska, industrial-scale logging on private and national forest lands is expected to significantly reduce brown bear habitat capability as important old-growth forest habits are converted to second-growth that has limited value to bears and many other species (Schoen et al. 1993). Throughout much of this area, the timber harvests are concentrated in the highest-quality timber stands found in southeastern Alaska (Schoen et al. 1988). These stands are used extensively by brown bears during summer and have been identified as critical brown bear habitats (Schoen and Beier 1990). The impacts of this logging will be long-term and irreversible under current logging schemes. In addition, logging may reduce the long-term productivity of some of the region's important salmon spawning streams which would have obvious implications for bears.

In most of the rest of Alaska, brown bear habitat is still relatively intact and there does not appear to be a serious threat of losing significant habitat over the next 25 to 50 years. Although Alaska may not face the same level of habitat loss that has occurred throughout brown bear range in the lower 48 states, the suitability of bear habitat must incorporate the influence of human activities (Schoen 1990). Habitat fragmentation, roads, and garbage disposal are part of the infrastructure of resource development (logging, mining, petroleum development, hydropower development, agriculture, commercial and residential

real estate development) that, along with tourism, is the major emphasis in Alaska's growing economy. These factors contribute significantly to direct mortality of brown bears as described below.

Human-Bear Interactions

As generalist omnivores, brown bears recently occupied a wide range of habitats and had one of the greatest natural distributions of terrestrial mammals (Nowak and Paradiso 1983). Today, assuming the physical availability of suitable habitat, the most critical factor influencing brown bear conservation in Alaska and elsewhere is the degree of interaction with humans.

Human populations in Alaska have increased dramatically. Prior to World War II, Alaska's human population numbered approximately 70,000. The Alaska population in July 1991 was estimated to be 570,000 and the state was listed as the second-fastest growing state in the nation between 1990 and 1991 (U.S. Commerce Department Census Bureau). Clearly, people will increasingly dominate the future landscape in Alaska.

As human populations expand and demands for resources increase throughout the industrial world, more pressure is placed on Alaska's natural resources. Today, resource extraction and tourism are the major industries shaping Alaska's economy. Major resource developments in Alaska include fishing, oil and gas development, logging, mining, agriculture, road and rail construction, real estate development, mariculture and aquaculture, and hydroelectric development.

As Alaska's natural resources are developed and tourism expands, people will become increasingly common throughout brown bear habitat in the state. Logging, oil and gas development, and mining all require an extensive transportation infrastructure. This fragments previously inaccessible or lightly inhabited areas of bear habitat and increases opportunities for legal hunting as well as for adverse bear-human interactions including defense of life and property kills and illegal hunting. A direct correlation was found between autumn brown bear kill and cumulative kilometers of road construction on northeastern Chichagof Island during the period 1978 to 1989 (Fig. 2) (Titus and Beier 1991).

Outside of Alaska's major urban centers, the two regions most vulnerable to habitat fragmentation are the south coastal forests which are being extensively logged and the North Slope. Over the long-term, the transportation infrastructure will significantly increase the probability that individual bear home ranges will be bisected by a road or utility corridor. Increased human access inevitably leads to higher bear mortality (Peek et al. 1987; Miller and Chihuly 1987; McLellan and Shackleton 1988, 1989; Schoen 1990).

Another byproduct of development is garbage. Garbage dumps associated with mining, logging, petroleum development, and local communities have been an attractant for bears and resulted in significant bear problems throughout Alaska. Bears that become conditioned to humans and human foods usually become nuisances and may become threats to human safety (Herrero 1985). The usual result is that such bears are commonly killed. Such attractant sites end up as "population sinks" where bears are drained from ecosystems (Knight et al. 1988).

Although agriculture does not pose a serious threat to loss of bear habitat in Alaska, the livestock industry has potential to significantly reduce bear populations through killing of bears seen as economic threats to livestock herders. Currently, the most significant threats derive from cattle ranchers on Kodiak Island and reindeer herders in northwestern Alaska. Additional threats to bears would develop if schemes to develop moose or pig farming or to expand the area involved with reindeer ranching succeed.

Fish hatcheries and mariculture facilities developed within high-density coastal brown bear habitat are also potential sites of conflict. If human garbage, hatchery stock, and fish foods are not handled and secured properly, they may attract bears from long distances. As these facilities proliferate along the coast, a significant proportion of bears may be vulnerable to nuisance control actions.

Although most of Alaska's lands are public lands, parcels of lands selected by the State of Alaska have been widely converted to small privately owned plots. Many Alaskans have built recreational cabins on these plots in areas where there was previously little human presence or construction. Many of the persons using these cabins view bears as a threat to their personal safety and are angered by damage bears cause to their structures. There are currently places in the state where complaints from owners of these remote cabins have led to efforts to reduce bear numbers through increased hunting. It is probable that owners of these cabins also shoot many bears that are not reported as required by law. In some places, lands transferred to corporations of Alaskan natives under terms of the Alaska Native Claims Settlement Act have similarly been developed for maximum economic returns with corresponding losses to bear numbers and habitats.

Alaska's wilderness character has attracted adventurous travellers for more than a century but until recently only in small numbers. In 1951, fewer than 10,000 people visited Alaska. The Alaska Visitors Association estimated nearly one million people visited Alaska in 1992 generating $1.1 billion in revenue. Today, tourism has become Alaska's number one growth industry and is an important force in Alaska's economy. As more wilderness guides and tourist travel the back country, adverse encounters with bears will increase. On the positive side, however, there is an increasing demand for access to areas where tourists can view bears in natural settings and several bear viewing areas have been established in recent years. If managed carefully, such programs have the potential for educating people about the special needs of bears and increasing public support for bear conservation.

Management

Outside of National Parks, brown bears are managed for sustained yield harvests by hunters in most of the rest of Alaska. During the last decade, an average of 1,090 bears have been legally taken and reported in Alaska (Table 1). An unknown number of additional bears are killed annually and not reported. The number of bears harvested annually in Alaska has increased over the last 3 decades (Table 1). This increase reflects a rise in the popularity of bear hunting as well as expanding bear populations in some areas such as the Alaska Peninsula where populations are recovering from overexploitation during the late 1960s and early 1970s.

Except for rural subsistence bear hunters in northwestern Alaska, hunters are required to purchase a license and big game tag to hunt bears, and successful hunters are required to have the hide and skull of their kills examined and sealed by a representative of the Alaska Department of Fish and Game. During this examination, the sex of the kill is determined from the hide and a tooth is extracted from the skull to determine age by counting cementum annuli. Sport hunters may not take a bear more frequently than once every 4 years in most of Alaska. Compliance with kill reporting requirements is considered high in most areas of the state but kills are underreported by hunters, in many in rural areas. Liberalized bag limits (1/year), elimination of the need to purchase a tag, and easier reporting mechanisms have been instituted in portions of rural northwestern Alaska in an effort to increase voluntary reporting of brown bear kills.

The most popular brown bear hunting areas in Alaska are the Kodiak Archipelago, Alaska Peninsula, and northern islands of southeastern Alaska (Admiralty, Baranof, and Chichagof). In the Kodiak area, harvests have been limited by means of a lottery for hunting permits since 1976. On the Alaska Peninsula, harvest have been limited by closure of the area to bear hunting during alternate regulatory years since 1975. Together, 37% of the Alaska brown bear harvest derives from Kodiak and the Alaska Peninsula. An additional 10% of the harvest comes from high density populations on Admiralty, Chichagof and Baranof islands. Statewide, over half of the annual harvest comes from the high density south coastal populations where about half of the bear population occurs (Table 2).

Several areas in Alaska are also managed to provide enhanced opportunities for brown bear viewing. These include the McNeil River State Game Sanctuary, Denali and Katmai National Parks, O'Malley Creek on Kodiak Island, and the Stan Price State Wildlife Sanctuary on Admiralty Island. Anan Creek on the mainland in southeastern Alaska is being developed for black bear viewing. Public demand for bear viewing opportunities is higher than can be sustained without adversely impacting bears and the quality of viewing opportunities. Thus, human use is limited in some sites by access permits. As the tourism industry continues to expand in Alaska, public demand will likely grow for creating additional bear viewing sites.

Public Education Needs

The image of the brown bear continues to both fascinate and frighten people. Improved public education will be an important component of conservation efforts designed to preserve this species in Alaska. Public education goals include educating visitors and Alaskan residents about ways to safely live, recreate, and extract resources in areas occupied by brown bears, and to provide the public with a balanced image of bear-human interactions. Goals for public educational efforts include: 1) reduce the number of human injuries by bears; 2) reduce the amount of property damage caused by bears; 3) reduce the number of bears killed unnecessarily, or in defense of life or property; and 4) increase hunters understanding of the need for conservative management of hunted bear populations.

Recommendations for Brown Bear Conservation in Alaska

Research:

- Maintain long-term studies of hunted and unhunted bear populations in several different ecosystems within Alaska.
- Quantify how human presence affects brown bear habitat use and population viability.
- Quantify thresholds of habitat disturbance on bear population viability.
- Develop cumulative effects models for development activities affecting regional bear populations.
- Assess genetic variability of regional bear populations in Alaska.

Monitoring:

- Establish regional population benchmarks for selected brown bear populations throughout Alaska. These population estimates should be repeatable and include a measures of precision. These estimates are needed to monitor status and trends of populations so that management changes may be made before populations become threatened.
- Monitor habitat integrity in selected regions of the state (e.g., North Slope oil fields, Southeast coastal rain forest, etc). Photographic and EROS satellite imagery will allow managers to track the habitat fragmentation by transportation and utility corridors and/or quantity and juxtaposition of clearcuts within a forest.

- Continue to closely monitor sport harvest levels of brown bears within Game Management Units distributed throughout the state. Improve documentation of subsistence harvests, defense of life and property kills, and illegal kills.

Inventory:

- Inventory important/critical brown bear habitats within each region of the state.

Gap Analysis:

- Conduct an analysis to determine regional gaps in habitat protection from an inventory of important/critical brown bear habitats.

Education:

- Develop a comprehensive bear safety education program with modules that cover recreation, industry, and rural residents. The purpose of this program will be to reduce defense of life and property kills.

- Require bear safety training for resource agency, industry, and tourism organizations operating in bear country.

Policy:

- Develop improved interagency agreements on how to manage bear/human conflicts in Alaska.

- Develop improved interagency agreements on solid waste management and bears in Alaska. The central focus for this policy should be the requirement for fuel-fired incineration of garbage at industrial camp sites and communities located in Alaska brown bear habitat.

Planning:

- Establish comprehensive regional planning as a major tool in bear management and conservation in Alaska. Regional plans should include a comprehensive inventory of brown bear populations and critical habitats with coordination among state and federal resource agencies and the Alaska Natural Heritage Program. Current and future industrial, agricultural, transportation, and recreational developments should be overlaid on the distribution of important bear habitat. A gap analysis could then identify areas where conservation planning should focus and cumulative effects analysis could predict impacts over time to regional and area specific bear populations. Planning on this scale would minimize the loss of

critical habitats and reduce habitat fragmentation. Interagency cooperation is essential because of the varied and disjunct land management jurisdictions throughout Alaska.

Law Enforcement:

- Increase funding for enforcement activity to monitor and reduce the illegal kill of brown bears in Alaska.

Ecotourism:

- Bear viewing programs in Alaska are in high demand. Future development of programs should be carefully planned and developed to provide a variety of viewing experiences ranging from high quality low participation programs such as that at the McNeil River State Game Sanctuary (Aumiller and Matt in press) to high participation programs like those in some Alaskan National Parks like Katmai and Denali.

- Emphasize the economic value of brown bears to local residents. Many local residents in rural Alaska consider bears a nuisance and are inclined to kill them needlessly. The big game guiding industry and the tourism industry should work cooperatively with ADF&G and its cooperating agencies to assess the economic value of brown bears to Alaska and help ensure that some of that value is shared with local residents.

Conclusion

Alaska offers the greatest opportunity in the world for developing a model conservation program for brown bears. The successful conservation of brown bears in Alaska will require that managers incorporate an ecosystem perspective into their research and management programs. To maximize future options, it is critical that resource managers plan for large areas for long periods. Interagency cooperation will also be essential for maintaining Alaska's unique brown bear resource. A critical first step for ensuring the long-term conservation of brown bears is for Alaskan scientists, resource managers, policy makers, and educators to craft a strategic conservation plan. This plan should be designed to assure that Alaskan bear populations remain healthy in the face of accumulating threats.

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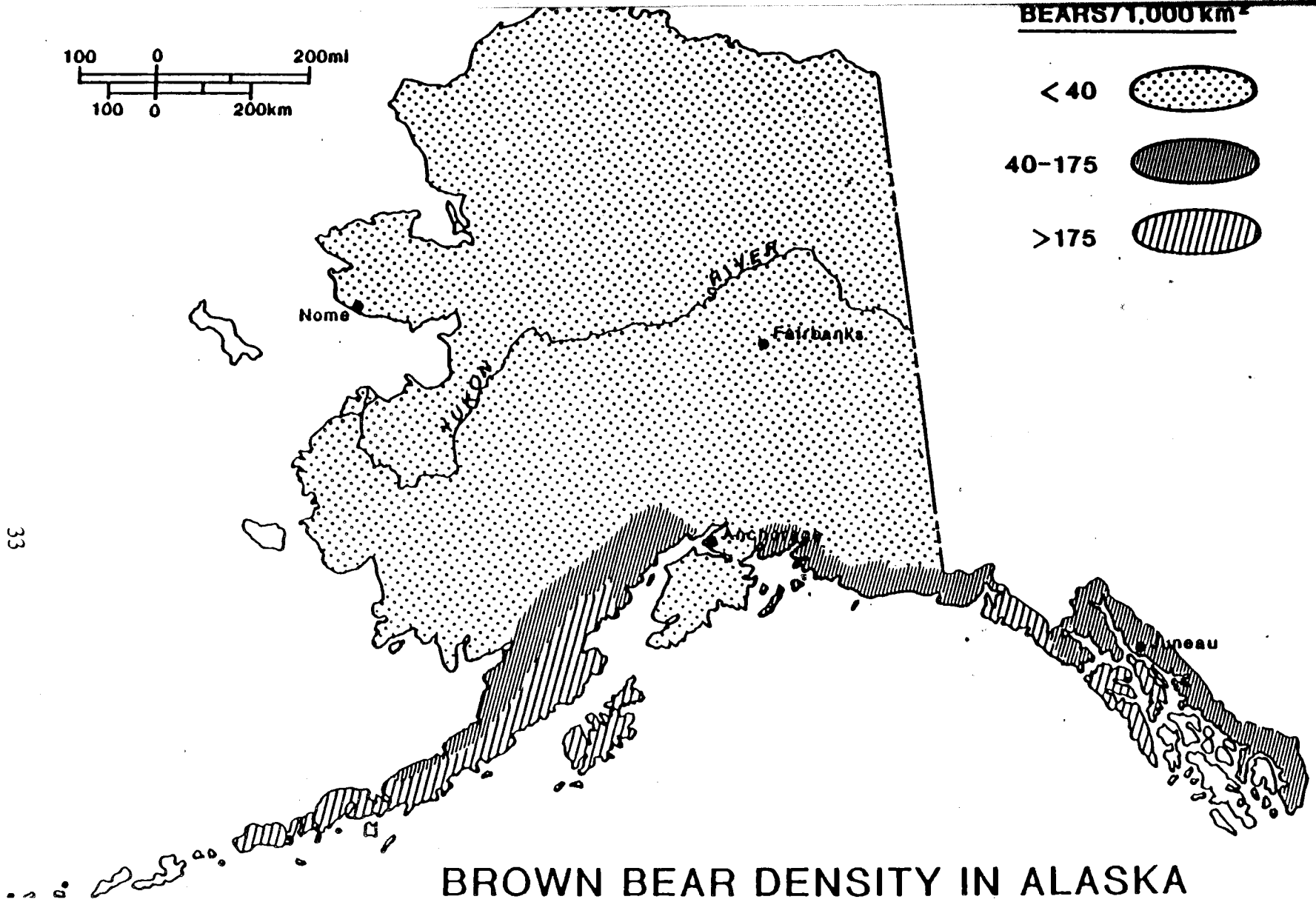


Figure 1. Portions of Alaska occupied by high (>175 bears/1,000 km^2), intermediate (40-175 bears/1,000 km^2), and low (<40 bears/1,000 km^2) density populations of brown bears. Classifications were based on subjective extrapolations from areas where density was estimated through intensive studies (Miller et al. in prep.). Brown bear distribution in Alaska has remained unchanged during 1800-present.

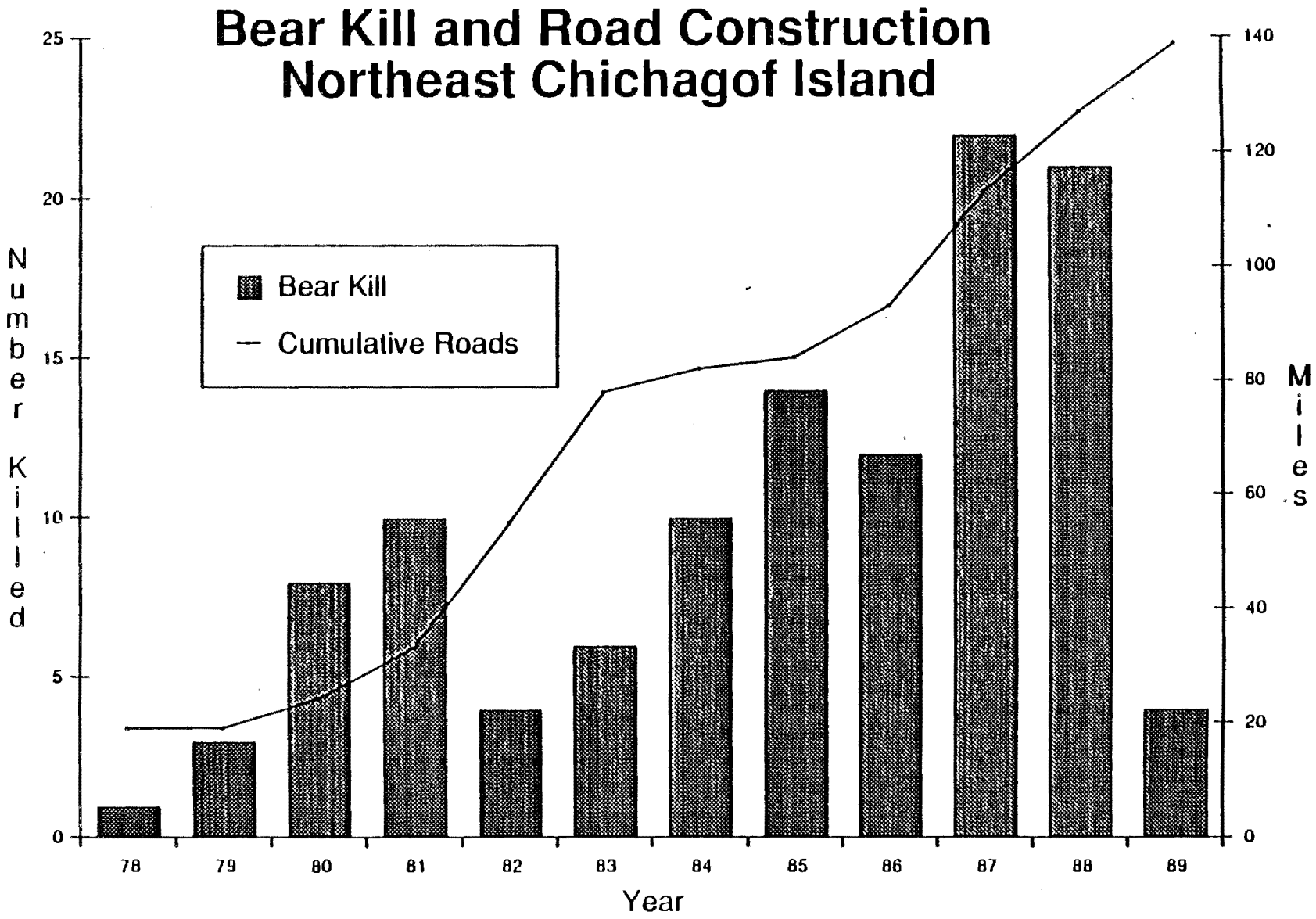


Figure 2. Relationship between bear mortality and road construction on Chichagof Island in southeastern Alaska (from Titus and Beier 1991). Fall hunting season was closed in 1989 and use of vehicles was prohibited but field studies during 1990-1992 documented continued illegal killing along the road system (Titus and Beier 1991).

Table 1. Alaskan brown bear harvests, 1961-1991.

Year	Harvest
1961	470
1962	534
1963	557
1964	634
1965	776
1966	866
1967	790
1968	641
1969	510
1970	628
1971	739
1972	831
1973	924
1974	779
1975	826
1976	832
1977	774
1978	818
1979	882
1980	882
1981	888
1982	823
1983	974
1984	1,118
1985	1,156
1986	1,121
1987	1,215
1988	1,104
1989	1,088
1990	1,145
1991	1,152

Table 2. Proportion of total area of brown bear habitat in Alaska (1.48 million square kilometers), estimated brown bear population (31,200), and reported annual kill (10 year average = 1,078) in each of 3 density strata (>175, 40-175, and <40/1,000 km^2).

Density Strata	Percent of Area (km^2)	Percent of Estimated Population	Percent of Reported Annual Kill
High Density	8.5	50.2	58.i
Intermediate Density	7.3	9.0	9.2
Low Density	84.1	40.8	32.7

Appendix C. Executive summary of a statewide brown bear management report.

BROWN BEARS IN ALASKA: A STATEWIDE MANAGEMENT REPORT

EXECUTIVE SUMMARY

The number of brown bears in Alaska was estimated to be in the range 24,600-38,700 with a best estimate of 31,200. This estimate is lower than a similarly derived 1978 estimate not because bear populations have declined but because of improved information on bear densities derived from field studies. About 41% of the Alaska brown bear population occurs in low density populations (<40 bears/1,000 km^2) that cover about 84% of the state; 50% occurs in high density populations (>175 bears/1,000 km^2) that cover 8.5% of the state, and 9% in intermediate density populations (7.3% of the state). There is an increasing trend in Alaskan brown bear kills by hunters. Currently, about 1,100 bears are annually killed and reported in Alaska. An unknown number of additional bears are killed and not reported or die from wounds. Much of the increase in bear harvest in recent years (60%) compared to a decade ago came from harvest increases in the coastal Game Management Units (9, 4, 16, and 8). This resulted even though hunting regulations became more conservative in GMU 8, slightly more conservative in GMU 4, and were only slightly liberalized in GMU 9. This suggests an especially high demand for hunting opportunities for large bodied coastal brown bears compared to the smaller interior "grizzly" bears. However, interior areas as well as some coastal areas (GMUs 26, 16, 14, 6, 22, and 21) showed the largest percentages increases in harvests relative to this baseline period. Widespread liberalizations of bear hunting regulations, especially in interior areas, contributed to increased harvests. Harvest yield expressed as reported bear kills/unit area was highest in GMU 8 (Kodiak Island). For interior populations, highest yield (kill density) was in GMU 13E where populations are thought to be declining. Number of Alaskan brown bears killed by non-resident hunters has increased consistently over the last 3 decades while number of bears killed by resident hunters has declined since 1985. Numbers of brown bear tags sold to resident and non-residents have remained constant in recent years. Success rate for resident hunters is about 7.6% compared to 50.8% for non-resident hunters. Statewide, successful hunters took an average 5 days to take a bear, slightly more for non-residents than for residents. Between the highest and lowest GMUs, there was a 2-3x range in number of days hunted by successful hunters. Available technology for setting hunting quotas and detecting trends in bear numbers is inadequate for precise management of populations. This, along with low reproductive rates for brown bears, argues for a conservative approach toward harvest management in most areas.

Table C1. Estimated brown bear population in different Alaskan Game Management Units and subunits.

GMU	Area mi²	Area km²	Best Guess	Minimum	Maximum	Status
1A	5,292	13,696	291	227	354	Stable
1B	2,979	7,710	180	135	225	Stable
1C	7,562	19,570	334	251	418	Stable
1D	2,670	6,910	237	178	296	Stable
3	2,968	7,681	45	30	60	
4AD	1,664	4,306	1,660	1,494	1,824	Stable
4BAR	1,607	4,159	816	719	913	Stable
4CHI	2,104	5,445	1,625	1,501	1,772	Stable-declining?
4KRUZ	200	518	127	121	133	Stable
5A	2,974	7,697	522	392	653	Stable-declining
5B	2,797	7,239	270	203	338	Stable
6A	3,287	8,507	245	161	329	Stable
6B	850	2,200	102	79	124	Stable
6C	713	1,845	101	69	133	Stable
6D	5,289	13,688	301	184	417	Declining?
7	3,520	9,110	96	50	150	Stable?
8	5,097	13,191	2,732	1,968	3,538	Stable
9A	2,134	5,523	400	320	480	Stable
9B	7,091	18,352	1,000	800	1,200	Stable
9C	7,560	19,565	2,400	1,920	2,880	Stable
9D	4,849	12,549	900	720	1,080	Stable
9E	12,005	31,069	3,200	2,560	3,840	Stable
10 Unimak	1,586	4,105	250	200	300	Stable
11	12,782	33,080	547	434	724	Stable
12	9,978	25,823	329	290	426	Stable
13	23,376	60,497	880	640	1,120	Declining
14A	2,561	6,628	47	43	51	Decreasing
14B	2,152	5,569	105	87	123	Stable
14C	1,912	4,948	60	55	65	Increasing
15	4,876	12,619	181	90	270	Stable?
16A	1,850	4,788	76	54	102	Stable-declining?
16B	10,405	26,928	746	532	1,055	Declining
17	18,771	48,579	1,350	1,080	1,620	Stable-increasing
18	41,159	106,519	343	313	392	Stable
19	36,486	94,426	905	724	1,086	Stable
20A	6,796	17,588	145	124	165	Declining
20B	9,114	23,587	80	47	112	Stable?
20C	11,902	30,802	261	195	326	Stable?
20D	5,637	14,589	169	118	220	Declining

Table C1. Continued.

GMU	Area mi²	Area km²	Best Guess	Minimum	Maximum	Status
20E	10,680	27,640	517	475	558	Declined, now stable
20F	6,267	16,219	60	36	83	Stable?
21	43,925	113,678	722	580	870	Increasing
22A	5,838	15,109	249	206	292	Stable?
22B	6,840	17,702	328	282	373	Declining?
22C	1,674	4,332	81	74	88	Declining
22D	6,739	17,441	210	198	224	Stable
22E	4,138	10,709	98	90	108	Stable
23	43,422	112,376	1,246	623	2,492	Unknown
24	26,055	67,430	1,210	970	1,450	Increasing
25A	21,300	55,124	584	456	713	Stable-increasing
25B.	9,099	23,548	198	176	220	Stable-increasing
25D	17,569	45,469	382	340	424	Stable-increasing
25C	5,149	13,326	74	48	101	Stable?
26A	53,465	138,367	1,007	806	1,108	Increasing
26B	15,515	40,153	262	210	288	Stable
26C	10,273	26,587	391	312	430	Stable
Subtotal	574,503		1,486,814		31,677	24,99039,136

Basis or authority estimates by GMU:

GMU

1 Robus, Larsen, Land, Dinneford pers. commun. 4/19/93

3 Robus, Larsen, Land, Dinneford pers. commun. 4/19/93

4 Young (1991 PR report modified by 1993 pers. comm.)

5 Robus and Dinneford pers. commun. 4/19/93

6 Griese (1991) and Nowlin (1993)

7 Estimate of Del Frate (1993) based on 4,800 km² of habitat, 20/1,000 km², limits = +/- 50%/

8 Smith (1991) and Barnes et al. (1988)

9 Sellers(1993 and pers. comun. 4/2/93), +/-20%. "Stable" for last 8 years; increasing" over last 20-30 year period (Sellers pers. commun. 4/2/93)

10 Sellers (pers. comun. 4/2/93)

11 Tobey (pers. commun. dated 4/27/93) based on 16,089 km² of habitat 5,000' elevation, and low, best, and high densities of: 27, 34, and 45/1,000 km2, respectively.

12 Gardner (June 1993 pers. commun.)

13 Miller (1993)

14 Harkness (1993 and 4/23/93 pers. commun.)

15 Estimate of Del Frate (1992 and pers. comm.), based on 9,048 km² of habitat, 20 bears/1,000 km², and limits = +/- 50%/

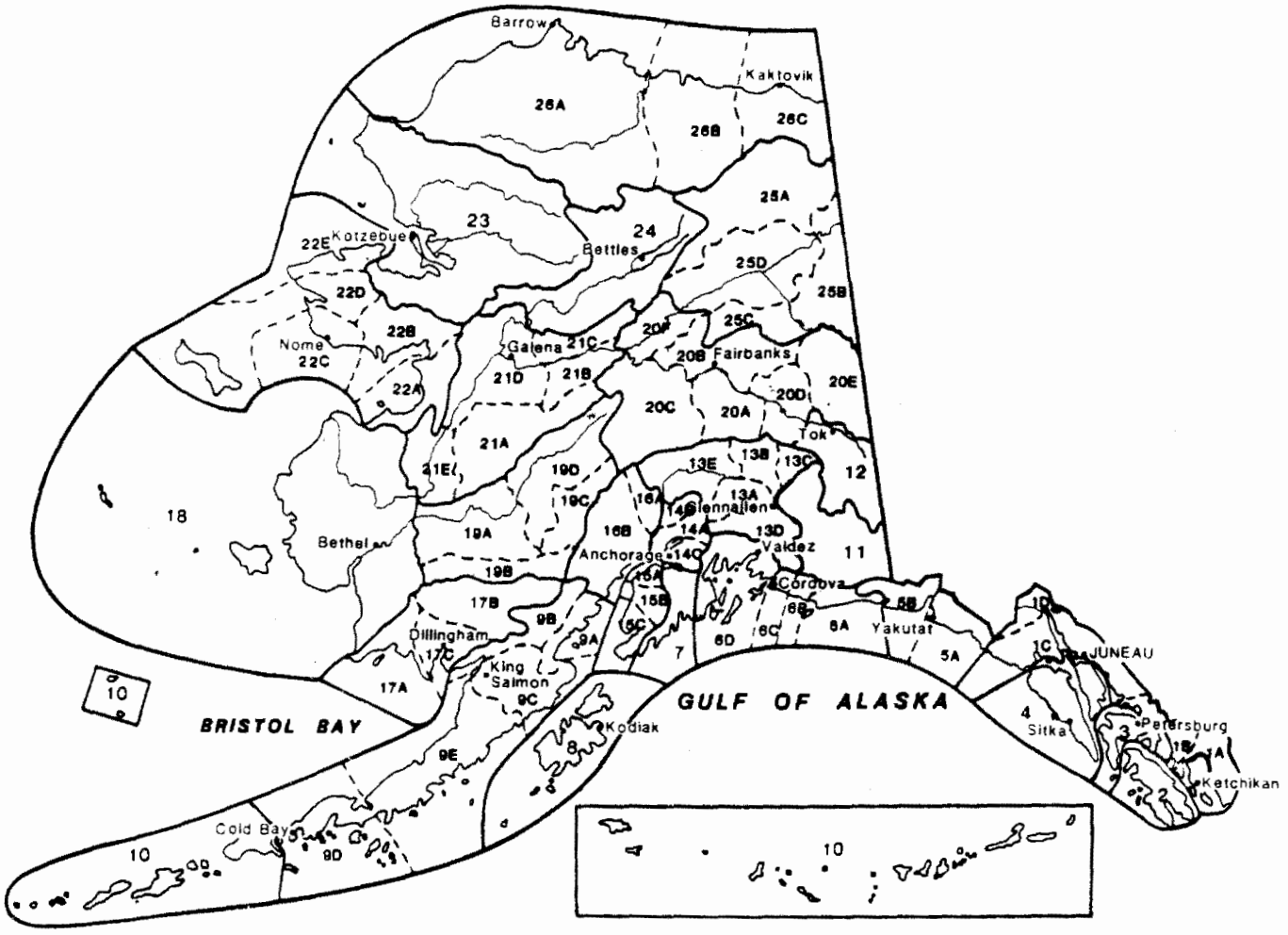
16 Griese (1991 and 4/23/93 pers. commun.)

17 Van Daele (1993), +/- 20% for limits

Table C1. Continued.

18 Kacyon (4/1/93 pers. comun.) based on 14,519 km^2 habitat in GMU 18
19 Whitman (1991), limits based on +/- 20%
20 A-C & F Eagan and Reynolds (pers. commun. 6/29/93)
20D DuBois (5/25/93 pers. commun.)
20E Gardner (June 1993 pers. commun.)
21 Osborne (4/16/93 pers. commun., limits based on +/- 20%
22 Nelson (1993) based on extrapolation from density estimate + 20% for coy and ylgs
23 J. Dau (memo to John Coady dated 3/18/92 and to S. Miller dated 4/21/93). There is a large degree of uncertainty associated with the estimate for GMU 23 and Area Biologist J. Dau feels his guesses reflect the need for more information rather than a realistic population estimate. Estimate for bears 2+ converted to all bears by adding 15%. Limits are based on -50% and +100%.
24 Osborne (4/16/93 pers. commun., limits based on +/- 20%
25A Reynolds (1989), and Stephenson (4/27/93 pers. commun.)
25B Reynolds (1989), and Stephenson (4/27/93 pers. commun.)
25D Reynolds (1989), and Stephenson (4/27/93 pers. commun.)
25C Eagan and Reynolds (pers. commun. 6/29/93)
26A-C Reynolds (pers. commun. 7/27/93, limits = -20% and +10%)

Alaska's Game Management Units



Federal Aid in Wildlife Restoration

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. Alaska receives 5% of the revenues collected each year, the maximum allowed. The Alaska Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be reponsible hunters. Seventy-five percent of the funds for this project are from Federal Aid.