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Effects of Harvest on Grizzly Bear Population Dynamics in the Northcentral Alaska Range

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Final Research Performance Report
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Study 4.28

FEDERAL AID
RESEARCH FINAL REPORT

PROJECT TITLE: Effects of Harvest on Grizzly Bear Population Dynamics in the Northcentral Alaska Range

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GRANT AND SEGMENT NR.: W-24-5, W-27-1, and W-27-2

PROJECT NR.: 4.28

WORK LOCATION: Northcentral Alaska Range (southcentral Unit 20A)

STATE: Alaska

PERIOD: 1 July 1996–30 June 1999

I. CUMULATIVE PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: Determine sustainable mortality rates for female grizzly bears in the northcentral Alaska Range through modeling observed dynamics of reproductive and survival population parameters.

We applied formulations of Euler-Lotka equations (Eberhardt and Siniff 1977; Eberhardt 1985; Eberhardt et al. 1994) included in a model developed by Ward Testa (personal communication, Alaska Department of Fish and Game, Anchorage) to determine sustainable yields of grizzly bears. We determined rates of natural mortality and all recorded mortality for the female segment of an Alaska Range grizzly population. Inputs included Kaplan-Meier survival rates (Pollock et al. 1989), female birth rate (birth rate of female cubs/adult female/year; Testa 1996), age of first parturition and maximum age.

OBJECTIVE 2: Collate and analyze data to prepare for scientific publication: an assessment of population dynamics of harvested grizzly bears, sustainable harvest rates for females, a model of population response and recovery in a heavily-harvested population, use of genetic relationships to assess population analysis, and pharmacokinetics of the capture drug Telazol® following immobilization.

Parameters necessary for assessments of population trajectory and stability, which enable calculation of sustainable harvest rates, were collated and analyzed. These include sex and age of bears in the population, female age at first production of young, litter size, interbirth interval, and age-specific mortality rates.

Tissue samples for assessing genetic relationships were collected for genotyping as part of a master's degree research project at Montana State University.

Data collection to determine rates of physiological clearance of the drug Telazol® following immobilization of grizzly bears was completed.

II. WORK NOT ACCOMPLISHED AS CONTRACTED

All work was completed as contracted.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 1: In consultation with a biometrician, develop a model describing sustainable harvest of this population.

A model based on staggered-entry of Kaplan-Meier survival rates (Pollock et al. 1989) and Euler-Lotka formulations (Eberhardt 1994), with Testa's (1996) calculation of mean annual production rate of females was used to estimate sustainable harvest.

JOB 2: Collate, analyze and prepare for publication results gathered during 1981–1996 in studies of dynamics of a hunted grizzly bear population in the northcentral Alaska Range.

Data on mortality, survival rates, cub production, litter size, age at first and last parturition, sex ratios, annual status of individual bears, intervals between litter production and weaning of offspring, hunter selection and population size were collated and analyzed. Analysis of these data was prepared in formats appropriate for publication in scientific journals.

JOB 3: Prepare publications on population dynamics in a hunted grizzly bear population in northcentral Alaska; population response to harvest at high, low, and sustainable rates for Alaskan grizzly bears; and comparisons of population dynamics in long-term studies of Alaskan grizzly bears.

Age-specific mortality rate determination and analysis of the population parameters listed in Job 2 are necessary preparatory components for examination of population dynamics or response to harvest. These aspects have been prepared and initial outlines have made for various publications. Manuscripts for scientific journals have been outlined, but have not been submitted, with the exception of a paper coauthored on population estimation techniques and comparative density (Miller et al. 1997).

WORK NOT ACCOMPLISHED AS CONTRACTED

Although data were prepared for several publications, only one (Miller et al. 1997) was published during this period. Completion of papers on population dynamics and response to harvest were contingent upon compilation and analysis of the long-term data set used for age-specific survival rate calculations. These calculations are complete and will allow completion of manuscripts for publication in scientific journals.

IV. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

Data collected ancillary to the objectives allowed analysis of morphometrics and girth-age-weight relationships, which will be published in the future. In addition, movement patterns observed during aerial flights conducted in the course of addressing objectives for this report will allow analysis of fidelity to, and emigration from, established and maternal home ranges. Final preparation, review, editing and publication of grizzly bear population density estimation and mark-resight techniques were completed during this period. Similarly, collation and analysis of data was completed for preparation of a manuscript detailing effective protocol for brown bear capture.

V. RESEARCH RESULTS

Using this model estimated sustainable yield in this population was estimated considering natural mortality alone, and total observed mortality which includes both natural and human-caused mortality. Human-related mortality included deaths from hunting in which hunters reported their kills, wounding losses, defense of life or property kills, illegal kills, presumed deaths of cubs or yearlings following the mother's human-caused death, and capture-related deaths.

Observed average age of first parturition for 31 females was 5.94 (95% CI = 5.5–6.4), mean litter size was 2.0 (95% CI = 1.75–2.25) for 79 litters with a total of 165 cubs, and average interbirth interval was 2.67 (n = 63; 95% CI = 2.4–3.0).

Survival data included observations of 257 individual bears over 568.073 aggregate years. Of those monitored, 40 were females of unknown maternal lineage; 49 were female offspring with known maternal lineage; 48 were male offspring with known maternal lineage (only monitored until death, their weaning as 2-year-olds or until 1 June, whichever came first); and 120 of unknown sex were monitored with their radiocollared mothers until death, their weaning as 2-year-olds, or until 1 June, whichever came first.

Based on staggered-entries of this data (Pollock et al. 1989), Kaplan-Meier calculation of survival to mean age at first parturition, accounting only for natural mortality, was 0.61 (95% CI = 0.50–0.73). In comparison, Kaplan-Meier calculation of survival to mean age at first parturition, when both natural and human-related causes of mortality were considered, was 0.36 (95% CI = 0.23–0.48).

Yield for all females, based on natural mortality rates only, was estimated at 9.4%, with λ (population rate of growth) = 1.1037 (95% CI = 1.0367–1.1613). In comparison, mean annual yield for all females when all sources of mortality were included was 1.4%, with λ = 1.0143 (95% CI = 0.9221–1.0952). In comparison, using the same approach for a grizzly bear population in British Columbia and Montana, Hovey and McLellan (1996) calculated that λ = 1.085 (95% CI = 1.032–1.136). Other models, based on hunter harvest or cautionary input parameters estimated lower sustained yields of 4.6–7.0% (Miller 1988; Eberhardt et al. 1994; Swenson et al. 1994). Because the model we used appears relatively unresponsive to substantive changes in model parameters, it should be carefully interpreted and cautiously applied until further verification of its utility can be made.

Tissue samples for assessing genetic relationships were collected and were to be analyzed as part of a graduate student research project at Montana State University. Genotyping was completed, but the student dropped out of the program and assessment of genetic relationships was not completed. No Federal Aid funds were used for this project.

Data collection to determine rates of physiological clearance of the drug Telazol® in grizzly bears following immobilization was completed, and a manuscript is in preparation in cooperation with coworkers. Tentative analysis indicates that blood levels of Telazol® are cleared by >50% in <60 min. No Federal Aid funds were used for this project.

VI. PUBLICATIONS

The following publication describing population size was directly related to the project and was published during this period.

Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques
MILLER SD, GC WHITE, RA SELLERS, HV REYNOLDS, JW SCHOEN, K TITUS, VG BARNES, JR., RB SMITH, RR NELSON, WB BALLARD, AND CC SCHWARTZ. 1997. *Wildlife Monographs* 133.

Abstract: Accurate density and population estimates are needed to manage bear populations but are difficult to obtain. Most such estimates reported for bears are largely subjective and lack estimates of precision. Fifteen brown bear (*Ursus arctos*) and 3 black bear (*U. americanus*) density estimates were obtained in Alaska during 1985 through 1992 using 2–9 replicates of capture –mark-resight (CMR) techniques in 17 different areas. Our studies used radiotelemetry to document movements of marked animals into and from search areas. This procedure essentially eliminated the need to correct density estimates for edge or periphery effects caused by absence of geographic closure. To estimate population size we used a maximum-likelihood estimator modified to accommodate temporary movements of marked animals into and from our search areas. Our approach permitted direct calculations of density from our population estimates. Our procedures provided density estimates that were repeatable, were comparable among areas, included estimates of precision and were more objective than methods historically used to estimate bear abundance. Our density estimation procedures have widespread applicability for other wildlife studies using radiotelemetry.

Our estimates were obtained within a wide spectrum of habitats and provided a range of Alaskan densities from 10.1 to 551 brown bears (all ages)/1000 km^2 and from 89 to 289 black bears (all ages)/1000 km^2. Our highest brown bear density is probably near the maximum for this species, but areas with lower densities (3.9/1000 km2) have been reported in Alaska. Areas with black bear densities higher than in our study areas probably occur in Alaska. Brown bear densities were 6–80 times greater in coastal areas where abundant runs of multiple species or salmon *(Oncorhynchus* spp.) were available to bears than in interior areas. Our CMR techniques provided useful data for bear population

management and impact assessment and has potential for application to other species and areas.

The following two publications are directly related to this project and are in preparation.

Selection of adult males by brown bear hunters — perception or reality?

REYNOLDS HV, VG BARNES JR, RB SMITH, S SZEPANSKI, AND J WANT. *In prep*. Selection of adult males by brown bear hunters--perception or reality? Presented at 13th International Conference on Bear Research and Management, Jackson, Wyoming, May 2001.

Abstract: Sustained yield of hunted brown bear (*Ursus arctos*) populations and strategies for managing hunting depend on whether hunters selectively kill males. In Alaska, management decisions are primarily based on estimates of sustained yield for each specific population, annual trends in numbers of bears killed in each population, and the sex and age characteristics of the kill. Calculations of sustained yield have been rough estimates based, in part, on the assumption that brown bears taken by hunters are killed in the proportions that are representative of the sex and age composition of the population = 2 years of age. In contrast, big game guides and many hunters portray their hunting practices as being selective for large adult males. If guides and hunters are correct in this characterization, then harvest should be biased towards males.

We tested the hypothesis that hunter kill of Alaskan brown bears is not selective for specific sex or age category. We tested use vs. availability by comparing sex and age characteristics of hunter-killed brown bears in 2 regions of the state with those determined by research studies of populations in the same regions. We accounted for mean differential vulnerability to harvest by spring and fall hunting seasons due to regulatory protection of females accompanied by offspring. For those and other regions of the state, we further partitioned analysis for each game management unit by hunter type (unguided residents vs. guided nonresidents), harvest density and hunting pressure, area differences in brown bear size, estimated bear density, and by management goals for each unit.

We suggest how this analysis can be applied to timing of hunting seasons and management based on kill density of females only. We explore what role hunter education can play in changing hunter attitudes and field skill development to identification of males and how regulatory changes could provide motivation in development of selectivity skills by brown bear guides and resident hunters.

BLAKE JE, HV REYNOLDS, AND H SEMPLE. *In prep*. Pharmacokenetics of tiletamine HCL/zolazepam HCL (Telazol®) in grizzly bears. For submission to *Journal of Wildlife Diseases*. Expected submission date 2001.

The following three publications were ancillary to the project and contain data collected in the course of completing other project objectives.

Procedures for maximizing safe and humane capture of brown bears

REYNOLDS HV, BN MCLELLAN, AND JE SWENSON. *In prep.* Procedures for maximizing safe and humane capture of brown bears. Presented at 13th International Conference on Bear Research and Management, Jackson, Wyoming, May 2001.

Abstract: Based on our experience of capturing over 2800 brown bears during 1973–2000, we suggest capture protocols that have proven successful in minimizing risk of mortality or injury to bears in Alaska, British Columbia, and Sweden. For example, by following these methods, only 2 of 657 (0.3%) bears captured died from capture-related causes in our studies in northern Alaska during 1986–2000. We compare efficacy, advantages, disadvantages and differences in handling characteristics of immobilizing drugs in various concentrations for tiletamine HCL/zolazepam HCL (Telazol® /Zoletil®, Fort Dodge Labs) and its synergist medetomidine HCL (Zalopine®, Farmos), ketamine HCL/xylazine HCL (Ketaset®, Bristol Veterinary Products/Rompun®, Lemmon Co.), tiletamine HCL (M-99®, Lemmon Co.), and phencyclidine HCL (Sernylan®, BioCeutic Laboratories), among others. We discuss how effective doses of immobilizing drugs differ among capture techniques, monitoring the effects of the drugs on physiological parameters, if and when additional dosages should be given, expected recovery times, and differences among darting guns.

We discuss advantages, disadvantages and selectivity of capture using helicopters in open and forested habitat, snares in forested habitat, culvert traps, and free darting. Approach methods using a helicopter should vary depending on the age and social status of targeted individuals, including breeding pairs, solitary adults, solitary sub-adults, and family groups. Attempts to capture cubs of the year should be made only under certain situations. Techniques can be applied to minimize danger to estrous females under the effects of drugs from adult males, reduce mortality and injury to bears during helicopter capture, and minimize exposure of partially immobilized bears to natural hazards. Captures of multiple bears at one time can be accomplished but should only be attempted under specific conditions. Appropriate handling and treatment of immobilized bears should include measures to maintain physical well being, including appropriate body temperatures, and careful selection and fitting of radio collars to avoid injuries.

Longevity and reproductive performance in old-aged brown bears in Alaska

REYNOLDS HV, VG BARNES, JR, AND RB SMITH. *In prep*. Longevity and reproductive performance in old-aged brown bears in Alaska. Expected submission date, 2002.

Abstract: Most records for longevity of brown bears have been documented at zoos rather than from wild populations. Arguably, because of the protective environment of zoos with attendant veterinary care and ready access to food, bears may reach ages that are unlikely to occur in wild populations. Because of hunting or natural mortality, most studies assume that wild bears die by the age of 20–25 years, or if they live, provide negligible additional productive capacity to the population, due to reproductive senility. We show that even

though their representation in populations is diminished by age 20, both males and females may be present and reproductively active well beyond that age.

We documented maximum ages for free-ranging brown bears in Alaska. A female from Kodiak Island near Karluk Lake (57°N, 154°W) was killed by a hunter during October 1991 at a minimum known age of 34 years. A 30-year-old female, monitored since 1982 in the northcentral Alaska Range (64°N, 147°W) was observed alive during October 2000, accompanied by 2-year-old offspring at the mouth of her winter den. A male from the western Brooks Range (69°N, 162°W) was last observed alive during May 1994, at age 34 years, his freshly bloodied radio collar was found in the area 17 months later.

All 3 bears were members of hunted populations, but hunting pressure and other factors that allowed the bears to survive to advanced aged differed. Hunting pressure on Kodiak Island is high due to the presence of large bears desirable to many hunters and to the high bear population density. Similarly, hunting pressure in the northcentral Alaska Range was high during the 1980's to early 1990's. However, hunting regulations do not allow the kill of females accompanied by cub or yearling offspring. Further, it is rare for hunters to kill females in family groups with 2- or even 3-year-olds at their side. Therefore, depending on the timing of hunting seasons, productive females may only be vulnerable to hunter kill during the fall season of the year in which they weaned offspring and then bred, or 1 of 6–8 seasons, depending on whether they break familial bonds as 2- or 3-year-olds, and whether they produce a new surviving litter the following year.

In contrast, in the western Brooks Range, although males are vulnerable to hunters during any open season, hunting pressure is light because of the size of the bears is relatively small and less desirable to hunters, the population density there is relatively low and the availability of other species to hunt is minimal.

We further test the hypothesis that the proportion of old-aged bears in our study populations in 4 areas of the state do not differ from those killed by hunters in the same in 4 areas. We further test the hypothesis that young females are more productive than older females, who may be subject to reproductive senility. We compare records of production among 4 age groups of females, aged 6–10 years, 11–15 years, 16–20 years, and 21–30 years, captured during research studies in these same 4 areas. As expected, there are a higher proportion of females in the first 2 quartiles than in the 16- to 30-year quartiles. Similarly the total number of offspring produced by the 2 quartiles of younger females than by the 2 composed of older ones. However, survival rates of offspring for females in the older quartiles are higher, so net production of young that survives until weaning may partially compensate for their smaller representation in the population. The potential for male reproductive senility was assessed both genetically and through direct observation.

Models of brown bear population behavior should be cautious in application of assumptions of reproductive senility, and account for differences in survival of offspring born to older-aged mothers.

SCHWARTZ CC, HV REYNOLDS, VG BARNES JR, RA SELLERS, SD MILLER, BN MCLELLAN, J KEAY, R MCCANN, S HERRERO, WF KASWORM, AND R MACE. *In prep.* Metapopulation analysis of reproductive senescence in brown bears. (Expected submission date, late 2001–early 2002)

VII. RESEARCH EVALUATION AND RECOMMENDATIONS

This study demonstrated the substantial annual variation that can occur in population parameters annually or even during 2- to 3-year periods. Such variation likely plays a crucial role in the dynamics of bear population and can only be identified by long-term investigation. Since effective management is based on a clear understanding of population dynamics, it is very important that studies investigating grizzly bear populations be conducted over a period of at least 10 years.

Development of an alternative model of sustainable yield using probabilistic Bayesian analysis was initiated, but is not complete. This approach could prove far more useful in providing understanding of how individual parameters are used in any model. In addition, use of a stochastic population model for the dynamics of grizzly bears could give more realistic results than the presently applied deterministic model. Other biometric priorities did not permit production of a model using Bayesian approaches; however, this time-consuming approach should be addressed in the future.

Observations made during this study indicate that bear populations are subject to external conditions that result in substantial annual variation in cohort size, cub production, litter size, survival, and period of maternal care. Similarly, human-caused mortality varies from year to year, often related to weather during hunting season or openings of seasons for ungulate species. However, in most modeling exercises, these parameters are treated as mean values, an approach which may mask real dynamics within the population. Improvements in applicability of models to observed conditions and parameter variation need to be further addressed.

Monitoring of population parameters and tracking of presence of adult females as an indicator of population recovery have been minimal during this report period. A final assessment of changes in these data and how female harvest has varied should prove valuable in management of bear populations throughout interior Alaska. Survival data on 2- to 5-year-old females may be biased and driving the model we applied to its apparent high yield estimate. If the study is continued, monitoring of these cohorts should be a priority. Alternately, if further investigation shows that the survival data for these cohorts is accurate, and more appropriate models substantiate sustainable yield we calculated, then many of the bear populations in Alaska could be subjected to higher mortality rates than are presently allowed with minimal effect.

Most Alaskan predator-prey studies have focused on reduction in ungulate calf and adult numbers as a result of wolf and bear kills. Ongoing studies of ungulate production and survival are presently taking place in and adjacent to study area for this grizzly bear project. Although kill rates by wolves and effects of ungulate availability on pack dynamics have been addressed, similar information is not available for grizzlies. Additional research to address the issues of individual predation rates by bears and how availability of prey affects bear populations should be initiated to provide a more complete picture for predator-prey interrelationships in Interior Alaska.

VIII. FEDERAL AID TOTAL PROJECT COSTS FROM BEGINNING TO END OF PROJECT

Total project costs for this period were $121,000, including salary and operating costs.

IX. LITERATURE CITED

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