ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
Wildlife Restoration Grant

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PROJECT TITLE: Nelchina Brown Bear Demographics

PERIOD OF PERFORMANCE: July 2009 – June 2018

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PRINCIPAL INVESTIGATOR: Chris Brockman

COOPERATORS: Michael Guttery, Todd Rinaldi

Authorities: 2 CFR 200.328
2 CFR 200.301
50 CFR 80.90

I. SUMMARY OF WORK COMPLETED ON PROJECT

Objective 1:
Estimate Nelchina brown bear productivity, cub survival, annual rate of population change or lambda (λ), and compare the estimated population growth rate to the change in density estimates from 1998 and 2011.

Accomplishments:
Nelchina brown bear productivity, cub survival, and annual rate of population change (λ) were estimated. The λ estimate was compared to the change in density from 1998 and 2011.

In total 129 bears were captured and monitored during this project. Of these, 84 were female and 45 were male. All marked bears were included in a Capture Mark Resight (CMR) survey to estimate density. The female bears were monitored for survival and production of cubs and the cubs of marked female bears were monitored for survival. This vital rate data was used to calculate the annual rate of population change. We used a stage-structured matrix population model in Program R to calculate λ. For this model stage-specific detection (p_i), mortality (μ_i^j) and state-transition (Ψ_i) probabilities were estimated using a Bayesian implementation of a multistate mark-resight model which included all live and dead states. All detection probabilities were estimated using vague *N*(0.5,1000) prior distributions truncated at [0,1]. Intercept parameters pertaining to mortality and state transition estimates were specified on the multinomial logit link scale using N(0,1000) distributions truncated at [-5,5] whenever >2 transitions from a particular state were possible, otherwise priors were specified in the same fashion using a traditional logit link. Posterior distributions were obtained via Markov Chain Monte Carlo (MCMC) estimation in Just Another Gibbs Sampler (JAGS 4.0).

On 14–19 May 2011 a CMR survey was conducted in a 3,000 km^2 area of GMU 13A. The survey area was divided into 12 equal sized rectangular survey units of 250 km^2. Six pilot-observer teams flew for six days in fixed-wing aircraft to complete the survey. Each pilot-observer team flew one section in the morning (7:30am–11:30am) and one section in the evening (4:00pm–8:00pm) resulting in each team flying each section once during the six-day survey. A telemetry command plane was also involved in the survey, locating all collared bears by VHF during each survey to identify if individuals were in a survey unit during the survey or outside the survey area.

We calculated density estimates of 12.98 (95% CI=11.38–14.82) for independent bears and 20.36 (95% CI=18.96–21.86) for all bears per 1,000 km^2. We compared these density estimates to the 1998 estimates. Based on these density estimates, the population of independent bears declined at an average rate of 3.7% (λ=0.963) per year whereas the total density declined at only 2.3% annually (λ=0.977) between 1998 and 2011. Using the vital rate data the mean population growth rate was estimated to be 0.958 (SD = 0.024), indicating an annual decline in abundance of approximately 4%.

Objective 2:

Identify degree of calf/adult moose predation by collared brown bears, both within and outside the study's moose calving area. Data collected will include:

i. Demographics (age, sex, and reproductive class);

ii. Locations of bears;

iii. Activity and identified kills; and

iv. Isotope signatures for diet.

Accomplishments:
This objective was completed and the degree of predation on adult and calf moose by collared bears was estimated and reported.

We captured brown bears 15–17 May by darting from a helicopter (four in 2011, four in 2012, and nine in 2013). The bears were recaptured, and collars recovered between 17 and 29 June in each year. The four brown bears captured in 2011 were previously collared as part of an ongoing study and selected because they had a history of predating ungulate calves, as verified by aerial observation. We selected these bears to ensure that video footage would be collected to evaluate the camera–GPS technology as a useful tool for investigating bear predation characteristics. The bears captured in 2012 and 2013 were opportunistically selected for collaring, with the caveat that they were adults (>5 yr old), and both sexes were represented. Female bears both with and without cubs were selected.

We fit each bear with a prototype Lotek Wireless™ GPS_3300 collar equipped with a digital camera (Lotek Wireless Inc., Newmarket, ON, Canada). The GPS_3300 collars had a location accuracy of 5–10m 95% of the time. We selected the sampling interval in 2011 without prior information on handling time and based it on 28 hours of available camera battery life. We adjusted the sampling intervals in subsequent years to evaluate the effects of interval selection on detection of kill rate and handling time. In 2011, we programmed camera collars to record a 10-second video clip and GPS location every 15 minutes. The camera programming included a duty cycle of 18 hours on and 6 hours off. The 6-hour-off period was different for each collar (0001–0600, 0601–1200, 1201–1800, and 1801–2400 hr). We only used duty cycles in 2011. In 2012, we programmed the collars to record a 10-second video clip every five minutes and a GPS location every 15 minutes. In 2013, we programmed four collars to record a 10-second clip every five minutes and a GPS location every 10 minutes and programmed five collars to record 10-second clips and GPS locations every 10 minutes.

We estimated activity budgets for brown bears whose collars collected sufficient video information. To analyze ungulate calf predation, we defined sufficient video information as those individuals having six or more complete days of samples obtained after 20 May. This date was selected because it was the median date of first observed calf kill for five of the seven brown bears observed to consume calves. We excluded two brown bears from the median first-kill-date analysis, because one bear was not collared until 25 May, and the second bear returned to its den after collaring and did not kill a calf until 30 May. We categorized all activities at the level of an individual video clip beginning one day post collar-deployment to avoid post immobilization effects. We calculated the frequencies of individual behaviors as the percent of video clips in which a given behavior was the dominant behavior.

We further evaluated each instance of feeding on an ungulate to determine whether the bear was feeding on a fresh or old carcass (i.e., scavenging). We classified a prey item as fresh if 1) it was still alive, 2) it was an intact carcass displaying no rigor mortis, or 3) muscle tissue and blood appeared bright pink, bones were clean of dirt and wet, the fur was clean and unmated, and connective tissues were clean and white in appearance. We classified a prey item as old if 1) muscle tissue appeared dark maroon, 2) blood was coagulated and dark, or 3) hair was matted, dirty, or loose, and bones were covered in dirt and appeared dry. We assumed fresh carcasses to have been killed by the collared bear. We classified old carcasses as scavenged or revisited kills based on GPS locations.

To determine that all kills were included and no kills were double-counted (Fig. 2), we sorted all video clips classified as feeding on an ungulate through metadata, including the time stamp (from the videography) and associated GPS location recorded within the nearest 10- or 15-minute interval. We determined individual kills by appearance of carcass (primarily degree of consumption), time, and distance between previous kill and current kill. If subsequent clips of feeding were not distinguishable as separate kills by appearance of carcass, but occurred ≥200 m, we classified them as separate kills. To account for the 6-hour periods when cameras cycled off in 2011, we adjusted the number of observed kills by multiplying confirmed kills by 1.33, assuming that kills occurred at the same rate when the camera was off as when the camera was on. This assumption was supported by a lack of temporal pattern and consistent rate of calf kills in the non–duty-cycled cameras used in 2012 and 2013.

Of the seven brown bears with sufficient data for analysis, four were documented consuming adult ungulates. The mean adult ungulate kills/bear for all seven brown bears while the cameras were working (15 May–17 Jun) was 1.4 (0–5.3), consisting of 0.6 adult moose, 0.6 adult caribou, and 0.2 unknown adult ungulates (either moose or caribou). Among these bears, the mean number of observed calf kills/bear observed was 28.4, including 13.3 moose calves (0–30.6), 11.9 caribou calves (0–30), and 3.3 unknown calves (either moose or caribou; 0–8.0). The number of sample days (1 day post–collar-deployment until camera failure or removal) ranged from 11 to 31 ($\bar{x}$ = 23.4)/brown bear, resulting in a mean rate of 1.2 calf kills/day (range = 0.3–1.8).

We collected blood and hair samples from bears at time of capture for isotopic analysis. The isotopic signatures of bears from blood were compared to the diet recorded in the camera footage. The discrimination values that gave the best fit for the camera footage were applied to the bears that did not have cameras to estimate diets for those bears. The same discrimination values were applied to the hair samples to determine seasonal variation in diets of bears and degree of dietary variability among bears.

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The project resulted in documenting the highest kill rates of ungulate calves of any previous study, identifying handling time of ungulate calf kills as a major factor in their detection. The use of isotope signatures correlates to the degree of carnivory documented in the camera footage.

Objective 3:

Develop an outline for a brown bear management strategy in Unit 13. The outline will provide the basis for addressing future intensive management objectives for moose set by the Board of Game.

Accomplishments:

Information from this project has been provided to management staff in Unit 13 who will continue to develop a brown bear management strategy relative to IM in consultation with PI's and biometric staff. This objective is in progress and will continue after this grant has expired. Work on this will continue as information on this topic becomes available and as the manuscript for Objective 1 completes the publication process.

The management implication is that brown bears can handle higher harvest rates than previously thought. The protection of females accompanied by cubs and cubs is a significant barrier to overharvest.

II. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

There were no cost overruns, amendments or additional work accomplished on this objective. There were delays in the completion of objectives due to staff turnover. The original principal investigators left their positions during this project and this project was reassigned to other biologists and biometricians.

III. PUBLICATIONS

Brockman, C. J. (2015). *Evaluation of brown bear predation on ungulate calves in southcentral Alaska using neck mounted cameras, GPS, and stable isotopes* (Master's Thesis, University of Alaska Anchorage).

Brockman, C. J., Collins, W. B., Welker, J. M., Spalinger, D. E., & Dale, B. W. (2017). Determining kill rates of ungulate calves by brown bears using neck-mounted cameras. *Wildlife Society Bulletin*, *41*(1), 88-97.

Brockman, C. J., Guttery R. M., Dale B. W., Schwanke R. A., Tobey R. W., and Koons D. N. (2019) Effect of heavy harvest on a brown bear population in Southcentral Alaska. *Journal of Wildlife Management*, (submitted).

IV. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Brown bears have a relatively low reproductive rate compared to other terrestrial mammals in North America. Due to this low reproductive rate they are susceptible to overharvest. Intentional overharvest occurred in the lower 48 states and in the Canadian prairies in the 1800's and early 1900's, resulting in the extirpation of brown bears in those areas. Only in Alaska and a few provinces of Canada has hunting for brown bears been maintained. The effect of hunting on brown bear populations is not well studied or understood. Early work in Alaska was conducted under fairly restrictive harvest regimes indicated that only light harvest could be tolerated. This project and work conducted by Bruce McLellan indicates that some brown bear populations can be maintained under much higher harvest than previously thought. In addition, this project documented the highest kill rates of ungulate calves by bears of any previous study – identifying handling time of ungulate calf kills as a major factor in their detection. The use of isotope signatures correlates to the degree of carnivory documented in the camera footage. This project is scheduled to be repeated beginning in the next few years to attain additional population trend data to evaluate the long-term impacts of liberalized regulations. This line of study is valuable as brown bear populations in the lower 48 states grow, we are more likely to see hunting for bears as possibility and as a management tool.

Pertinent Studies:

Keay, J. A., C. T. Robbins, and S. D. Farley. 2018. Characteristics of a naturally regulated grizzly bear population. Journal of Wildlife Management 82:789–801. http://doi.wiley.com/10.1002/jwmg.21425.

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McLellan, B. N., G. Mowat, T. Hamilton, and I. Hatter. 2016. Sustainability of the grizzly bear hunt in British Columbia, Canada. Journal of Wildlife Management 81:218–229. http://doi.wiley.com/10.1002/jwmg.21189.

Miller, S., Miller, S.M., 1988. Interpretation of bear harvest data. Alaska Department of Fish and Game, Division of Game.

Miller, S. D., J. W. Schoen, and C. C. Schwartz. 2017. Trends in brown bear reduction efforts in Alaska, 1980–2017. Ursus 28:135–149. http://www.bioone.org/doi/full/10.2192/URSU-D-17-00002.1.

Miller, S. D., R. A. Sellers, and J. A. Keay. 2003. Effects of hunting on brown bear cub survival and litter size in Alaska. Ursus 14:130–152. http://www.jstor.org/stable/3873014.

Miller, S. D., G. C. White, R. A. Sellers, H. V. Reynolds, J. W. Schoen, K. Titus, V. G. Barnes, R. B. Smith, R. R. Nelson, W. B. Ballard, and C. C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. Wildlife Monographs 133:5–55.

Testa, W., W. Taylor, and S. Miller. 1998. Impacts of heavy hunting pressure on the density and demographics of brown bear populations in southcentral Alaska. Federal Aid in Wildlife Restoration. Projects W-27-1-5, Study 4.26.

Prepared by: Chris Brockman

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