ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT NUMBER: AKW-B-R1-2020

PROJECT NUMBER: P4.42

PROJECT TITLE: Southeast Alaska brown bear data analysis and report preparation

PERIOD OF PERFORMANCE: July 1, 2019 - June 30, 2020

REPORT DUE DATE: September 1, 2020

PRINCIPAL INVESTIGATOR: Anthony P. Crupi

Authorities: 2 CFR 200.328
2 CFR 200.301
50 CFR 80.90

I. SUMMARY OF WORK COMPLETED ON PROJECT

Objective 1: Analyze and prepare for publication historic data on brown bear population and habitat ecology in Southeast Alaska.

Accomplishments: During this reporting period we completed our objectives, by gathering and synthesizing historic data (Job1a), conducting population demographic data analyses (Job1b), and preparing manuscripts suitable for publication (Job1c). We analyzed brown bear data from Admiralty and Chichagof islands in Southeast Alaska (SEAK) collected between 1981 and 2015. These analyses generated a wealth of new information on brown bear population ecology and habitat selection and these data have been successfully integrated into resource management and policy decisions. As the field of wildlife ecology has developed, so too have the tools available for analyses. Through this project we improved our understanding of coastal brown bear populations by applying current analytical methods to historic data useful to synthesize this body of research. Fees associated with publication were not incurred during the project period, hence there were some cost savings to the budget.

We compiled historic population data related to survival for bears studied on Admiralty and Chichagof islands. On Admiralty Island we monitored 126 brown bears (72F:54M) equipped with VHF radiocollars from August 1981–August 2015. We determined the fates of these animals and documented mortality for 46 study animals. The majority of brown bear mortality resulted from harvest (57%), while other bears died from various causes including natural mortality (13%), bear-killed (13%), capture-related (11%), defense of life and property (4%), and vehicle collision (2%). We monitored 218 brown bears (140F:78M) on Chichagof Island from June 1983–October 2003 and documented the mortality of 50 bears. Sport harvest of brown bears (n=26) studied on Chichagof Island followed patterns similar to Admiralty Island, however, bears killed in defense of life and property was substantially higher. Most bears were harvested by hunters (52%), ten bears were documented to have been killed in defense of life and property (20%), while unknown cause (14%), bear-killed (4%), capture-related (4%), natural (2%), illegal harvest (2%), and agency-killed (2%) categories comprised the remaining mortalities.

Several brown bear VHF and GPS location datasets were collected on Admiralty and Chichagof islands and we digitized the VHF telemetry data and integrated those locations with GPS spatial data in a geospatial database for modern analysis in ArcGIS and R. We collected 7,570 aerial telemetry locations and 104,287 GPS collar locations for use in the analysis of Admiralty and Chichagof islands bear populations.

To measure seasonal habitat selection by brown bears on Admiralty and Chichagof islands, we constructed resource selection function (RSF) models to statistically compare the environmental terrain factors and landscape variables with locations used by study animals. We modeled selection of male and female bears, both with and without offspring, in the early and late summer seasons. RSF models were built based on subsets of the location data dependent on study area (Chichagof or Admiralty Island), sex cohort (male, female with offspring, female without offspring), season (early or late summer), and collar type (GPS or VHF). The early and late summer periods were defined by the periods 1 June–15 July and 16 July–15 September, respectively. We modeled resource selection with terrain covariates derived from IfSAR elevation data and landcover class covariates derived from LANDSAT imagery spectral data. The terrain covariates were comprised of elevation (m), slope (°), solar radiation (KW/m^2), vector ruggedness, topographic position, terrain wetness, and in the late summer, distance to salmon stream (m). To allow for direct comparison of the magnitude of coefficients, continuous terrain variables were all scaled by subtracting their mean value and dividing by two times the standard deviation.

The spectral data from which landcover classes were obtained was LANDSAT imagery collected 15 May 2017 and 1 August 2013, with a small cloud-obscured portion of the August imagery patched with imagery collected 2 August 2014. Vegetation class development proceeded via a geospatial object-based image analysis process in which the LANDSAT data was first grouped (segmented) into relatively similar, adjacent pixels. These segments were then attributed with a suite of values obtained from IfSAR and LANDSAT datasets. These attributes were used as independent covariates in a random forest model in which the response was vegetation class obtained from photo-interpretation, and this random forest model was used to predict the vegetation class of all study area segments. All predicted vegetation classes were obtained this way except timber harvest clearcut, which were obtained directly from a United States Forest Service database. We produced an original set of nine vegetation classes and collapsed similar classes into 5 distinct categories to ensure an adequate number of animal locations occurred in each class to estimate model coefficients. The final vegetation classes used in models included alpine, brush, muskeg, clearcut, and coniferous forest. Coniferous forest was used as the reference class against which the selection coefficient for each of the other vegetation classes was compared.

Generalized linear mixed models (GLMM) were used to model resource selection of brown bears. Models based on GPS-collared bears included random intercepts for individuals to account for unbalanced design due to differing number of locations per study animal. Model selection was performed using an all-subsets framework, such that the landcover classes were always represented. This strategy resulted in 63 candidate models, consisting of 1–7 terrain covariates and 4 vegetation-class covariates for each of the data-subset models. Using k–fold cross validation, we found the RSF models all showed good cross validation results meaning they were highly predictive.

In the early summer, male brown bears on Admiralty Island selected low elevation in estuary habitat in terrain with a positive relationship with solar radiation. This cohort also showed preference for alpine and brush habitat, with mean elevation of 323.0 ± 264.3 m. Elevational profiles showed that male bears regularly transitioned between estuary and alpine habitats, as breeding activity commonly occurs in these habitats during early summer. Males bears GPS collared on Chichagof Island did not have sufficient data to model resource selection in the early summer. However, VHF collared Chichagof males showed similar selection patterns to Admiralty male bears.

In the late summer season male bears on Chichagof Island selected low elevation with low slope and low solar radiation, near salmon streams, in estuary and clearcut habitats. These bears showed moderate avoidance of muskegs and alpine habitat. The mean elevation selected was 33.5 ± 40.5 m. The top model for Admiralty Island male bears in late summer showed similar selection patterns, however clearcut habitat was not included due to the limited spatial extent of timber management within the study area. The mean elevation used by Admiralty Island males was 26.1 ± 45.7 m. Male bears on Admiralty Island also avoided muskeg habitat but favored alpine and brush habitat more than the Chichagof Island males at the end of late summer.

In the early summer, female bears on both Admiralty and Chichagof islands showed selection for elevations lower than were available, and preferred alpine and brush habitat with higher slope and rugged terrain. Some female bears shifted between high and low elevation terrain and when at low elevation these female bears selected estuary and clearcut habitats. The mean elevation of terrain selected during this season was 370.6 ± 274.8 m and 363.9 ± 202.9 m on Admiralty and Chichagof islands, respectively.

Female brown bears on Admiralty and Chichagof islands selected lower elevations in late summer than in early summer. The mean elevation of habitat selected by Admiralty Island female bears was 92.9 ± 155.9 m and 227.1 ± 193.4 m for Chichagof Island females, considerably higher than elevations selected by male bears, possibly an indication of avoidance. Similar to early summer selection patterns, female bears used alpine, brush and estuary habitats, and avoided muskegs. Chichagof females also selected clearcut habitats in late summer, likely for berry foraging in this early successional forest type. On Chichagof Island we were able to develop models for females with and without offspring. The top model for both cohorts showed similar magnitude and direction of coefficients. However, the most notable difference between models was that females without cubs included a negative relationship with solar radiation and distance to salmon streams as significant factors. Single female bears selected habitat near salmon streams though not to the degree of male bear selection, as males likely dominated salmon foraging opportunities.

We observed an interesting pattern in female bears during late summer on Admiralty and Chichagof islands showing routine movement between low and high elevation terrain. Several days spent on salmon streams were followed by travel to elevations between 400 and 800 m for a day or two, presumably to forage on berries or retreat from competition with other bears, before descending back down to riparian areas. Both female bears with and without offspring exhibited this pattern, though females without cubs used elevations lower than females with cubs. Both female cohorts used substantially higher elevations than males.

We generated late summer home ranges for GPS collared bears on Chichagof Island. Compared to mainland populations, home range of bears were significantly smaller on Chichagof Island. Mean home range size of male and female bears was comparable with areas of 5.4 ± 6.1 km^2 and 5.1 ± 3.0 km^2, respectively. The mean home range size for females with cubs was substantially larger at 10.2 ± 6.4 km^2. It is likely that the additional elevational movement by this cohort resulted in larger home ranges. We suspect this to be a mechanism used to partition habitat with male bears, with females avoiding risk of injury or death of themselves or their cubs by only visiting spawning areas at certain times of day when males may be less active. To investigate this potential, we constructed rose plots of the mean elevation of GPS locations for all cohorts on both islands within each hour of the 24-hour period. All cohorts used lower elevations during the late evening and early morning hours, though we did not observe an obvious pattern of temporal elevation partitioning.

II. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

We were unable to complete the publications prior to the close of the budget fiscal year.

III. PUBLICATIONS

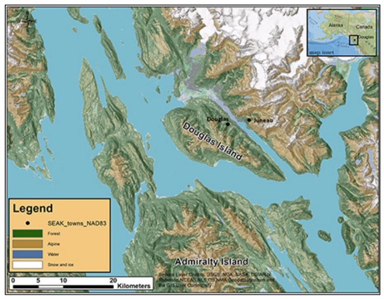
Crupi, A., K. Titus, R. Flynn, L. Beier and D. Gregovich. 2020. *In Prep*. Brown bear seasonal habitat selection of high-density insular populations on Admiralty and Chichagof Islands. Alaska Department of Fish and Game, Juneau, AK. *Ursus*.

Presentation "Unit 4 Brown Bear Population Abundance and Management" delivered at the State of Alaska Brown Bear Species Workshop in Fairbanks February 2020. Discussed the case study used to integrate brown bear population estimation techniques with harvest management and conservation measures used by brown bear research and management.

Mysterious Brown Bear Appearance and Southeast Bear Research
Alaska Fish and Wildlife News
http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=954

Mysterious Brown Bear Appearance and Southeast Bear Research

By Riley Woodford



When a brown bear appeared on Douglas Island in the spring of 2017, bear biologist Anthony Crupi was well prepared to investigate its origin. Douglas is home to black bears, but brown bears are almost unheard of. In 1974 a hunter took a brown bear on Fish Creek, the only other documentation of a brown bear on the island.

Douglas Island is adjacent to mainland Juneau in northern Southeast Alaska, barely separated at the narrowest region by a tidal wetland. Crupi lives on the island and works there in the town of Douglas at the Southeast regional office of the Alaska Department of Fish and Game.

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

During the past three decades the Alaska Department of Fish and Game has conducted extensive research on brown bears in Southeast Alaska. These studies have investigated habitat use and movement patterns, population demographics, effects of industrial mine development, implications of timber harvest and road construction on habitat and coastal salmon streams, as well as potential impacts of road access projects to SEAK communities. Data collected have been critical to the harvest management of brown bear populations and development of land management guidelines used to conserve bear and other fish and wildlife habitat. Our studies on Admiralty and Chichagof islands (Schoen and Beier 1990, Titus et al. 1999, Titus and Beier 1999, Flynn et al. 2007) and the mainland coast (Flynn et al. 2010, Flynn et al. 2012, Crupi et al. 2017) have generated a wealth of valuable information on brown bear population and habitat ecology in SEAK. The goal of this project was to analyze and prepare historic data on brown bear population ecology from previous research conducted in SEAK. The results from these studies have provided wildlife research and management biologists with appropriate information useful in developing management strategies for brown bears. We continue to learn about coastal brown bears in SEAK through our current research project titled "Brown bear population density and habitat selection on the northern mainland coast of Southeast Alaska" (P4.43). With the completion of this project, we recommend continuing support for the conservation of brown bears in SEAK.

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