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

GRANT NUMBER: AKW-B-R1-2021

PROJECT NUMBER: 2.01

PROJECT TITLE: Integrated Spatial Capture-Recapture Approach to Estimate Abundance of Sitka Black-tailed Deer.

PERIOD OF PERFORMANCE: July 1, 2019 – June 30, 2021

PERFORMANCE YEAR: July 1, 2020 – June 30, 2021

REPORT DUE DATE: Submit to FAC August 28, 2021

PRINCIPAL INVESTIGATOR: Daniel R. Eacker, Wildlife Biologist III

COOPERATORS: University of Idaho

Authorities: 2 CFR 200.328
2 CFR 200.301
50 CFR 80.90

I. PROGRESS ON PROJECT OBJECTIVES DURING PERFORMANCE YEAR

OBJECTIVE 1: Develop and simulate integrated spatial capture-recapture model to inform study design.

Activity 1A: Develop new approach using spatial capture-recapture methods to estimate age-class-specific and total population size for deer.
Activity 1B: Predict relative probability of use in study area from previous studies and conduct simulations using new approach to estimate the bias and precision with different sampling designs, deer densities, and snowfall levels.
Activity 1C: Draft manuscript of simulation/pilot study and submit to peer-reviewed journal.

ACCOMPLISHMENTS: This objective was completed during year 1 as it was needed to implement the study. These simulations guided the pilot study design that combines data from game camera photos and fecal DNA (fDNA) sampling to estimate deer density on Mitkof Island in Unit 3 with a 10–15% coefficient of variation (CV). However, we further improved our integrated spatial capture-recapture approach during this reporting year by coding the model to run with the R package 'nimble', which reduced computer run time from around 2–3 days to about 30–60 minutes and improved convergence. The package 'nimble' increases Markov chain Monte Carlo (MCMC) sampling efficiency by allowing the user to apply specific sampling algorithms to different parameters in the model.

Rather than producing a publication in a peer-reviewed journal of our simulations/pilot study results as previously planned, we focused on preparing estimates of trend in deer abundance/density during the first two reporting years (see Objective 6).

OBJECTIVE 2: Sample deer populations using game cameras and fDNA and record site covariates.

Activity 2A: Deploy game cameras on deer winter range.

Activity 2B: Collect deer pellets using path sampling technique and record habitat type, snow depth, pellet length, search effort, and presence of other species (i.e., moose, wolf, bear).

ACCOMPLISHMENTS: During June 2021, we serviced 64 game cameras and installed new batteries and memory cards. We found that one camera at high elevation had succumb to water damage, one camera experienced battery failure prematurely on 27 Nov 2020, and for reasons unknown, 8 camera cards at our Gun Range site had no data on them; it is unclear why the cameras did not record data as the cameras are currently functioning normally and recording data. The camera experiencing water damage was repaired at no cost and was reinstalled at the site. Otherwise, we collected camera data from 55/64 cameras that yielded a total of 164,015 photos, and we recorded temperature (at all sites) and snow depths (at some sites). We found that recording snow depths from camera photos is time consuming, but also that these measurements had high correlation with weather data from the Petersburg Airport weather station; thus, it seems unnecessary to record these data. However, we recorded presence/absence of snow as we processed game camera photos and noted the presence of other species.

We sampled deer pellets for fDNA as planned during winter of this reporting year. We completed 3–4 sampling occasions at the same 3 fDNA sites as the two previous years. We searched at least 52 km of transect for deer pellets using 2 personnel. We collected a total of 328 fDNA samples from 164 deer pellet groups following our well-established sampling protocol. We experienced poor sampling conditions and collected fewer samples due to the lack of significant snowfall until mid-January. We continued to use snow tracking of deer to locate fresh pellets. We tracked sampling effort more closely by saving GPS track logs and will use these tracklogs in the future to properly account for variation in sampling effort. Finally, we collected habitat type, snow depth, and we measured pellet width (as an initial test to separate fawns from adult deer) while surveying transects for deer pellets.

Additionally, we installed 24 game cameras at the 3 fDNA sites. This will allow us to collect age ratio data at fDNA sites, and we have one full site with 16 cameras (i.e., Ohmer Creek site) that will allow us to validate our camera approach against the fDNA sampling site. Also, we have GPS-collared deer at Ohmer Creek that will provide spatial mark-resight data as a further test of the utility of camera sites.

OBJECTIVE 3: Process game camera photos and fDNA.

Activity 3A: Retrieve game cameras and catalog daily minimum counts of deer on game camera photos by fawns, does, bucks, and unknown age-class int an Access database. Record snow depth and document presence of other species in game camera photos.

Activity 3B: Package and ship fDNA samples to lab for processing.

ACCOMPLISHMENTS: We used our stand-alone, web-based software developed in the shiny package in Program R to process game camera photos into species-specific counts. Two expert reviewers identified deer in photos to sex and age class (i.e., juvenile, adult female, adult male) whenever possible, and heavily scrutinized photos of deer to provide accurate counts following published methods. We focused only on the winter period (1 Dec–31 Jan) since this period was relevant to our DNA sampling, but we will process spring recruitment and fall buck/doe camera photos this fall as ancillary data.

After inventorying and quality-checking the fDNA samples, we packaged and shipped them to the Laboratory for Ecological, Evolutionary and Conservation Genetics at the University of Idaho, Moscow, Idaho for processing. The DNA extraction and PCR has already taken place for our 164 samples collected this last winter, which is important for having high genetic success from non-invasive fecal samples. We received our results for winter 2019–2020 and again experienced high rates of genotyping success (81%) despite having a larger number of technicians sampling in the field.

OBJECTIVE 4: Radio-collar and monitor deer to estimate survival, cause-specific mortality (when available), relative probability of use, and to inform movement parameters in the SCR model.

Activity 4A: Capture 30 adult female deer on winter range using ground darting or netgunning. Chemically immobilize (for ground darting) and instrument deer with GPS radio-collars set to a 6-hr fix rate. Collect other biological samples (ear tissue punch, blood, hair and feces) and body weight.

Activity 4B: Track radio-collared deer using ground-based telemetry to estimate survival and collect cause-specific mortality data when available.

ACCOMPLISHMENTS: We captured and collared 21 deer during the last reporting year. We were able to deploy 3 more collars in wintertime but experienced one capture-related mortality due to a water hazard; thus, we had a total of 20 GPS-collared adult female deer on-air collecting a location every 2 hours. One deer captured around Papke's Landing made an exploratory movement about 5–6 miles during the beginning of the hunting season (1 Oct) to a remote part of the island and then returned on 28 Jan 2021. Only one individual died on 11 Feb 2021, and the fate was determined to be a wolf kill with high certainty. We recovered the collar and have downloaded the GPS data (n = 1,941 locations) for this older adult female deer. The estimated annual survival is 0.92 (95% Bayesian credibility interval [BCI] = 0.77, 0.99). The collars are planned to drop off September 1, 2022, after collecting 2 full years of data on each individual deer. Additionally, we just completed a capture session this August 2021, and safely captured and collared 8 more adult female deer, bringing our total to 27 deer on-air. We will attempt to capture 5 adult male deer this fall after the deer hunting season ends on 7 Nov and deploy any remaining adult female collars (n = 7).

Currently, we have sparse GPS relocation data for deer on-air since we received only one location every other day from the satellite network. However, as soon as the collars are recovered in September 2022 (FY23), we will begin fitting deer habitat selection models with the full dataset. For now, the sparse location data might be useful to inform home range size (i.e., the 'sigma' parameter) in spatial capture-recapture models, which can be explored after we receive the genotypes for our samples collected during this reporting year.

OBJECTIVE 5: Develop winter resource selection function to predict relative probability of use in the study area.

Activity 5A: Recover radio-collars, process GPS data. And extract spatial covariates (e.g., spatial snow water equivalent and habitat type). Compare remotely sensed snow depth measurements to estimates taken at sites.

Activity 5B: Predict relative probability of use for study area.

ACCOMPLISHMENTS: This objective is now planned for FY2023 after GPS data have been recovered from collars in September 2022. We anticipate having GPS collar data from about 30–40 individuals or 50 deer-years of data.

OBJECTIVE 6: Data synthesis and preparation of reports and publications.

Activity 6A: Collate game camera, fDNA results, and spatial covariates into a final dataset for analysis.

Activity 6B: Estimate deer abundance in study area using integrated SCR modeling approach.

Activity 6C: Prepare final reports and publications.

Activity 6D: Archive data, metadata, and biological samples.

ACCOMPLISHMENTS: This objective is not planned until FY2023, but we will provide results after they are received from the genetics lab by September 30th of each year and then collated and modeled. Now that we have two full years of fDNA and game camera photo data collected and collated, it is a top priority to finish an ADF&G research report this fall 2021 to update managers and for potential use at the Board of Game meeting. We collated relevant covariates (e.g., sex, session, search effort) and have prepared all available data for analysis. Additionally, we extracted the deer habitat suitability index, elevation, and size-density classes, but have not explicitly modeled these effects yet. So far, we have used Bayesian spatial capture-recapture modeling to estimate the population trend and density for the first two years of fDNA data (i.e., FY19 and FY20). We also summarized realized deer densities for the first year of data by size-density classes and presented these at the Forest Service's Regional Meeting this last fall (see Publications). Our next steps are to complete the model validation for the fDNA portion of the model and conduct model selection and validation for the camera data.

Along with working on this research report, we collaborated with other biologists to produce a manuscript focused on deer habitat selection on Prince of Wales Island that was recently accepted for publication and currently in press in the Journal of Forest Ecology and Management (see Publications). We also plan on producing a manuscript that will compare the trend in deer density from our fDNA/camera spatial capture-recapture methods to estimates from our newly implemented deer camera monitoring method on Mitkof Island and anticipate finalizing this peer-reviewed manuscript in FY24 (see Recommendations for this Project).

II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.

We completed all field sampling and data collation objectives for the reporting period. We have not processed the game camera photos from winter 2020–2021 due to more pressing tasks (i.e., finalizing abundance estimates and preparing for deer capture and collaring), but this is typically done in the fall or winter. Similar to our first year, we achieved a final genotyping success rate of 81% (201/248) for our winter 2019–2020 samples. Based on fDNA data only, we estimated an average deer density of 11.1 deer/km^2 (95% BCI = 9.0, 13.8) in winter 2018–2019 and 13.4 deer/km^2 (95% BCI =11.0, 16.2) in winter 2019–2010. This represented a population growth rate (λ) of 1.19 (95% BCI = 0.92, 1.57) at our fDNA study sites (~30 km^2). The top encounter model included only the effects of search effort, which in the absence of perfect tracklogs, we calculated by quantifying the length of each transect in a GIS and then summing the distances from the sample collection points to the transect line separately for each transect. We estimated a 74% probability that the ratio of males-to-females declined from winter 2018–2019 to winter 2019–2020. Thus, it seems that we found marginal evidence that the population is increasing on average (at least at our fDNA sampling sites) and that the buck-to-doe ratio has slightly declined; this is likely due to the series of mild winters the past few years and the increase in the length of the deer hunting season on Mitkof Island that was implemented in the fall of 2019 (i.e., the season went from a 2-week to 5-week season), respectively.

Our camera data may also support this result of an increasing population trend, but we found that our age ratio data from game cameras are unreliable in winter, at least for this first two years of data. A significant positive bias occurs for the density of adult males in the model since photo reviewers were more likely to classify a deer as unknown if it was an adult female or fawn. Thus, when the estimated age ratios in the model were used to assign unknown individuals with an age class, this further exacerbated the bias. We have since recalled these age-specific estimates from game cameras. In hopes of reducing bias and uncertainty in the future, we have measured and marked the viewing distance for each camera and restricted it to around 7 m. We plan to only include age ratios from spring and fall when the age classes can be more easily recognizable on camera, but we can track changes in male-to-female ratio using fDNA and we hope to validate our pellet width measurements taken in the field to elucidate age-class information for deer in winter as well.

III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

Our costs for genetic sampling have been under budget due to high genotyping success rates that negated the need to run samples twice to achieve a consensus genotype. At the same time, we have continued to experience some uncertainty for a few individual genotypes due to a lack of genetic diversity in this isolated deer population, which makes it difficult to identify individuals using microsatellite markers. Thus, we had the lab at the University of Idaho begin working on the identification of single nucleotide polymorphisms (SNPs) for deer, which will make use of the available funding and solve a critical problem for deer genetic mark-recapture. Using SNPs will resolve the issue of uncertainty in individual deer identification and remove any potential subjectivity and errors that can result from humans scoring microsatellite markers. This should undoubtedly save money in the future as it is costly to continue to identify more microsatellite markers each year rather than have a cutting-edge solution that could potentially be used to develop a regional deer genetic mark-recapture program should it be practical and warranted in the future.

IV. PUBLICATIONS

Peer-reviewed journal:

C. S. Shanley, D. R. Eacker, C. P. Reynolds, B. M. B. Bennetsen, and S. L. Gilbert. Using LiDAR and Random Forest to improve deer habitat models in a managed forest landscape. Journal of Forest Ecology and Management *in press*.

Popular press article and live radio interview:

https://www.ktoo.org/2021/03/11/tracking-the-elusive-sitka-black-tailed-deer/

Popular press article

https://www.kfsk.org/2020/08/26/18-mitkof-island-does-fitted-with-gps-collars/

Online media presentation and question/answer session:

https://www.facebook.com/MendenhallGlacierVC/videos/sitka-black-tailed-deer-monitoring-a-cryptic-forest-ungulate/729409011012685/

Virtual presentation:

D. R. Eacker. 2020. Predicting deer density using habitat selection. USFS Regional Silviculture & Wildlife Virtual Workshop.

V. RECOMMENDATIONS FOR THIS PROJECT

We recommend extending this 3-year pilot study for 1 more year (i.e., including one more year of sampling in winter 2022–2023). We will produce a final report in FY23 as planned that will include GPS collar data with 2-hr fixes (2 years), fDNA sampling of marked individuals (4 winters), and game camera photos (4 years) of unmarked deer. However, we have a unique opportunity to compare estimates of population trend from our camera monitoring project that aims to provide a less expensive and broader estimate of deer population trend against the more reliable fDNA mark-recapture data. For this comparison, we plan on adding one additional fDNA site to increase statistical power for these last two years of sampling. Monitoring wildlife with game cameras is an important and emerging field in wildlife biology, yet few researchers have been able to provide strong field tests of these methods. We anticipate that along with our multi-year spatial capture-recapture dataset, that this comparison will be informative and an excellent dataset for a scientific publication.

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