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-SW-2020 Amendment #1

PROJECT NUMBER: 1.33

PROJECT TITLE: Tracking reproduction, movement, and diet in caribou and moose

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

REPORT DUE DATE: Submit to Coordinator September 21, 2021

PRINCIPAL INVESTIGATOR: M. Keogh, T. Bentzen

COOPERATORS: Matthew Wooller and Audrey Rowe, University of Alaska Fairbanks

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Authorities: 2 CFR 200.328
2 CFR 200.301
50 CFR 80.90

I. SUMMARY OF WORK COMPLETED ON PROJECT

Objective 1: Determine the strontium and oxygen signatures in caribou teeth

1a. Transfer caribou jaws with teeth collected in 2018 to UAF.

1b. Participate in hunter check stations with ADF&G staff to collect addition samples (e.g. jaws with teeth) from the forty-mile caribou herd.

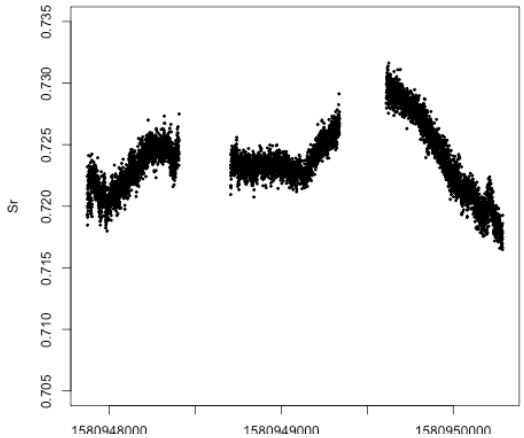
1c. Use established methods for Sr and O isotope analysis on up to 30 teeth from forty-mile herd caribou harvested in 2018.

1d. Analyze isotope data (Objective 1c) and apply spatial statistics to investigate caribou movement.

Accomplishments: 1a. completed. 1b. Hunter check stations were not run every year during the project due to COVID-19.

COVID-19 therefore prevented UAF graduate student Audrey Rowe from participating in the hunter check station during this project, although ADFG staff were involved in collecting additional samples from the hunter check stations. Future plans (beyond the project) are being made for her to participate for experience. 1 c. We analyzed isotope ratios of three molars in all forty-mile herd caribou mandibles from 2018 that included molars (many mandibles had only incisors present). Eighteen of the mandibles supplied had molars, for a total of 54 teeth analyzed (e.g. Figure 1)

Figure 1. Example strontium isotopes of three molars from a caribou in the 40-mile herd.



Five additional mandibles from collared caribou from the forty-mile herd that died in various other years were received and analyzed as well, totaling 15 additional teeth analyzed. 1d. We have begun applying spatial modeling methods based on UAF's recently peer reviewed protocols (Wooller et al. 2021) using our newly published isoscapes for Alaska (Funck et al. 2021; Bataille et al. 2020) (stemming from other funded projects) to determine likely movement patterns of the caribou across the landscape. The UAF team's spatial analyses showed the relatively poor coverage of spatial validation locations from the 40-mile herd (e.g. Funck et al. 2021). The UAF team therefore set about investing a significant amount of effort and time locating and accessing samples of rodent teeth from throughout the 40-mile herd region Rodent teeth represent local strontium isotope signatures and can be used to create and validate strontium isoscapes for a region (Funck et al. 2021). (Note: this was not included in the original proposed scope of work- but clearly needed to be conducted to allow future investigations). The UAF team has managed to acquire a total of ~100 specimens from four different museum collections that cover the 40-mile region (Figure 2). These are being prepared for analysis at UAF in the near future and will result in a new and revised strontium isoscape for the 40-mile herd region, which will form the basis for a new publication and open access data (as in Funck et al. 2021) set for future use. The UAF team will make this new map openly available to ADFG as soon as it is complete.

Additionally, the UAF team investigated whether cementum layers in some of the caribou teeth that had been analyzed already for their enamel also hold an isotopic record of caribou movement. A potential significant advantage of cementum is the lifetime record of movement as compared to enamel (approximately the first 2 years of life). Our preliminary analyses indicate that strontium is at a high enough concentration in the cementum to allow analyses using laser ablation.

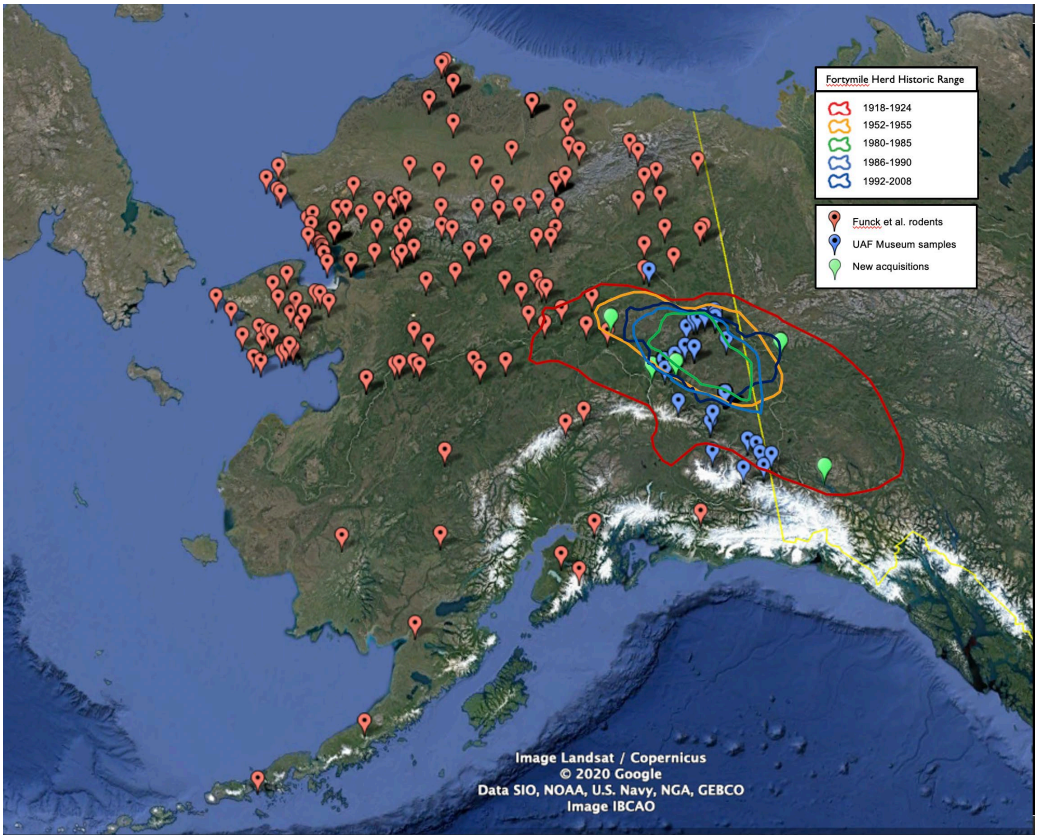


Figure 2. Map of rodent samples used for strontium isoscape formation.

References cited:

J. Funck*, C. Bataille, M. Cameron*, J. Rassic, **M.J. Wooller**, (2021). Building a bio-available strontium isotope 'rode'-map for Eastern Beringia. Journal of Quaternary Research.

Funck, J., Bataille, C., Rasic, J., and Wooller, M. (2021). A bio-available strontium isoscape for eastern Beringia: a tool for tracking landscape use of Pleistocene megafauna. *Journal of Quaternary Science* 36(1)**,** 76-90. doi: https://doi.org/10.1002/jqs.3262.

Bataille, C.P., Crowley, B.E., Wooller, M.J., Bowen, G.J., 2020. Advances in global bioavailable strontium isoscapes. Palaeogeogr. Palaeoclimatol. Palaeoecol. 555, 109849. https://doi.org/10.1016/j.palaeo.2020.109849

Wooller et al., 2021 Lifetime mobility of an Arctic woolly mammoth. Science. Vol 373, Issue 6556•pp. 806-808. DOI: 10.1126/science.abg1134

Objective 2: Determine nutrient and hormone concentrations in hair and hoof samples from male caribou from the forty-mile herd.

2a. Clean and process hair samples for C and N isotope analysis from the forty-mile herd of male caribou (2017=20; 2018=20).

2b. Submit hair samples (N=40) to the Alaska Stable Isotope Facility (ASIF), UAF for C and N stable isotope analysis.

2c. Sample 5 hooves (8 samples along each hoof) and submit samples to the ASIF for C and N stable isotope analysis to assess temporal pattern found in caribou hooves.

2d. Based on the results from Objective 2c, collect tissue from ~4 points along the length of each hoof (N=30) and submit samples to the ASIF for C and N stable isotope analysis.

2e. Based on the results from Objective 2c, collect tissue from ~4 points along the length of each male caribou hoof (N=30). Extract and quantify cortisol and testosterone hormones from hoof samples.

ACCOMPLISHMENTS: All samples have been cleaned and processed for C and N isotope analysis. We analyzed samples from 76 caribou (74 male, 2 female) harvested in 2017 from the forty-mile herd. Hair and hoof samples (four sections per hoof) were submitted to the Alaska stable isotope facility at the University of Alaska Fairbanks and $\delta^{13}C$ and $\delta^{15}N$ values have been received. All isotope data has been received. All hair and hoof samples were processed, and steroid hormones extracted, and cortisol and testosterone measured on all samples. Data analysis is ongoing and a manuscript is being drafted for submission.

Objective 3: Determine nutrient and hormone concentrations in hair and hoof samples from female caribou and moose.

3a. Collect 8 samples along 10 hooves (5 caribou, 5 moose) and submit samples to the ASIF for C and N stable isotope analysis.

3b. Extract and measure hormones from hair and hoof samples collected from breeding female moose housed at the Kenai Moose Research Center. 8 females have ~12 samples each representing periods of non-pregnancy and pregnancy within each female.

3c. Extract and measure hormones from hair and hoof samples.

3d. Based on the results from Objective 3a, extract and quantify cortisol and progesterone hormones from 4 points along each hoof.

3e: Compare progesterone patterns between females with known and unknown calving histories.

ACCOMPLISHMENTS: During the previous reporting period, we received hair and hoof samples from the Moose Research Center (MRC) in Kenai, AK, and hoof samples from Region V moose. We did not analyze any caribou samples for this objective but focused on the 2 larger moose datasets. To date, all samples from the MRC have been processed and we determined the concentrations of cortisol and progesterone. We identified the progesterone threshold for detecting pregnancy in moose hoof samples and using the growth rate (Dan Thompson, separate project) identified where along the hoof samples should be collected for assessing reproductive state. An initial manuscript was drafted; however, given some unexpected findings in the hair samples we will collect another set of hair samples in December 2022 and measure progesterone and cortisol concentrations to confirm (or reject) our previous findings. No additional funds from this project will be needed. The drafted manuscript will be revised and submitted for publication in the Spring 2022. We have also measured cortisol in Region V moose hoof samples and the completed data set has been provided to Warren Hanson along with the methods section for the laboratory analysis. Warren will take lead on incorporating the cortisol data into the larger study and writing the report and manuscript. Mandy is assisting with interpreting the data and drafting the manuscript. Hair samples which were not analyzed in this project were returned to Region V.

II. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

There have been no Significant Development Reports (SDR) or amendments submitted during this performance year.

III. PUBLICATIONS

There have been no publications from this project. Presentations of data generated from this project are below.

Audrey Rowe. Strontium isotope analyses of 40-mile caribou teeth to track movement. PhD Committee Meeting 2019

Audrey Rowe. Strontium isotope analyses of 40-mile caribou teeth to track movement. PhD Committee Meeting 2020

Audrey Rowe. Strontium isotope analyses of 40-mile caribou teeth to track movement. Water and Environmental Research Center Student Flash Talk 2021

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

Not applicable. The lead PI (M. Keogh) resigned from her position and has continued on as a volunteer until the papers are published.

Prepared by: M. Keogh, M. Wooller, T. Bentzen

Date: 9/21/2021