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: W-33 **SEGMENT NUMBER:** 12

PROJECT NUMBER: 1.63

PROJECT TITLE: Evaluation and testing of techniques for ungulate management and operation of the Kenai Moose Research Center

PROJECT DURATION: 1 July 2011 – 30 June 2016

REPORTING PERIOD: 1 July 2013 – 30 June 2014

REPORT DUE DATE: 1 September 2014

PRINCIPAL INVESTIGATORS: John Crouse, Dan Thompson

COOPERATORS: USFWS Kenai NWR; Dr. Perry Barboza, University of Alaska – Fairbanks; Drs. John and Rachel Cook (National Council of Air and Stream Improvement); Dr. Tom Stephenson (California Department of Fish and Game)

WORK LOCATION: Kenai Moose Research Center

I. PROGRESS ON PROJECT OBJECTIVES DURING LAST SEGMENT

OBJECTIVE 1: MRC maintenance and operations.
Job/Activity 1A-C: We maintained and cared for 16-19 adult moose and bottle-fed 5 female calves that survived through their first year. Average calf mass at weaning and 1-year was 160kg and 210kg, respectively. The 5 females have been trained and accustomed to handling by humans to facilitate future research.

We removed the aged and failing exterior log sealant from the lab and residence cabins and refinished with a two-part sealant that will protect the logs from further deterioration. In addition, we applied a flexible, textured acrylic chinking to seal the open gaps between logs to eliminate heat loss and air infiltration.

We replaced approximately 200ft of fence in the southeast corner of the Pen 3 enclosure with new materials. Rotted and falling wooden posts that have remained attached to the fence were removed from approximately 1.5 miles of the north and east perimeter fence of Pen 3.

We replaced approximately 300ft of the northwest perimeter Pen 2 enclosure fence with new materials.

OBJECTIVE 2-5: Moose nutrition, physiology, and reproductive research.

Job/Activity 2A-2C: We measured weight, rump fat and loin muscle thickness and collected blood, urine and feces from both pregnant and non-pregnant adult female moose in August, December, April and June to further assess how well the proportion of urea nitrogen from body nitrogen (pUrea-N) indicates winter body protein loss in moose.

During late-summer and late-winter immobilizations, we collected rumen content samples from 3 adult females and shipped them to Dr. Wright and PhD candidate Susan Ishaq who are investigating the molecular diversity and evolution of the gut microbiome of herbivorous animals. These samples will be analyzed to correlate changes in the microbial population with changes in diet/season.

Job/Activity 3A-3D: We have been able to obtain 10 GPS telemetry collars with activity sensors at little or no cost (from other researchers' field studies that had retrieved collars from dead animals and, in some cases, from manufacturers with a beta version ready for testing by customers). GPS collars were fitted on moose at the MRC and we have observed animals to record activity during summer and winter periods (~250 hours). The preliminary data from these collars will be downloaded in fall 2012 and compared to direct observation measures. The results will be used to design experiments using 2-3 sampling modes and 2-3 sampling intervals to determine which are most appropriate to describe moose activity patterns.

We observed and recorded the activity of 2 male moose concurrent with collar activity sensor data acquisition during 6h periods twice monthly during July – September 2012 (72h total).

Job/Activity 4A-B: Feces and plant material to be used for the analyses of dietary fiber, energy, protein and tannin content were prepared for laboratory analyses.

OBJECTIVE 6: Vegetation management.
Job/Activity 6A-C: We acquired a 1996 digital orthorectified photograph and began building a GIS database of the MRC enclosures. We purchased 2 handheld Garmin GPSMAP 76S to aid fieldwork. Subsequently, we purchased a May 11, 2011 Digital Globe, World View 2 color satellite image (63 sqkm, digital orthophoto, 50cm resolution) and began classifying the existing vegetative cover within each of the MRC enclosures. We used current vegetation age structure and composition in conjunction with information from historic enhancement efforts to identify areas suitable for treatment to increase forage availability to moose. We developed a vegetation management plan for the MRC and during December 2012 through March 2013 mechanically treated a total of 240 acres using a hydro-axe (9 acres), bulldozer (215 acres) and feller-buncher (16 acres).

OBJECTIVE 7: Drug testing.
JOB/ACTIVITY 7A: Thiafentanil (A-3080) was purchased but we have been unable to evaluate its efficacy in Alaskan moose.

OBJECTIVE 8: Preparation of study plans, reports and publications.
Job/Activity 8A-C: The final performance report on project 1.63 was submitted.

KEVIN WHITE, NEIL BARTEN, STACY CROUSE, AND JOHN CROUSE. Benefits of migration in relation to nutritional condition and predation-risk in a partially migratory moose population. Ecology, 95(1)2014, pp.225-237.

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

JOB/ACTIVITY 1A-C: We maintained 16 moose during the last reporting period including 3 adult males, 8 adult females and 5 yearling females. The 8 adult females were moved into the enclosure holding the males during the rut (mid-September through mid-October) for breeding. All 8 females were pregnant determined by blood PSPB levels collected in December. The 3 adult males were fed 13% Reindeer Ration (50lb/animal/week) 1 November – 15 April to supplement their intake of native vegetation. Sixteen calves (all twins) were born between 07 May – 04, June 2014. Parturition was detected by change in pulse rate of intravaginal VHF transmitters (ATS, Insanti, MN USA). Calves were handled within 24h of birth to determine mass, collect blood and morphological measures and swab nasals for viral and bacterial pathogens. All calves were fitted with a VHF radio collar (Telonics, Mesa, Arizona, USA).

We replaced 0.125mi of the north Pen 2 perimeter fence with new materials. We replaced 3 entrance gates (Pen 1 – NW, Pen 1 – SE, Pen 4 – NW) with double-drive swing gates (16ft wide). We removed all of the old fence line moose traps in Pens 1, 2 and 3.

We applied a 2-part log sealant to both of the residence cabins and water-sealed the porch decking materials.

JOB/ACTIVITY 2A-2C: We measured weight, rump fat and loin muscle thickness and collected blood, urine and feces from all 13 female moose in September, December and April to monitor resource allocation to fat and lean mass. During April immobilizations, we collected rumen content samples from 3 adult females and shipped them to Dr. Wright and PhD candidate Susan Ishaq who are investigating the molecular diversity and evolution of the gut microbiome of herbivorous animals.

JOB/ACTIVITY 4C-F: Measurements of fecal output and forage digestibility can be used to evaluate food intake and digestive physiology in moose. Chromium (Cr) is an external digestibility marker commonly used in ruminant studies. However, Cr has been studied little in browsers. An external marker can be administered frequently (once or twice daily), continuously (by infusion or continuous release ruminal bolus technology) or in a single pulse-dose. Fecal sampling provides an estimate of fecal output where;

$$\text{Fecal dry matter output, } {}^{g}/_{d} = \frac{\text{marker dose, } g/d}{\text{marker concentration in feces, } {}^{g}/_{g} \text{ dry matter}}$$

Numerous studies have demonstrated marker dosing methods and fecal sampling frequency must be evaluated in order to accurately estimate fecal output. With our large animal enclosures, we anticipated not being able to administer an external marker to moose daily. Therefore, we conducted a study with 5 yearling females 24 February through 26 March 2014 to evaluate the palatability of a marker feed ration (0.0015g Cr/g feed) and to obtain measures of marker concentration in feces of animals fed a known amount of the marker ration once daily, 3 days per week. Dosing of Cr was provided in 500g of a pelletized feed consumed by animals on Monday,

Wednesday and Friday. Otherwise, animals foraged naturally on winter twig diets. Fecal samples were collected prior to feeding the marker ration, then on day 11, days 15-20, days 22-26 and days 29 and 31 of the study. Animals were weighed weekly on a walk on scale. Samples were sent to Dr. Perry Barboza (Department of Biology and Wildlife, Institute of Arctic Biology, University of Alaska Fairbanks) and are being analyzed for Cr concentration. We will use these data to model the marker output dynamics.

Daily marker dosing of Cr was provided in 500g of a pelletized feed (0.0015g Cr/g feed) to 8 lactating females from 02 June – 20 August, 2014. Fecal samples were collected twice weekly on Tuesday and Thursday. Samples (n = 192) were sent to Dr. Perry Barboza (Department of Biology and Wildlife, Institute of Arctic Biology, University of Alaska Fairbanks) and are being analyzed for Cr concentration. Plants and plant parts were collected monthly from 3 areas in each of the 2 enclosures (Pen 2 and Pen3) where moose had been observed browsing to determine dry matter and nutrient content (2 pens x 3 Sites x 5 Species x 30 Plants x 3 sampling periods = 2700 plants total). Analyses to be performed include %CP, %GE, sequential fibers, tannin analysis and total phenolics. Provided the marker technique works, combining estimates of fecal output with diet digestibility will allow us to determine how much food was consumed by lactating females during summer. These measures are necessary to improve our projected demands of reproductive females.
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JOB/ACTIVITY 6A-C: We used the Kenai National Wildlife Refuge hydro-axe to mechanically treat (cut) 20 acres of 25-year-old mixed aspen and birch forest in Pen 3 to create early seral deciduous forest.

We constructed 4 moose and hare exclosures (58m^2 each) within areas mechanically treated during the previous winter to monitor plant response in the absence of browsing.

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

Research to better understand moose reproduction and survival on the Kenai Peninsula continued. MRC staff were included in the capture and collaring operations 10 days each during November 2013 and March 2014 to provide assessments of moose body condition and deploy vaginal implant VHF transmitters to detect moose birthing events.

V. PUBLICATIONS: MRC staff attended the 48th North American Moose Conference and Workshop in Girdwood, Alaska during April 2014 and authored/co-authored the following oral (*) and poster (^) prestentations:

USE AND EVALUATION OF VAGINAL IMPLANT TRANSMITTERS IN MOOSE^

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2. Alaska Dept. of Fish & Game, 1800 Glenn Hwy., Suite 4, Palmer AK 99645
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4. Alaska Dept. of Fish & Game, 3298 Douglas Place, Homer, AK 99603

Abstract: Birth rates and calf survival typically drive population dynamics in moose. Because early mortality is often high, detecting parturition and monitoring calves soon after birth is critical for accurately determining productivity and early survival. However, aerial determination of parturition, twinning, and early calf survival are often difficult in forested habitats. While vaginal implant transmitters (VITs) have been commonly used in many domestic and wild ungulates, an evaluation of VITs in moose has not been extensively reported. From 2006 to 2013, we put >300 VITs in moose from different locations across Alaska during mid-gestation (typically February–March). Retention rates were high and there was no evidence of significant tissue damage or negative effects with future pregnancies. VITs greatly improved productivity surveys by reducing aerial search times and facilitated captures of neonates.

DECIPHERING GPS COLLAR DATA FROM CAPTIVE MOOSE^

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Abstract: Advancements in GPS collars have significantly increased our ability to collect a wide range of data (i.e., temperature, activity) associated with a GPS location. Deciphering this data can be troublesome as collar manufactures continually improve their collars and associated sensors. Furthermore, discrepancies in collar temperature and local weather stations indicate that animals or their associated habitat is influencing the collar temperature sensor. We used 1 captive moose, over 2 years, to test differences in Telonics GEN 3 and Telonics GEN 4 GPS collars. Collar temperature was on average warmer than the local weather station for both collar models during summer and winter, implying that the moose's radiant heat was increasing the temperature reading on the collar. Comparing between seasons, collar temperature was warmer in summer than winter when compared to the weather station. Differences between collar and weather station temperatures were greatest from midnight to 06:00, indicating that during the

coldest part of the day there was the greatest variation between collar temperature and the weather station. We also assigned habitat values to each GPS location, and we found differences in habitat selection based on season, solar radiation, and ambient temperature measured at the weather station. Summer habitat use was influenced mainly by solar radiation and thermal break points in temperature (14°C and 20°C); whereas winter habitat selection was influenced only by thermal break points in temperature (−5°C). Future studies using GPS collars and associated sensors need to validate how the animal and its associated habitat may influence data collected.

EVALUATING PROTEIN BALANCE IN WINTERING MOOSE*

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Abstract: Moose contend with declining supplies of energy and protein as the concentrations of plant toxins and fiber increase in browse. Body stores are used to meet demands for energy and protein when dietary supplies are insufficient for normal activities and reproduction. Measures of rump fat thickness are used to assess seasonal dynamics in body energy reserves but a similar indicator of body protein use has not been demonstrated. We used the stable isotope of nitrogen (∂15N) to distinguish between protein in the diet and the body of female moose (n = 6) over 3 winters. Body mass and rump fat thickness declined following rut in October through parturition in late May. Serum concentrations of urea were low in winter but increased in spring when green leaves emerged, which indicated that N oxidation was minimized when dietary protein was low. Body protein was used through winter when 76 ± 5 % of N in urea was derived from body protein whereas only 8 ± 12 % of urea-N was derived from the body in spring. Plant toxins may exacerbate N losses in moose during winter because more urinary N was lost as ammonia than as urea, especially as the concentration of phenols increased in urine. Moose recycled body proteins during winter because ∂15N values of serum proteins were 1.14 ± 0.62 ppt greater than those of red blood cells. Metabolites of N in urine and blood can be combined with rump fat thickness and calf mass to evaluate the effect of habitat on production of moose.

LINKING RESOURCE SELECTION TO OVERWINTER BODY CONDITION IN A COASTAL ALASKA MOOSE POPULATION*

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Abstract: Understanding the relationship between habitat selection and animal performance is of fundamental importance to wildlife ecology. Unfortunately, resource selection patterns are not necessarily linked to measures of individual or population performance and further understanding of such relationships are needed. In this study, we examined the linkage between resource selection and nutritional condition in adult, female moose during winter in Gustavus, Alaska. Specifically, we examined how individual variation in resource selection is correlated with loss of overwinter reserves of body fat. Initially, we developed a forage-based resource selection function (RSF) model (i.e., a model that yields values proportional to the probability of

use of a given resource unit) using GPS-radiotelemetry data (n = 25) and remote sensing data to describe resource selection patterns at the population-level. We then examined how individual variation in resource selection, relative to the population, influenced individual overwinter change in body fat (a correlate of reproductive success). Overall, RSF modeling results indicated that moose selected for areas with low snow depth and high forage biomass of willow (*Salix* spp.) and horsetail (*Equisetum variegatum*), critical winter forages. Further, we determined that loss of overwinter fat reserves tended to be lower for individual moose that exhibited stronger selection for areas with high forage biomass and low snow depth. These findings provide an empirical basis for understanding the nutritional implications of moose resource selection patterns in coastal Alaska.

A TALE OF TWO POPULATIONS: CHALLENGES OF MOOSE MANAGEMENT ON THE KENAI PENINSULA, ALASKA*

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Abstract: Moose on Alaska's Kenai Peninsula are an important public resource. In 2011 the state authority which sets wildlife regulations, the Alaska Board of Game, directed wildlife managers to initiate predator control programs to increase moose populations in 2 specific areas important for harvest. While close in proximity, these 2 moose populations in the northwest and southwest portions of the peninsula have differing management concerns. Before predator control was initiated in 2012, state managers initiated studies to assess limiting factors. Efforts to reduce wolf numbers were initiated in 2013 for the moose population in the northwest. A driving factor influencing the initiation of predator control programs is if the moose population falls below set size and harvest objectives. There is a need to periodically reassess how these objectives were set and if they are achievable with practical management actions. I will discuss these objectives in the context of objectives from around the state. I will also discuss the history and limiting factors of these 2 moose populations and the potential efficacy of predator control. Successful long-term and cost-effective management requires a nexus between the public, wildlife managers, regulatory authorities, and land managers. Decisions need to be driven by the biological potential of the given moose population and the feasibility of different management actions.

Prepared by: John Crouse

Date: October 2014