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-23 FY18

PROJECT NUMBER: 6.19

PROJECT TITLE: Dall's Sheep Literature Review and Research Design.

PERIOD OF PERFORMANCE: July 1, 2017 – June 30, 2018

REPORT DUE DATE: 1 September 2018

PRINCIPAL INVESTIGATOR: Brad Wendling, ADF&G

COOPERATORS: None.

I. PROGRESS ON PROJECT OBJECTIVES DURING PERIOD OF PERFORMANCE

Objective 1: Literature review and data analysis.

JOB/ACTIVITY 1A: Conduct a review of available literature and data on the biology, ecology and management of Dall's sheep and related species.

ACCOMPLISHMENTS: Literature review is an essential and ongoing duty of a research biologist. After interviewing DWC Region 3 management biologists (objective 2), the primary focus of the literature review in FY18-19 was on harvest and population management of Dall's sheep. Specifically, the potential impacts of full curl harvest strategy: both short term (e.g. energetic, overwinter survival) and long term (e.g. genetic consequences).

Job/activity 1b: Compile and analyze Dall's sheep population survey and harvest data collected in the Interior and Arctic Alaska.

ACCOMPLISHMENTS: . Minimum count surveys, and harvest statistics has continued to be collected through FY19. Historical survey and harvest data were shared with the NASA ABoVE research project and 2 research papers with Wendling as a co-author are in preparation. Paper 1 is titled "Environmental divers of Dall's sheep (*Ovis dalli dalli*) survival revealed through multiple remotely sensed variables" by Van De Kerk et al. Paper 2 is titled "Association between weather and Dall's sheep (*Ovis dalli dalli*) harvest success in Alaska" by Leorna et al.

Objective 2: Interview Division of Wildlife Conservation game managers in DWC Region 3 to understand their concerns of the effects of harvest and the ecological drivers of Dall's sheep populations.

ACCOMPLISHMENTS: In 2016 we interviewed 10 area management and assistant management biologists in region III to help facilitate a discussion and debate on sheep management and research needs. We first asked managers to rank order a list of possible research topics (Appendix 1). The second part of the survey were a set of questions we asked to help elucidate sheep management data needs and priorities on a statewide scale (Appendix 1)

Objective 3: Report findings from Objectives 1 and 2 and develop a proposal and detailed budget for a new research project on Dall's sheep.

ACCOMPLISHMENTS: I prepared a Federal Aid Project Statement for a new project on Brooks Range Sheep and submitted DWC HQ in May of 2018 when special funding for FY19 was announced. A research operational plan will be written in FY19.

Objective 4: Solicit funding to implement research project.

ACCOMPLISHMENTS: I plan to conduct field research on Dall's sheep as a federal aid funded project. I have submitted a proposal for funding to DWC HQ during the report (DWC HQ denied funding for FY19 but will reconsider for FY20). A formal research operational plan will be developed during FY19 as part of this project.

II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.

All accomplishments completed to date are outlined in the specific objectives above or in previous years' annual reports. Furthermore, after interviewing game managers, and conducting a literature review, a federal assistance project statement was written and submitted to DWC HQ (Appendix 2)

III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

A Federal Aid Project Statement titled "Brooks Range Dall's Sheep Ram Ecology and Health Assessment" was written and submitted to DWC HQ (Appendix 2.)

IV. PUBLICATIONS

None

V. RECOMMENDATIONS FOR THIS PROJECT

This project will end on June 30, 2019.

Prepared by: Brad Wendling and Scott Brainerd

Date: 8/27/2018

Appendix 1.
Fall 2016

Section 1.

Potential research topics and direction.

Please prioritize these topics in terms of what data from this list would benefit and/or inform your management efforts

1. Population drivers. **Overall Topic Score: 3,3,3,3,3,3, 1,2,3,2**

    a. Climate change, weather patterns, and habitat quality: Effects of climate change and weather patterns on distribution and range, winter range carrying capacity, shrub encroachment into the alpine, abundance, nutrition and fitness. **1,1,2,3**

    b. Disease/parasites: What are the endemic pathogens, and what concerns are there for transfer of novel diseases and parasites from livestock? **3,3,1,1**

    c. Predation: What influence does predation have on population dynamics of sheep populations? **2,2,2**

2. Harvest and population management. **Overall Topic Score: 1,1,1,2,1,1,2,3,2,1**

    a. Impacts of full curl strategy: Short term (e.g. energetic, overwinter survival) and long term (e.g. genetic) ramifications for harvest, population dynamics and fitness; Reproductive and genetic contribution of sub-FC rams to population dynamics and investigation into the "social hierarchy" and "dominance related mortality" theories. **1 ,1,1,1,1,1,1**

    b. Do you calculate harvestable surplus? If so, how? How many FC rams, or what proportion of FC rams, make it through hunting season and survive to the next hunting season **3,3,4,3**

    c. Alternative harvest strategies: Are there ways to increase harvestable surplus or the number of rams harvested? **3,2,2 ,2**

d. Do we need to translocate sheep? Possible target areas include the Ray, Beaver and / or Tikchik mountains.**2,3 ,5**

e. Do we need a better range and distribution map (at greater resolution than presently available)? **10! 5, 5 ,4**

3. Monitoring Abundance. **Overall Topic Score: 2,2,2,1,2,2,3,1,3**

   a. Survey methodology: Better resolution on surveys and/or attempt to better estimate overall abundance. Potential methods include:
      i) NPS distance sampling method (Line transect aerial survey). **3,3,1,4**
      ii) Estimating population abundance using Sightability Models. Estimation proceeds in two stages: 1) sightability trials conducted with marked animals (e.g. radio collared or paint), 2) fitted model used to adjust counts on future surveys. **1,1,1,3**
      iii) Adaptive Cluster methodology where 1) a random sample of plots are selected and sampled, and 2) if targeted element is found, all the surrounding plots are inventoried. **2**
      iv) Genetic mark-recapture methods where the mark would be the individual animals DNA collected via fecal pellets or biopsy darts. Potential recapture events include collecting samples from hunter harvested individuals. **2,1**

4. Other topics
   a. Anything not listed here - please feel free to add if necessary.
   - **"**Continue with horn data collection and explore age structure analyses using that data. See if Bruce can share his expertise in that area"
   - "Use Trend areas and look at how we can extrapolate to other areas within the GMU's"
   - "Get better response in subsistence and community harvest reporting"
   - What Factors are influencing horn growth"
   - Narrow down the areas where the proposals are and is there areas of data gaps that we can identify to address those issues.
   - Identification of critical movement corridors

Section 2.

Please prepare for a large scale discussion on sheep research and management issues by reviewing the following questions.

1) Can you give us a brief description of your area of responsibility, your experience with sheep in that area, and the types of sheep management decisions you are responsible for?
    - GMU 24A & B. Central Brooks Range management report. Decisions are limited because of park lands. Responsible for BOG, state and federal proposals.
    - GMU 20A & 25C. Have conducted minimum count surveys since 2000 and analyzed the data since 2009. Responds to BOG proposals. All hunts are under general season FC strategy.
    - GMU 25A, 26B, 26C, 24A. All hunts FC general season except RS595 which has poor reporting. We conduct trend counts and also monitor federal ground based surveys. Respond to BOG , AC's and RAC's.
    - GMU 23, 26A Baird Delong and Scwatka Mountains. Have done minimum counts for 20 years but switched to distance sampling with the park. Mange general season and draw hunts and am responsible for emergency closures.
    - DCUA, Mount Harper, Tanana uplands. Darren AB since 2011. Bob AB since May 2016. Responsible for S&I efforts. Provide technical guidance and mitigation on military training or land use actions. Allocate permits for the DCUA and mount Harper Draw hunts.
    - TMA, Glacier Mountain, Mentasta and Nutzotin mountains. Gross has been there from 2003 and Wells since 2012. Responsible for periodic surveys, sheep sealing and management reports and S&I efforts. Set number of TMA permits.
    - GMU 19C and 19B. Been conducting surveys in 19C since 2007. 19C under FC so that means hands off. Winter hunt tightly managed with strict quoata and access times for rams under ¾ curl.

2) Why are you monitoring sheep?
    - We do indirectly with Beth's survey. Public wants to see us doing something. It identifies relative changes in productivity.
    - Make sure there is enough sheep for a general season hunt. Helps predict expected yearly harvest.
    - Shows the public we are doing something.
    - Important cultural resource as well as general sport. Keep track to do the best we can in managing the population.
    - Inventorying efforts aid is setting the number of TMA permits. Also aid in informing the public and BOG.

- Allocation of permits for DCUA and Mount Harper. Track status of population health and distribution. Chase down periodic reports of domestic livestock in AK range. Use it to educate the public.
- Comp and harvest data is all we have. We need to make sure FC is working!

3) Do the results from your monitoring efforts influence your management decisions or harvest strategy? If so, in what way?
   - No, FC strategy is auto pilot and safe. We use the information for addressing regulatory proposals. Populations generally stable but ebbs and flows regardless hunting. Hunting is not a driver.
   - No on harvest strategy, yes on potential management decisions. For example closing the season following a crash.
   - No. May influence us into doing nothing but status quo is still a decision. Therefore we use that data to not make a change.
   - In the 1990's there was high mortality and we closed the season. This happened again in 2014.
   - Does not influence our general season hunts but does influence the number of TMA permits allocated.
   - Yes, less sheep means fewer permits. Anomalies health wise need to be addressed.
   - Year to Year it does not. Looking at comp data has me thinking about alternative harvest strategies.

4) If the answer to question #3 is no, would "better" or higher resolution data influence your management decisions or harvest strategy?
   - Not advocating for a big survey but keep the trend counts.
   - Possibly. At high density could have any ram hunts but with FC strategy it is easy.
   - Dependent on the results of FC harvest strategy. IF FC good then no. If FC bad then yes.
   - Yes
   - Need more info if the public wished to pursue alternate harvest strategies.
   - Possibly, most decision based on harvest trend. Right now we are conservative.
   - Yes, but the reality of the politics may prohibit changes to hunt strategy.

5) Are there non-quantifiable benefits to surveys? If so, please name some.
   - Shows the public we are doing something.
   - It is information for the public and hunters.

- Relatively inexpensive survey that shows the public we are doing something. We survey state land that is highly exploited. If it is good there we extrapolate to other areas of the Brooks Range.
- Get other data such as muskox and predator locations.
- Information the public likes. Gives you knowledge of the country you manage.
- Observation of anomalies in distribution and movement.
- Intimate knowledge of my area that I cand share with hunters.

6) Describe your <u>most</u> and least intensive monitoring program(s). Include tools you use and the size of the area.
   - Trend count area is most intensive. Least intensive is monitoring harvest data but is most important. ***Request Bruce give us a primer on Age Structure analysis work on the Mulchatna heard.
   - White Mountain census with BLM and USFW is most intensive. 20A survey is a small trend area and is least intensive.
   - Trend count area.
   - Minimum count least intensive. Distance sampling most intense with multiple airplanes and biometricians.
   - Most TMA 900-100 square miles. Least hard park and Tanana Hills.
   - DCUA every year. Yukon highlands every other year but driven by money and weather.
   - Winter hunt is most intensive.

   - How do you make decisions when you don't have adequate data?
   - ***Request Bruce give us a primer on Age Structure analysis work on the Mulchatna heard.
   - No decision under FC harvest strategy.
   - Our management is not data driven. We use anecdotal information on years we do not complete the survey.
   - Lots of good resources. Old good pilots that give anecdotal evidence.
   - Been lucky in getting TMA surveys accomplished. Not necessary under FC strategy.
   - Go more conservative and discuss with AC and public. Get them to buy in and make the decision for us.
   - Not comfortable with it but FC strategy is what we hang our hat on.

7) What uncontrollable, natural factors affect you accomplishing your goals for monitoring sheep?
   - Do not really have a monitoring goal. Weather effects sightability.
   - Weather
   - None

- Weather. Big area with few sheep. Difficult topography for unseasoned pilots.
- Weather, snow.
- Weather
- Weather wind smoke

8) What are the human factors outside your control that affect you accomplishing your goals for monitoring sheep in your area?
    - Money!! There is not a monitoring goal.
    - Funding
    - Choice if we rank caribou work over sheep. NPS and USFW closing areas for no apparent reason. ANWR not allowing us to work. Pilot availability.
    - Short staffing and staff turnover both at the state and federal level. Conflicting surveys with other species.
    - Youth season cuts into survey time. Other priorities may keep us from doing sheep work. Money.
    - Funding, military training, other workload responsibilities, staff issue.
    - Resources. Personnel and financial.

9) What data do you need to make management decisions that you don't currently collect? What new monitoring approaches have you tried or considered?

    - The issue of Selective harvest is glaring and it is a big anti-hunting driver!!! We need to establish a genetic archive for all harvested and captured sheep. Verify ageing of rings with cross sections of teeth.
    - Possibly an actual population estimate with reasonable CI. Then we could have alternative harvest strategies.
    - We need to understand potential impacts FC harvest strategy. We need to flesh out what FC strategy means. Are we proud if FC rams are left on the mountain after hunting season? Is that maximizing take?
    - Need better composition dat. Maybe dual surveys with the minimum count and distance methods. Need better reporting on some of the federal hunts.
    - Look at FC regulation and how it effects populations. Maybe better reproductive and survival data to explore other hunt strategies. What are the factors influencing horn growth. Maybe some ground based surveys during aerial surveys. Better age and sex classification during surveys.
    - Need specifics on mortality related to age classes specific to DCUA. Identify movement in and out of DCUA that may be missed. Possibly a sightability correction factor using decoys and dummies rather that radio collars.
    - We need a better understanding of the FC strategy. A better understanding of population drivers and habitat quality and carrying capacity.

10) Are you familiar with the distance sampling work conducted by the NPS? Based on that knowledge, could it be applied to enumerate populations in areas that you manage?

Do not like it.
We are using it.
Maybe for a large scale.
Locals do not like it.
Have not tried it but potentially useful.

11) Are you familiar with the mountain goat sightability correction work conducted by Kevin White and Grey Pendleton in SE? Based on that knowledge, could it be applied to enumerate populations in areas that you manage?

- Possibly look into it.
- Not a big proponent of it. Cannot quantify why we do or do not see animals from the air.
- No comment.
- Question what sightability would do for us.
- No comment
- Willing to try the technique. Sightability is essential. Without it is survey is just and index.

Appendix 2.

Federal Assistance
Project Statement

Funding Source: Wildlife Restoration

Grant Number: AKW-X _____ FY ___
Project Number:
Project Title: Brooks Range Dall's Sheep Ram Ecology and Health Assessment
Project Start and Ending Dates: -

Project Statement Guidelines

1. Need

Three critical issues identified by managers of Dall's sheep in Alaska are: 1) the potential effects of selective harvest over time, 2) the potential effects of climate change on sheep habitat, and 3) the potential effects of *Mycroplasma ovipneumoniae* (*M.ovi*) introduced to naïve mountain sheep populations. Recent research suggests selective harvest of large horned rams may favor the reproductive contribution of rams with slower growing horns (Douhard et al. 2015, Festa-Bianchet et al. 2014, Garel 2007, Coltman et al. 2003). Other research indicates changes in horn growth are better explained by demographic, nutritional, and environmental factors (Monteith et al. 2018, Trail et al. 2014, Loehr et al. 2010, Hik and Carey 2000). While research on Dall's sheep is scant compared to other Alaskan big game species (e.g., moose, caribou), previous work

has focused primarily on ewe health and demographics, lamb mortality, and anthropogenic disturbance of sheep (Lohuis 2016a, 2016b, Arthur 2014, Wendling 2008, Lawler 2004, Scotton 1997). There is a tremendous data gap on the ram component of Alaskan sheep populations.

In most of Alaska, non-subsistence sheep hunts are managed under the full curl regulation. This regulation was implemented throughout most of the state by 1989, and it was intended to focus harvest on mature rams. It is primarily based on the dominance related mortality (DRM) hypothesis proposed by Geist (1966; 1971), which states that mature rams are at heightened risk for overwinter mortality due to energy expenditure during the rut. The presence of these mature rams in a population, and their participation in rut, may ensure an orderly rut, but if most of the mature rams are removed by hunting, juvenile rams purportedly participate in mating to a greater extent. Increased participation by younger rams then results in increased harassment of adult ewes, rams courting/chasing anestrous ewes, increased male-male competition. Further, a prolonged mating season is possible as rams remain with ewe groups past the rut in an attempt to secure copulations. According to the DRM hypothesis, such increased participation by young rams causes greater energy expenditure by both rams and ewes, depleting their energy reserves, which in turn lowers pregnancy and parturition rates, and compromising overwinter survival among all cohorts.

Sheep research in Alaska in the 1970's and 1980's relied upon observations of marked individuals at mineral lick sites to determine individual animal survival, and observations of marked ewes accompanied by offspring at lick sites to determine reproductive status (Heimer and Watson 1984). Alternatively, multiple survey flights and/or ground observations, usually without benefit of marked individuals, were used to assess population level reproductive rates (Nichols 1978). Different demographic groups of sheep use licks at different rates, seasons, and times (Tankersley 1984). Aerial observations only provide a snapshot of a population in time, and do not give insight into the demographic processes that shape population structure, and cannot differentiate ewes from yearlings or subadult rams that remain with nursery groups. Finally, as much as 50% of lamb mortality in a given year happens in the first month of life, often before adult ewes rejoin nursery groups (Lohuis 2016) and utilize lick sites (Tankersley 1984), where they would be observable to further assess reproductive success. Population level conclusions drawn from either observations at lick sites or from aerial surveys should therefore be interpreted with caution.

The DRM hypothesis, and, specifically, the effects of ram population structure on rutting behavior and success, has never been directly tested on individual animals. In an early attempt to test the hypothesis, Singer and Ziegenfuss (2002) observed increased courtship activity by young Dall's sheep rams in heavily hunted populations that had an absence of older rams compared to an unhunted population nearby. However, in separate studies, Murphy et al. (1990), and Singer and Nichols (1992) did not assess differences in overwinter survival of rams or ewes or differences in pregnancy and parturition rates (assessed by aerial observation). However, as described above, data collection in this should be interpreted with caution.

Murie (1944) estimated that mortality rates of 2-8 year old rams were relatively low, ranging from 4-9%. However, these estimates were based on opportunistic skull collections. Other work indicates mortality in these cohorts may be higher: Nichols (1984) showed that 14-43% of young

rams would succumb to natural mortality prior to attaining full curl status. Data from a small number of 3-6 year old rams (n=32, between 2012-2016), radio-collared in the Chugach range, indicate that annual mortality rates are higher than Murie's estimates and similar to those measured on adult ewes, ranging from 8-27% annually (Lohuis 2016a,b). A larger dataset on ram survival rates may ultimately provide insight toward addressing questions about realizing additional hunting opportunities on this cohort.

M.ovi is a bacterium that can lead to respiratory disease in wild sheep. It has been identified as a pathogen associated with big horn sheep die offs in several populations in the western United States and Canada. It is thought that young rams emigrating can spread this pathogen from one sub population to the next. In 2017 M.ovi was first reported in Dall's sheep populations in Alaska with no known evidence of illness or deaths. While this project is not disease oriented per se, it does provide us the opportunity to assess the health of the captured cohorts. Further, by studying the movement behavior of young rams, we will better understand the potential for disease dispersion if an outbreak were to occur.

To better understand the potential effects of selective harvest regimes, the gold standard for tests of hunter-induced evolution and DRM would be two nearby long-term monitoring programs of one protected and one subject to selective hunting, with accurate data on horn size, individual reproductive success and survivorship (Festa-Bianchet 2017). This research needs to be conducted in areas that have similar large-scale weather patterns, Dall's sheep population densities, and nutritional resources. In the central and eastern Brooks Range, we can design such a study. Lastly, with the recent discovery of *M.ovi in* Alaskan sheep populations, examining emigration behavior of immature rams will not only aid in determining the number of adult rams in an area, it will also provide insight to potential disease dispersal.

Our working hypotheses for this study are:

1) Ho1: There will be higher mortality of immature (2-7 year old) rams in the heavily harvested population when compared to the adjacent lightly harvested population.

2) Ho2: Immature rams in the heavily hunted population will have reduced body condition, health, and horn growth compared to the lightly harvested population.

2) Ho2: That immature rams will have a greater paternal contribution in the heavily harvested population compared to the adjacent lightly harvested population.

4) Ho3: Immature rams should display greater movement rates in the heavily harvested population than the lightly harvested population during the hunting season and during the breeding season.

4) Ho4: The Dalton Highway and Dietrich Valley represent an effective barrier restricting movement of immature rams between the study areas.

5) Ho5: Patterns of habitat selection by immature rams should be similar between study areas.

6) Ho6: Climate change will induce changes in habitat distribution which will influence sheep distribution and movements in the long term.

7) Ho7: *Mycroplasma ovipneumoniae* is not present in the study areas due to isolation from potential sources (domestic sheep) in the area.

2. Purpose – This project will establish a long-term ram ecology project in two study areas in the central and eastern Brooks Range; one with heavy hunting pressure, and one with minimal subsistence hunting within a National Park. By marking (both GPS and VHF collars, and collecting DNA) immature rams and lambs/yearlings in the two study areas, and monitoring them through time, we can address several issues identified by management biologists.

3. Objectives

Objective 1: Estimate survival of immature rams and determine causes of mortality

Job/Activity 1a: Capture 30 sheep in each area (total 60) and instrument them with GPS/VHF collars in year 1, 2, and replace collars on original sample and augment in years 4 and 5.

Objective 2: Estimate the reproductive contribution of immature rams

Job/Activity 2a. Collect DNA from lambs and lamb fecal pellets in years 2-5.

Job/Activity 2b. Collect DNA from harvested rams years 1-5.

Objective 3: Investigate seasonal and annual movement patterns and habitat selection of immature rams

Job/Activity 3a. Analyze GPS data.

Objective 4: Assess health, body condition, horn size, disease

Job/Activity 4a. Perform a complete health evaluation and disease screening at time of capture.

Job/Activity 4b. Measure horn morphometrics at time of capture.

Objective 5. Develop sightability correction factors for immature rams

Job/Activity 5a. Use marked animals to estimate a sightability correction factor during Management Biologists annual minimum count survey.

Objective 6: Review literature, write annual progress reports, write final project report, and publish results in peer reviewed journals.

Job/Activity 6a: Literature review, data analysis, reporting writing, and publication of results.

4. Expected Results or Benefits

The Alaska sheep hunting public, while small, is a vocal and passionate group. In recent years they have voiced concerns about Alaska sheep populations and current management strategies. The Alaska Board of Game has received numerous proposals that could alter current sheep management and harvest strategies. The recent proposals have addressed the dissatisfaction that some hunters have expressed regarding perceived hunter crowding and decreased availability of full-curl rams for harvest opportunities.

There has been an ongoing contentious debate within the scientific community about the potential negative effects of selective harvest on mountain sheep. This study will provide: 1) information on the justification of full curl harvest strategies, 2) will provide a rigorous test of potential effects of selective harvest, 3) assess the health of the ram component of the population, and 4) establish some baseline information (e.g. habitat selection and movement rates) for the rams in the central and eastern Brooks Range.

5. Approach

The general approach of this 5 year study is to GPS/VHF mark 60 rams (30 in year 1, and 30 in year 2) in two different study areas and follow them through the course of the study. These collars will be replaced because of limited battery life in years 4 and 5. The treatment study area described below is an area with intensive hunting pressure. The control study area will be of comparable size in Gates of The Arctic National park and will have minimal subsistence hunting pressure. Rams will be weighed, and ultrasound will be used to measure subcutaneous rump fat at the time of capture. Blood will be collected into vacutainers from the jugular vein for serology, a comprehensive metabolic panel, disease serology, and serum archiving. An ear punch will be taken to collect the individual DNA. We will record morphometric measurements including jaw and metatarsus length, chest girth, and horn length (including total length, distance between annulus, and base circumference). We will collect tonsillar swabs from each animal. One swab will be used for standard bacterial culture while the other will be used to test for the presence of mycoplasma bacteria in this population. Beginning in year 2 of the study we will attempt to collect DNA from virtually all lambs born in each study area via direct captures and fecal pellet collection. We will collect muscle tissue for DNA from rams harvested near the study areas at the time of compulsory sealing. With the DNA collected from the GPS marked rams, harvested rams, and lamb captures and fecal pellets, we will conduct a paternity analysis. GPS data collected from the collars will be used to build habitat selection models, and assess movement rates, emigration, and home range size.

6. Useful Life

Not Applicable.

7. Geographic Location

Field work will be conducted in the Central and Eastern Brooks Range in GMU's 24B, 24A, and 25A. The treatment study area will overlap ADF&G's approximately 800 mi^2 survey area consists of the upper North Fork Chandalar River and the upper Bettles River drainages in eastern Unit 24A and western Unit 25A. Smaller drainages within area include Mathews, Big Spruce, Sheep, Quartz, Phoebe, Willow, Geroe, Baby, and Robert creeks as well as portions of the Dalton Highway Corridor Management Area.

The control Study Area will be in a yet undetermined portion of Gates of the Arctic National Park should NPS choose to collaborate.

8. Principle Investigator

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9. Program Income

Not Applicable.

10. Budget Narrative

Budget for first year of project. See Appendix 1 for five year project budget breakdown.

71000 Staff time (PCN 11-2105 ; 4 months)	**$38.2K**
72000 Travel	**$0**
73000 Contractual	**$178**
74000 Supplies	**$120**
75000 Equipment	**$0**
Total Project Direct Costs	**$336.2**

Examples:

71000 Personnel: 4 mo. PCN 11-2105 Wildlife Biologist III

72000 Travel: Instate air and ground travel, lodging, meals, and incidentals

73000 Contractual: Air charter for captures and aerial surveys, training/conferences, publications

74000 Supplies: Animal Capture Drugs

75000 Equipment: None

11. Multipurpose Projects

Not Applicable.

12. Relationship with other Grants/Projects

Not Applicable

13. Schedule/Timeline

- March/April 2019-20 Capture rams and attach GPS collars and assess health
- July 2019-2023 Estimate sightability correction factors during minimum count surveys
- August/September 2020-2023 Collect DNA from harvested rams that were taken near the heavily hunted study area at the time of compulsory sealing
- March/April 2022-2023 Recapture rams and attach GPS collars and assess health
- May 2020-2023 Capture lambs and collect DNA. Collect lamb fecal pellets for DNA

14. Environmental Compliance

- Requires National Park Service permits for capture and use of helicopters within National Park boundaries.
- Requires IACUC approval.

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. Five year project budget.

[in $K]	Year 1	Year 2	Year 3	Year 4	Year 5
GPS/VHF Collars	110	110	.	110	110
Subscription Fee	10	10	10	10	10
WBIII Salary (4 months)	36	36	36	36	36
Ram Captures	80	80		80	80
Lamb Captures		80	80	80	80
Fixed Wing Time	36	36	36	36	36
Graduate Student	.	.	40	40	40
Professor	12	12	12	12	12
Lab Analyses	30	55	25	55	55
Field/Misc	10	10	10	10	10

conference/publications	.	.	3	3	3
Minimum Count Survey	10	10	10	10	10
Total	**334**	**439**	**262**	**482**	**482**