

Project Title: BIGHORN SHEEP SURVIVAL AS A FUNCTION OF FORAGE USE AND QUALITY, SOIL NUTRIENTS, AND POPULATION HEALTH, PARTICULARLY RELATING TO LAMB RECRUITMENT. (Dr. Stephen Williams, John Mionczynski, Dr. Jack States, Ronald K. Smith)

Project Type: Research/Monitoring

Affiliate: Bighorn Restoration Group

Location of Project: Wyoming/Temple Peak Bighorn Herd Unit/ Southern Wind River Mountains & Northern Wind River Mountains

Description of Project:

The Temple Peak Bighorn Sheep Herd currently consists of approximately 100 individuals, 21 of which have been fitted with radio-collars (funded by the *Wyoming Wild Sheep Foundation*) for tracking purposes. Capture, disease testing, pregnancy determination of ewes, body condition, and radio collaring took place in the early spring months (February and March) of 2016 and 2017. GPS data shows the home range of this herd spans jurisdictional boundaries between the Wind River Indian Reservation (WRIR) and adjacent U.S. Forest Service, BLM, and private lands. GPS data collected during the winter of 2016-2017 indicated that the herd winters in four different areas: Washakie Rim, Crooked Creek, Trout Creek, and North Fork of Popo Agie Canyon. The Crooked Creek and Trout Creek bighorns mingle routinely, with all sheep collared in 2016 from these two winter ranges migrating to summer ranges near the continental divide, whereas, bighorns wintering on the other two areas remained relatively sedentary on lower-elevation habitat during the entire year. Disease testing results collected in 2016 showed that this herd was surprisingly free of problematic pathogens. Preliminary results obtained from the recent 2017 capture/disease testing event, however, show *Mycoplasma ovipneumoniae* (MOVI) being identified in four of the nine bighorns captured, which undoubtedly has compromised the general health and immune systems of the infected individuals.

The existence of this GPS monitored population provides the opportunity to evaluate several important parameters for both the collared individuals and their lambs, as well as for non-collared bighorns in their company. Habitat utilization, migration corridors, identification and analysis of mineral licks, relative health, natality, mortality, survival of the offspring of ewes identified as being infected with MOVI and lamb survival of those ewes not infected with MOVI, evaluation of forage preference and quality by season and location, relative health, survival, and recruitment in both the non-migratory as well as the migratory subpopulations are parameters which can therefore be obtained through monitoring, analysis, and observation.

Previous data collected from the Wind River Mountains further to the north, (near Dubois) has shown that forage quality on high elevation summer ranges can, at times, reach marginal or even critically deficient levels for some mineral nutrients, particularly during wet summers (Hnilicka, et al., 2002). These summer mineral deficiencies are likely a significant factor in reduced lamb survival.

During very wet summers some mineral nutrients become diluted simply due to the prolific levels of forage produced. Increased soil moisture as well as chemical and biological soil

processes in wet soils has also been shown to reduce bioavailability levels of some mineral nutrients (Hnilicka, et al., 2002). Macro and micronutrient dietary deficiencies in bighorn diets undoubtedly weaken and put stress on the animal's health, compromise immune systems, increase the likelihood of the animals being more susceptible to diseases, and are undoubtedly a significant contributing factor in ewe milk quality and production, as well as reduced lamb survival.

The high levels of snowpack in the Wind River Mountains as of April, 2017 has set an excellent stage for documentation of mineral nutrient levels in bighorn preferred forage as well as in associated soils during what is shaping up to be an unusually wet summer. The latest National Weather Service statistical information (April 22, 2017) for snow-water equivalent in the Wind River Basin shows average levels at 196% of median, with NRCS data showing many individual locations reading well over 200% and up. The Lander area, in particular has set an all-time record for precipitation during the first three and a half months of this year. A major winter storm has since added to these totals, with long-range forecasts predicting a continued wetter than normal conditions to continue.

Previous research (Hnilicka, et al., 2002) has shown a significant decrease in both soil and forage trace mineral availability during wet summers when compared to drier periods. The measured deficiencies, primarily cobalt and selenium and perhaps copper, coincided with an observable health decline in Whiskey Mtn. Bighorns. This was especially noticeable in lamb mortality and deterioration of ewe body condition, and likely was a significant factor in the continuing health decline in adults moving onto winter ranges. A similar declining health response in pikas to mineral deficiency was reported by K. Palmer, a graduate student working with S. Williams and others (Palmer, et al., 2007). This study was conducted in the same habitat and location as the bighorn sheep discussed above.

Expected soil and forage mineral deficiencies may include the following elements and vitamins:

Cobalt: Recent studies on trace mineral deficiencies in domestic and wild sheep have supported past studies which show that when sheep are on a cobalt deficient diet, there is a gradual loss of appetite, observable starvation symptoms of weight loss, muscle wasting, anemia, and eventually death. Secondary signs of cobalt deficiency include fatty liver, increased mortality of offspring shortly after birth and increased susceptibility to infectious pneumococcal pathogens.

Selenium and vitamin E: It is well established in the scientific literature that these two are absolutely essential in sheep diets where they play a key role in mounting immune response to infectious pathogens and are vital for growth, reproduction, and preventing white muscle disease. Both pneumonia and white muscle disease symptoms are likely to show up again this year.

Copper: A deficiency in this element is common when sheep graze forage low in copper in the presence of higher amounts of iron, molybdenum and sulfur. When two or all three of these elements are high, they bind copper causing poor bone mineralization and anemia. We are not sure that this is a problem in the southern Wind River Mountains but this is an issue worth monitoring.

REFERENCES:

Hnilicka, P., J. Mionczynski, B. Mincher, J. States, M. Hinschberger, S. Oberlie, C. Thompson and B. Yates. 2002. Bighorn sheep lamb survival, trace minerals, rainfall and air pollution: Are there any connections? 13th Proceedings of the Northern Wild Sheep and Goat Council.

Mionczynski, J., K. Palmer, J. States, N. Stanton, M. Ben-David, E. Brown, A. Allgeier, and S. E. Williams. 2009. Implications of Climate Change at High Elevations: Inorganic Nitrogen, Soils and Impacts on Wildlife. Poster Presentation at the Forest and Plains Symposium, March 10, 2009, University of Wyoming Conference Center, Laramie, WY.

Palmer, K. M., N. L. Stanton, M. Ben-David, J. Mionczynski, and S. E. Williams. 2007. Area pika exposed to and affected by selenium deficiency? *Journal of Wildlife Diseases* 43:475-484.

Since 2002, numerous internal reports have been generated from the continuing research on the Whiskey Mountain bighorn sheep herd. These reports are available on request.

Problem to be Solved: The Wyoming Game & Fish Department, U.S. Fish and Wildlife Service, and Joint Tribal Fish & Game Department has been studying various parameters of the WWIR/Temple Peak Bighorn Herd unit for the past two years with the goal of “developing a roadmap of steps needed to ensure the success of any potential re-introduction projects.” In 2016 disease testing of 14 individuals from various subgroups of the WRIR/Temple Peak Bighorn Herd showed the herd to be the most disease-free herd in the State of Wyoming. However, in a more recent capture and testing event (mid-March 2017) five of the nine bighorns tested positive for MOVI.

It is possible that individual bighorns were carrying symptomless, infectious microbes, but that disease symptoms only became expressed in the herd when environmental conditions became conducive to compromising the immune response of bighorns due to environmental stressors such as nutritional deficiencies.

The proposed project explores possible reasons for the sudden reversal in disease status, which now jeopardizes future plans for possible expansion of the WWIR/Temple Peak Bighorn Herd.

Describe How You Propose Solving The Problem: This project proposes to address the possible reasons for the abrupt change in health of bighorn sheep in the WRIR/Temple Peak Bighorn Herd that surfaced in the most recent disease assessment of the herd. We propose to follow up on the correlations established by previous research findings by the proposal authors and others: i.e., high precipitation regimes resulted in lower concentrations of essential dietary minerals in soils and forage plants resulting in a corresponding decline in adult health and increase in lamb mortality.

Two graduate students or other temporary field researchers along with the project authors will be engaged in data collection and analysis during the spring and summer months of 2017. Additional data collection and analysis will also likely be required during a second summer field season, however, this proposal only addresses the 2017 field season. The proposed study will follow a line of investigation for the following research:

RESEARCH OBJECTIVES

- I. Identify key forage species used by area bighorns for both the non-migratory subpopulation and the high elevation migratory subpopulation of the Temple Peak herd. This data will be compared to previous data collected for the Whisky Mountain Bighorn Herd.
 - a. Identify parts of plant species eaten
 - b. Document seasonal changes in plants consumed: (Observations to be recorded every two weeks).
 - c. Take photographs and record locations.
 - d. Collect key forage species for nutritional analysis. Analyze for the standard suite of macro and micronutrients. Dietary analyses will be supplemented with hair, fecal, and when possible tissue necropsy analysis. Forage samples for these species will also be collected and analyzed at similar elevations on habitat utilized by the Whisky Mountain Herd.

(If finances are limited, collect *Carex sciurioides* for analysis since this plant integrates mineral nutrients at a similar ratio as do a broad range of important forage species (Mionczynski, unpublished observations. See also, Mionczynski, 2009).

- II. Identify geology and soils for each important habitat zone utilized by Temp Peak Herd Bighorns. Spot checks will also be taken at high elevations utilized by the Whisky Mountain Herd for comparison.
 - a. Take photographs and record locations.
 - b. Collect soil samples (minimum of three per location. (Special precautions must be taken to assure sample preservation for analysis).
 - c. Test soils on site for as many soil parameters as possible: pH, salt content, oxidation/reduction potential and others.
 - d. Parameters that cannot be tested on site will be analyzed at a certified analytical lab.
 - e. Determine locations, use, and analyze mineral content of mineral licks utilized by bighorns for both migratory and non-migratory subpopulations.
- III. Record seasonal range use by Temple Peak Bighorns. This will include maps and migration routes of both rams and ewes.
- IV. General Observations During Field Visits
 - a. Record number of rams, ewes and lambs.
 - b. Record lamb suckling times.
 - c. Record relative health, behavior, and other general observations of bighorns.
 - d. Record any predator interactions.

Biography of Applicant:

Name: Dr. Stephen Williams (See end note)

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Additional Authors: John Mionczynski, Dr. Jack States, Ronald K. Smith

Are You a Member of WY-WSF? Yes (Ronald K. Smith)

Budget	Cost to be Funded By WY-WSF Grant	Cost to be funded by other cooperators
Equipment	\$1,425 ¹	
Services	\$3,200	\$1,960 ²
Publishing	\$0 ³	
Monitoring	\$16,250 ⁴	\$3,000
Supplies	\$500 ⁵	
Other	\$22,750 ⁶⁻⁸	
Totals	\$44,125	\$4,660

Notes:

1. Equipment: Necropsy kit (\$25), Soil Analysis kit (\$500), Spotting Scope (\$600), Binoculars (\$300).
2. Analysis: Soil and forage analysis will be done cooperatively between Inter-Mountain Labs in Sheridan and Olson Labs in Brookings (SD). The University of Wyoming through monies held in an account administered by Dr. Stephen Williams will contribute \$300. The *Lander Community Foundation* has committed \$750 toward mapping and the *Bighorn Restoration Group* has committed an additional \$910 toward mapping costs.
3. Publishing: It is anticipated that an additional field season will be required during the summer of 2018 to verify and obtain additional data. Publishing will occur during year two even if funding for year two is not approved.
4. Human Resources: This includes 100 hours of fieldwork each for two field workers (to be recruited from graduate student cores at UW, NOLS or elsewhere). The *Bighorn Restoration Group* has agreed to fund \$3,000 towards this portion of the project.
5. Supplies: This includes field refrigeration at \$200, various lab supplies (glass ware, chemicals, etc.) at \$200 and expendable containers etc. at an estimated \$100.
6. Travel: This will include local travel only (e.g. from Laramie to study sites, from Lander to study sites).
7. Per Diem/Lodging. For food and housing while mostly in the field and occasional out of field housing needs.
8. Consultants: Dr. Stephen Williams (\$10,000) of the University of Wyoming will provide the following: train field workers, analyze data, prepare reports, facilitate meetings, budget management and conveyance of information to stake holders. John Mionczynski (\$10,000) will provide: training, in-field operations with field workers, data acquisition, meetings and interactions with stake holders. Dr. Jack

States (\$1,000) will provide reference materials, some minor training, general support and data management.

Other Organizations Providing Financial Aid and/or Support of the Project:

Bighorn Restoration Group (\$3,910/ \$910 of which has already been allocated for mapping), Lander Community Foundation (\$750 allocated for mapping), Central Wyoming College (Mapping Software, Facilities). NOLS has committed to provide sampling collection support. The Joint Tribal Fish & Game Dept. will allow research access to tribal lands.

Media Contacts:

Lander Journal, Riverton Ranger, Casper Star Tribune, Wyoming PBS.

Dr. Stephen Williams is retired from the University of Wyoming, although he still does some work for U.W's College of Agriculture and Natural Resources. He now works as a consultant through S.E. Williams & Associates LLC.