Bleats and Blats

Official Newsletter of the
Desert Bighorn Council
December 2013

Inside:

Hello DBC members and friends,

I apologize for the delay in getting this newsletter to you all. No excuse other than work. At least part of work that interfered involved capturing and moving desert bighorn sheep here in Arizona. In early November, we captured 40 bighorn in the Black Mountains in Unit 15D near Kingman and moved them to People's Canyon in the Arrastra Mountains in Unit 16A (south towards Phoenix). This was a supplement to a release we did in 2011 and adjacent to the establishment of our Hell's Half Acre population in Unit 18B to the east.

The second translocation occurred in mid-November and was the initial step in re-establishing a population that disappeared from the mountain in the late 1990s. Thirty-one bighorn sheep were captured in the Trigo and Plomosa mountains north of Yuma and released in the Catalina Mountains near Tucson. Two additional supplemental releases are planned for the next three years. It is always amazing to watch the sheep scatter up a mountain where they haven't been seen for awhile.

The next newsletter is planned for late February; please send me any updates or announcements to include by January 31st. I hope to hear from you! It is very difficult to pull a newsletter together without content. For more information about the Desert Bighorn Council, or to download a membership form, please visit our website at www.desertbighorncouncil.com (NEW website address).

All the best to you,
Amber Munig (DBC Secretary)

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Upcoming Research Projects in Arizona

Esther Rubin, Arizona Game and Fish Department

The Arizona Game and Fish Department's Research Branch is embarking on additional research on desert bighorn sheep this year. We will be working with our Region 3 (Kingman) and Region 5 (Tucson) biologists, and our Game Program, to examine bighorn sheep habitat use and the factors that put a bighorn sheep at risk of mortality in 2 desert mountain ranges. The Regions conducted 2 translocations that will provide an excellent research opportunity to gather information to help guide future management decisions. In Region 5, 31 bighorn sheep were translocated into the Catalina Mountains where the remnant bighorn sheep population disappeared in the 1990s; an additional augmentation is planned for next year. In this area, research will focus on bighorn sheep habitat selection and mortality patterns in relation to habitat attributes, including fire history and areas of human activity. In Region 3, 40 bighorn were moved from the Black Mountains to the Arrastra Mountains to augment an existing remnant population. This study area will again focus on habitat selection and mortality patterns, but will also include a predator-prey component. Mountain lions will be collared to examine their prey selection, space use, and movement patterns in relation to the bighorn sheep population.

Stay tuned for future updates on this project!

(This was written in September after the initial investigation. Additional information provided in a future newsletter.)

Bighorn Sheep and disease in the Old Dad Peak System and Marble Mountains of California

Compiled by Vern Bleich, Regina Abella, and Ben Gonzales

Desert bighorn sheep *(Ovis canadensis nelsoni)* populations in the Mojave Desert in southeastern California are currently experiencing the worst outbreak of pneumonia-related mortality in recent California history. The disease situation among bighorn in the Old Dad System and in the Marble Mountains of San Bernardino County is rapidly evolving and complex. Wildlife biologists and veterinarians with the California Department of Fish and Wildlife (CDFW), the National Park Service (NPS), academia, and non-governmental conservation organizations are working together to understand the source, causes, severity, and distribution of the disease and to develop management recommendations. Information provided herein has been compiled to provide insight into the current status of bighorn sheep in the affected areas, and to provide information on the results of the aerial survey conducted during July 2013. This information is current through 16 September 2013.

Approximately 300 bighorn sheep inhabit Old Dad Peak and its immediate environs in San Bernardino County, and represent two of several subpopulations that comprise the Central Mojave Metapopulation Fragment. In mid-May 2013, a NPS technician visited the Old Dad Peak Wildlife Water Development (Old Dad WWD) in Mojave National Preserve (MNP). The technician reported the presence of several carcasses of mature male bighorn sheep near that water source. Subsequently, additional carcasses of both sexes were discovered near the C. J. Kerr WWD, located several kilometers to the south, and an

additional carcass was found at the Vermin WWD several kilometers to the north of the Old Dad WWD. Subsequent ground surveys indicated the presence of what appeared to be healthy individuals, as well as other animals with clinical symptoms of respiratory disease; photographic stations at several water sources and direct observations by ground personnel failed, however, to yield evidence of compromised individuals in the East Marl and West Marl mountains, the Kelso Mountains, or in the Cindercone Area east of Old Dad Peak. Despite these initial observations, sick animals were subsequently confirmed in several of these areas.

As a result of these observations, NPS staff completed compliance documents for the collection of live animals for laboratory examination. The initial document (a categorical exclusion) set a limit of 15 individuals to be collected, and the second authorized the collection of animals showing clinical signs, but without a specific limit on numbers; there is general agreement that these documents are sufficient to undertake prospective management actions.

Two compromised individuals subsequently were collected near the Kerr WWD, and both tested positive for *Mycoplasma ovipneumoniae*, a bacterium that occurs commonly in healthy domestic sheep and goats, and that is thought to predispose or cause pneumonia in bighorn sheep. *M. ovipneumoniae* has also been confirmed in one of the bighorn carcasses located earlier.

Because the CDFW does not currently have a state contract for helicopter services, the California Chapter of the Wild Sheep Foundation, National Wild Sheep Foundation in Cody, Wyoming, and the Iowa Chapter of the Foundation for North American Wild Sheep provided $31,000 to implement an aerial survey and potential management actions. During 16–18 July, an aerial survey was conducted at selected locations throughout the Old Dad System, and included radial surveys in the vicinity of each of the perennial water sources known to occur in that area as well as three distinct topographic features (Cowhole Mountain, Little Cowhole Mountain, and Club Peak), none of which is known to support perennial sources of water, but each of which is inhabited by bighorn sheep on at least a seasonal basis. The pilot and observers flew at a rate of 2.5 minutes/km^2, identical to that flown during surveys of the area that have been conducted since 1988, and that has been determined to be very efficient in terms of data acquisition. The radial surveys differed, however, from prior fall population surveys in that they were centered on each water source or geographic area, and encompassed an area within a radius of 2 km of each feature (i.e., an area of ~13 km^2). Consequently, the conditions and timing of these flights do not allow us to compare observed numbers to those from previous surveys.

During the radial survey flights, a total 126 live bighorn sheep were observed during 17.1 hours of helicopter time (Table 1). This effort was undertaken in part to determine the presence of healthy or compromised bighorn sheep, and observers were to gain information on the distribution of compromised animals, search for and remove any domestic goats, domestic sheep, or feral exotic bovids encountered, and collect additional compromised bighorn sheep for examination.

It was the subjective opinion among the observers that fewer animals were seen than would have been expected had there been no change in the size of the population since the most recent survey in 2009. Observers confirmed the presence of additional live, but debilitated, animals near the Old Dad, Kerr, and Vermin WWDs, areas in which compromised or dead individuals previously had been detected . Moreover, compromised animals were observed in the Kelso Mountains, where debilitated individuals had not been previously detected during ground observations <1 week prior to the aerial survey. A compromised animal was also observed in the Cindercone Area, and a female was collected later near Cane Spring during a subsequent flight. A mature male exhibiting respiratory distress was also

collected in the Kelso Mountains. No domestic sheep or goats were observed during the surveys.

Laboratory examination revealed that the female from Cane Spring did not have pneumonia, and was negative for *M. ovipneumoniae*; her debilitated condition was the result of a uterine infection, peritonitis, and other internal problems. The male from Kelso was positive for pneumonia upon *post mortem* examination, and infection with *M. ovipneumoniae* was confirmed by DNA techniques. Available evidence thus far suggests a recent, point-source of infection in that (1) 26 serum samples collected from the Old Dad System during 2005–2006 were negative for evidence of exposure to *M. ovipneumoniae*, and (2) *M. ovipneumoniae* strains from the first three Old Dad Peak outbreak mortalities were identical. It is perhaps not coincidental that a domestic goat was observed in, and then removed from, the Marl Mountains in December 2012. Subsequent examination indicated the carcass of the goat was unremarkable and was free of pathogens for which it was examined. Unfortunately, neither serology nor genetic techniques were used to examine the carcass for evidence of *M. ovipneumoniae*. Although suspect, the goat has not been conclusively determined to be the original source of the infection. Perhaps of even greater concern, was the discovery on 15 August of the carcasses of 4 domestic sheep near Halloran Summit, immediately north of Club Peak, and evidence that live domestic sheep had been present in that area.

In a separate development on 8 August, a CDFW officer was passing through the Marble Mountains, an area that supports a population of about 175 desert bighorn sheep. The Marble Mountains are located in the Southern Mojave Metapopulation fragment and are separated from the Central Mojave Metapopulation fragment by Interstate 40, which is considered to be a significant barrier to bighorn movement. He observed a mature male bighorn sheep that exhibited signs of respiratory distress. An initial attempt to collect the animal was unsuccessful, but on 9 August CDFW personnel collected a young male showing signs of pneumonia, which was accompanied by another male and an adult female; attempts to collect the adult male and female were not successful at that time. On 14 August, a 5-year-old male and 3-year-old female with respiratory problems were collected, followed by the collection of two sick females (estimated to be 2, and 3, years-of-age, respectively) on 15 August. The carcasses each were delivered to the California Animal Health and Food Safety Laboratory in San Bernardino the day of collection and subjected to a full diagnostic workup. All were positive for bronchopneumonia on gross necropsy. As of this writing it has been determined that all 5 animals were positive for *M. ovipneumoniae* by DNA techniques, and that the strain of *M. ovipneumoniae* present among three of the five was determined by genetic methods to be identical to that detected among animals inhabiting the Old Dad System.

CDFW staff will continue to work with the National Park Service and the Bureau of Land Management to ensure that compliance documents are in place for current and planned future work on federal lands.

As noted in the opening paragraph, the current situation is complex and constantly evolving. We will endeavor to keep interested parties informed as new developments occur by providing updates and status reports.

Dr. Vern Bleich is an independent wildlife biologist, Ms. Regina Abella is the CDFW Desert Bighorn Sheep Coordinator, and Dr. Ben Gonzales is a CDFW Wildlife Veterinarian.

Table 1. Bighorn sheep helicopter survey results from 9 geographic areas flown in the Old Dad System 16–18 July 2013, Mojave National Preserve, San Bernardino County, California.

	Total Live Animals Observed			Live Animals Compromised*			% Compromised of Live Animals Observed		
Location	Ewes	Lambs	Rams	Ewes	Lambs	Rams	Ewes	Lambs	Rams
Henry Spring/ Granite Spring	0	0	0	0	0	0	0	0	0
Indian Spring/Cane Spring	19	7	14	0	0	0	0	0	0
Sheep Spring/Marl Spring	8	6	2	0	0	0	0	0	0
Kelso WWD	2	0	6	0	0	2	0	0	33.3
Cowhole/Little Cowhole	0	0	0	0	0	0	0	0	0
Old Dad WWD/Vermin WWD	18	0	5	9	0	4	50	0	80
Kerr WWD	32	4	2	13	1	2	40.6	25	100
Petroglyph Spring	0	0	1	0	0	1	0	0	100
Total	**79**	**17**	**30**	**22**	**1**	**9**	**27.8**	**5.8**	**30**

*Compromised as determined by high resolution photography-nasal discharge, poor body condition, head shaking (cough, sneeze) or would not run when pressured.

Table 2. Dead bighorn observed during helicopter survey of Old Dad System 16-18 July 2013, Mojave National Preserve, San Bernardino County, California

Location	Ewes	Lambs	Rams
Old Dad WWD/Vermin WWD	0	0	4
Petroglyph Spring	0	0	1
Total	0	0	5

Farewell to Jim Yoakum

Submitted by Rick Brigham, with help from Don Armentrout and Dick Weaver

James Donovan Yoakum (1926-2012)
Many of you reading this may not have known who Jim Yoakum was, but read on. He was born in Templeton, California on June 14, 1926. He served in the U.S. Navy from 1944-1947, seeing many tough battles, including Iwo Jima. His time in service was a small part of his life, but the G.I. Bill gave him an education, a career, and a place to call home. After seeing the devastation of war, he sought wilderness and wildlife. His first purchase after WW II was a saddle, while taking a job as a forest lookout near Big Sur, on the California coast. After that summer he attended Humboldt State College in the redwoods of California, graduating in 1953. He went on to Oregon State University, where he earned a Masters in 1957. Jim was hired by the Bureau of Land Management as its first wildlife biologist and spent most of his 28-year career in the BLM Nevada State Office in Reno. He did take time out to study alpacas and vicunas in South America in the mid-1960s and did a stint or two teaching at both Humboldt State and University of Nevada Reno. Jim was a very strong advocate for wildlife and for professionalism among wildlife biologists. He was a mainstay in the Nevada chapter of The Wildlife Society as well as the Western Section of TWS, where he held several positions and was

honored with several awards. Jim continually pushed biologists around him to do better for wildlife and wildlife management.

He earned his MS on Pronghorn from OSU studying pronghorns. Those speedsters were the wildlife love of his life. He co-authored "Pronghorn Ecology and Management" with Bart O'Gara, a comprehensive 900+ page book. The book represents a monumental bookend to his love of wildlife and wild places and a solid foundation for those who follow.

While earning his Master's, Jim used a black Labrador retriever to help him locate antelope fawns. The dog would hold the fawns down with his paws until Jim got to them. He had a succession of Labs, mostly black (the second to the last one last one, Teena, was a yellow Lab), throughout the rest of his life, and they accompanied him anywhere he drove. It should be noted that "Teena" is an American Indian name for pronghorn.

Along the way, Jim also found time for desert bighorn sheep. He attended many DBC annual meetings in the 1960s and into the early 1970s. Jim served one year as a member of the DBC Technical Staff, but is most remembered for being DBC Transactions editor from 1965 through 1971.

For those of you who attended the 50th year of the Council in Las Vegas in 2007, Jim was there, older and slower but still the hard-core wildlife advocate he always was.

Jim passed over on November 20, 2012.

Notice – Hells Canyon Information Dissemination Website

Recently a website has been launched to disseminate information about pneumonia in bighorn sheep in Hells Canyon. The address is www.bighornhealth.org. The purpose of this website is to reach a variety of audiences to inform them about pneumonia in bighorn sheep. Investigators on this project are from Idaho Department of Fish and Game, Penn State's Center for Infectious Disease Dynamics, Princeton University, The USGS, and elsewhere. We formed the Bighorn Sheep Disease Research Consortium in 2009 to bring an interdisciplinary approach to the puzzle of bighorn pneumonia. Pneumonia has been killing bighorn sheep since settlers first brought domestic sheep to graze in bighorn habitat. Although the link between bighorn sheep pneumonia and domestic sheep is well known, little headway has been made in controlling, or even understanding, this disease. For more information, contact:

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Northern Wild Sheep and Goat Council Symposium

The Northern Wild Sheep and Goat Council 19th Biennial Symposium is in Fort Collins, Colorado, June 2-5, 2014. This symposium is a sanctioned Western Association of Fish and Wildlife Agencies workshop and is being hosted by Colorado Parks and Wildlife and the Colorado Chapter of The Wildlife Society. Sessions topics that are being considered include implementation of new wild sheep risk assessment and domestic grazing analysis tools, evaluating results of management actions to respiratory disease in wild sheep, wild sheep and mountain goat interactions, and mountain goat (or sheep) and human conflicts.

Recent Literature Related To Bighorn Sheep

Apanaskevich, D. A. 2013. Reinstatement of *Dermacentor kamshadalus* Neumann (Acari: Ixodidae) as a valid species parasitizing mountain goats and sheep in the United States, Canada, and Russia. Journal of Medical Entomology 50(4):691-700.

Abstract: Reexamination of *Dermacentor albipictus* (Packard, 1869) holdings stored in the United States National Tick Collection revealed several collections of a morphologically distinct *Dermacentor* species. Comparison of these specimens with other *Dermacentor* taxa showed that they are identical to an old taxon originally described as *Dermacentor variegatus kamshadalus* Neumann, 1908. For more than a century, this taxon was known only from the male holotype specimen collected in Russia, and the name was considered a junior synonym of *D. albipictus. D. kamshadalus* is reinstated here to a full species rank, and its male is redescribed and its female and nymph are described for the first time. Adults of *D. kamshadalus* can be distinguished from those of *D. albipictus* by a short spur on trochanters I, shorter spurs on coxae I, shorter dorsal cornua, more numerous perforations on spiracular plates, less numerous and shorter setae on idiosoma, especially around spiracular plates, and considerably paler coloration of the conscutum and scutum. The nymph of *D. kamshadalus* can be differentiated from that of *D. albipictus* by shorter spurs on coxae I and the numerous perforations on the spiracular plates. Adults and nymphs of *D. kamshadalus* are recorded from the United States, Canada, and Russia, where they have been collected from mountain goats, *Oreamnos americanus* (de Blainville), bighorn sheep, *Ovis canadensis* Shaw, and sheep, *Ovis* sp. of which the species was not stated.

Davis, M. J., S. Thokala, X. Xing, N. T. Hobbs, M. W. Miller, R. Han, and S. Mishra. 2013. Testing the functionality and contact error of a GPS-based wildlife tracking network. Wildlife Society Bulletin. DOI:10.1002/wsb.303

Abstract: Telemetry is a fundamentally important tool for studying animal movements. Traditional telemetry systems have provided time-specific information on locations of individuals; however, recent developments in instruments allow for the tracking of networks of interactions among individuals. Currently, these devices rely on very high frequency (VHF) radio technology, and cannot precisely gauge where interactions occurred without on-site triangulation. Furthermore, although commercially available devices can log successful communication attempts between collars as little as 1 m apart, researchers cannot accurately determine distances within the pre-set detection (contact) threshold of these units. Data loss from proximity-logging devices, and even traditional telemetry devices that are lost or damaged in the field, poses another obstacle to monitoring wildlife social networks. We have

developed a prototype proximity-logging Global Positioning System (GPS) collar that offers greater spatial resolution of social interactions, and reduces probability of data loss. In this study, we used captive bighorn sheep (*Ovis canadensis*) to test the GPS capabilities, contact rates, and contact distance error of our prototype collars. The GPS fix success rate of our collars was >97.93% (n = 95,041; 95% CI = 97.84–98.02%). The collars were communicating with each other about 98% (n = 22,253; 95% CI = 98.50–98.81%) of the time and reciprocal communication occurred 9% of the time. Contact distance error was 9.5 m, which is what would be expected taking into account a baseline GPS spatial error of ±5 m in open environments. The high GPS fix success, low GPS error, and ability to log accurate social interactions with low contact distance error by our prototype collars suggest that the implementation of GPS with proximity-logging technology has the potential to improve currently available social network data.

Gilad, O., X. B. Wu., and F. Armstrong. 2013. Assessing the feasibility for reintroducing desert bighorn sheep to Guadalupe Mountains National Park: habitat, migration corridors and challenges. Applied Geography 41:96-104.

Abstract: Desert bighorn sheep were once part of the Guadalupe Mountains ecosystem but were extirpated in the 1930s due to disease transmittance from domestic sheep and goats, habitat loss, and unregulated hunting. The Guadalupe Mountains (Texas) are now managed by the National Parks Service which wishes to restore native species to their historical range. A habitat suitability study is an important step in restoring desert bighorn sheep to the mountains since restoration efforts are labor intensive and costly. This study uses Geographic Information System (GIS) modeling to identify suitable areas within the park for bighorn sheep and evaluate possible migration corridors between the park and a nearby mountain range (Sierra Diablo) that currently supports more than 400 bighorn sheep. Landscape analysis was conducted to compare the spatial attributes of the habitat areas in the Guadalupe Mountains to those in the Sierra Diablo Mountain Range and assess habitat quality. Our results found 79.95 km^2 of suitable habitat for desert bighorn sheep in Guadalupe Mountains National Park which exceeds the established size to support a minimum viable population size of bighorn sheep (100–125 individuals). Landscape analysis indicated a larger area of optimal habitat at the park with larger mean patch size, lower edge density, and shorter mean nearest neighbor distance than in the Sierra Diablo mountain range. The Sierra Diablo was found to have a larger area of suitable habitat which may indicate that the park may be able to support a smaller population if water development mirrors that of the Sierra Diablo. Several migration corridors were identified between the park and areas with a viable population of bighorn sheep and this connectivity is important for migration and gene flow. Considerations should be given to water development, non-native, competitor species (Barbary sheep) and predators (mountain lions).

Hedrick, P. W. 2013. Conservation genetics and the persistence and translocation of small populations: bighorn sheep populations as examples. Animal Conservation. DOI: 10:1111/acv.12064

Abstract: Understanding and evaluating the factors that influence the persistence of small populations and establishment of new populations are basic goals of conservation biology. Genetic effects due to genetic drift and inbreeding can have important impacts on the success of new populations. Many bighorn sheep populations in western North America have had low numbers and many have gone extinct. Here, the possible effects of genetic drift and inbreeding are evaluated in three populations of desert bighorn sheep initiated in the 1970s from translocations. One of these has no molecular genetic data but has substantial demographic data (Aravaipa Canyon), one has both extensive demographic

data and some molecular genetic data (Red Rock), and one has limited demographic data and some molecular genetic data (Tiburon Island). Overall, either from theoretical pedigree analysis and population genetic estimates from demographic history (Aravaipa, Tiburon) or from molecular data (Red Rock, Tiburon), it appears that the levels of genetic drift and inbreeding are substantial in all of these populations. This impact was larger when higher variance in male reproductive success was assumed. In other words, it appears that genetic factors are and will be important in the establishment and persistence of these populations. These examples in long-term monitored bighorn sheep populations are relevant to many endangered species in similar situations where demographic data are available but there is little or no historical molecular genetic data.

Martin, A. M., H. Presseault-Gauvin, M. Festa-Bianchet, and F. Pelletier. 2013. Male mating competitiveness and age-dependent relationship between testosterone and social rank in bighorn sheep. Behavioral Ecology and Sociobiology 67(6):919-928.

Abstract: In males, the acquisition and development of behavioral and morphological secondary sexual traits typically depends on testosterone and correlates with mating success. Testosterone level could affect competition for mates and thus be a target of sexual selection. We sought to relate testosterone levels to male mating competitiveness, by teasing apart the relationships between testosterone, behavior, and growth before the mating period. We monitored 24 adult bighorn rams (*Ovis canadensis*) at Ram Mountain, Alberta, from 2008 to 2011. Using linear mixed models, we tested the relationships between testosterone metabolites in feces, social rank, and both growth and size of two sexually selected traits: horns and body mass. The correlation between testosterone and social rank varied with age. Testosterone and rank were weakly and negatively correlated for young rams, positively correlated for prime-aged rams, and negatively correlated for older rams. Although testosterone had an increasingly positive effect on total horn length until 8 years of age, we could not detect any effects on annual growth rate of horns or body mass. Testosterone may be related to male's ability to compete for mates through its relationship with behaviors determining social rank, rather than by influencing the development of morphological traits. Differences in testosterone levels among competitors may be a proximate cause of variance in fitness.

Miller, M. W., B. M. Hause, H. J. Killion, K. A. Fox, W. H. Edwards, and L. L. Wolfe. 2013. Phylogenetic and epidemiologic relationships among Pasteurellaceae from Colorado bighorn sheep herds. Journal of Wildlife Diseases 49(3):653-660.

Abstract: We used 16S rRNA sequencing and leukotoxin gene (lktA) screening via PCR assay to clarify phylogenetic and epidemiologic relationships among Pasteurellaceae isolated from bighorn sheep (*Ovis canadensis*). Only six of 21 bighorn isolates identified as "*Mannheimia haemolytica*" in original laboratory reports appeared to be isolates of *M. haemolytica* sensu stricto based on 16S rRNA sequence comparisons; the remainder grouped with *M. glucosida* (n=8) or *M. ruminalis* (n=7). Similarly, 16S rRNA sequence comparisons grouped only 16 of 25 trehalose-fermenting bighorn isolates with reference strains of *Bibersteinia trehalosi*; nine other trehalose-fermenting bighorn isolates formed a clade divergent from *B. trehalosi* reference strains and may belong to another species. Of the 16 bighorn isolates identified as *B. trehalosi* by 16S rRNA sequences, only nine carried detectable lktA and thus seemed likely pathogens; none of the *Bibersteinia* clade isolates yielded detectable lktA despite reportedly showing Î² hemolysis in culture. Our findings suggest that traditional metabolism-based methods for identifying Pasteurellaceae isolates lack sufficient accuracy and resolution for reliably discerning bacterial causes of respiratory disease in bighorn sheep. Consequently, these traditional methods should minimally be augmented by molecular techniques to

improve epidemiologic relevance. Streamlined surveillance approaches focused primarily on detecting pathogenic Pasteurellaceae (e.g., *M. haemolytica* sensu stricto and lktA-positive *B. trehalosi*) and other select pathogens may be most informative for investigating and managing bighorn respiratory disease.

Morawski, A. R., C. M. Carlson, H. Chang, and C. J. Johnson. 2013. In vitro prion protein conversion suggests risk of bighorn sheep (*Ovis canadensis*) to transmissible spongiform encephalopathies. BMC Veterinary Research 9(1):1-12.

Abstract: Background: Transmissible spongiform encephalopathies (TSEs) affect both domestic sheep (scrapie) and captive and free-ranging cervids (chronic wasting disease; CWD). The geographical range of bighorn sheep (*Ovis canadensis*; BHS) overlaps with states or provinces that have contained scrapie-positive sheep or goats and areas with present epizootics of CWD in cervids. No TSEs have been documented in BHS, but the susceptibility of this species to TSEs remains unknown. Results: We acquired a library of BHS tissues and found no evidence of preexisting TSEs in these animals. The prion protein gene (Prnp) in all BHS in our library was identical to scrapie-susceptible domestic sheep (A136R154Q171 genotype). Using an in vitro prion protein conversion assay, which has been previously used to assess TSE species barriers and, in our study appears to recollect known species barriers in mice, we assessed the potential transmissibility of TSEs to BHS. As expected based upon Prnp genotype, we observed BHS prion protein conversion by classical scrapie agent and evidence for a species barrier between transmissible mink encephalopathy (TME) and BHS. Interestingly, our data suggest that the species barrier of BHS to white-tailed deer or wapiti CWD agents is likely low. We also used protein misfolding cyclic amplification to confirm that CWD, but not TME, can template prion protein misfolding in A136R154Q171 genotype sheep. Conclusions: Our results indicate the in vitro conversion assay used in our study does mimic the species barrier of mice to the TSE agents that we tested. Based on Prnp genotype and results from conversion assays, BHS are likely to be susceptible to infection by classical scrapie. Despite mismatches in amino acids thought to modulate prion protein conversion, our data indicate that A136R154Q171 genotype sheep prion protein is misfolded by CWD agent, suggesting that these animals could be susceptible to CWD. Further investigation of TSE transmissibility to BHS, including animal studies, is warranted. The lack of reported TSEs in BHS may be attributable to other host factors or a lack of TSE surveillance in this species.

Olson, Z. H., D.G. Whitaker, and O. E. Rhodes Jr. 2013. Translocation History and Genetic Diversity in Reintroduced Bighorn Sheep. The Journal of Wildlife Management 77(8):1553–1563.

Abstract: Because genetic diversity provides the substance for adaptation and evolution and its decline signifies the potential for deleterious effects on demography, biologists must understand how management action can facilitate or hinder the retention of genetic diversity at the level of the population being managed. We assessed genetic diversity in 8 reintroduced populations of bighorn sheep using 16 microsatellite markers and a 515-base-pair segment of the mitochondrial control region. Populations were categorized by their translocation histories: first-order populations were those established directly from large source populations, second-order populations were established using individuals from first-order populations, and populations with mixed translocation histories were those established or supplemented with sheep from more than 1 sample on a source population. Nuclear and mitochondrial datasets yielded complementary signals of declining genetic diversity (mixed>first order>second order) that differed predictably in magnitude. Our suite of microsatellites revealed that populations with mixed translocation histories had greater allelic richness (AR) and expected

heterozygosity (HE) than second-order populations, but we found no statistical differences between mixed:first order or first:second order population pairs. Mitochondrial diversity, however, was limited to populations with mixed translocation histories. Similarly, we detected significant differentiation (FST) among most populations using data from microsatellites, but found major differentiation in mitochondrial diversity. All first-order and second-order populations shared a single haplotype, whereas mixed populations contained 6 haplotypes. Finally, estimates of effective population size (Ne) derived from our microsatellite data were uniformly low (range 9–27), indicating that the maintenance of genetic diversity in the reintroduced populations of bighorn sheep in our study likely will require management action; possibly including future translocations and improvements in natural connectivity among populations.

Have you ever wondered about how people capture bighorn sheep? This book will show the details of what people do to capture them from the point of view of a bighorn sheep. (Saige's teacher actually helped her print and bind this into an actual book – I have the only copy – I treasure it. *Amber*)

I dedicate this book to my family,
especially to my mom.

Imagine you were a bighorn sheep, and you were grazing on a hill.

All of a sudden a net goes over you and you are pulled into the sky by a helicopter.

1

Soon you are lowered and picked up on a stretcher! You are put on a table, and you get a hole in your ear with a tag. A radio collar goes around your neck and you get some shots.

2

After you get your tags, you are put in a trailer. After a while, another bighorn sheep comes in. An hour later, five more have come in.

3

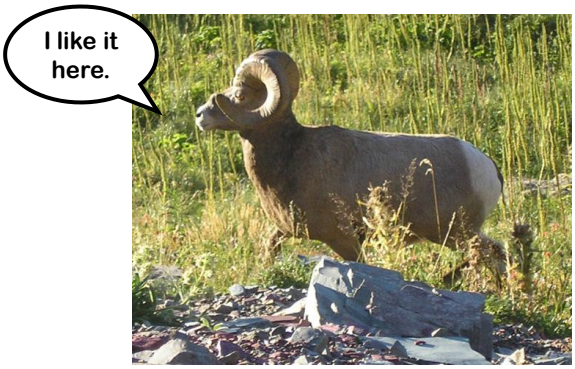
After five days there are forty bighorn sheep! You are very hungry. Finally they bring grass to you.

4

After a while, the truck starts to move, you are very scared. An hour later the truck stops. Thirty minutes later the door opens and you are finally free!

5

But the mountain where you now live looks different. You wander around and decide you like the new mountain. You have a great time there with your new friends. You finally decide you never want to go back to your other home. You also don't want to see humans again!



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Bibliography

*All the pictures in this book are from the following websites.

- Some photos by Saige Munig, Morgan Munig (my sister), and Emily Alexander (my grandmother).
- http://photography.nationalgeographic.com/staticfiles/NGS/Shared/StaticFiles/Photography/Images/POD/b/bighorn-sheep-264233-sw.jpg
- www.stevegarufi.com/bighorn-sheep-pictures.htm
- www.wildlife.state.nm.us/conservation/bighorn...
- http://www.wildlife.state.nm.us/conservation/bighorn/documents/images/Sheepintrailer2.jpg
- http://www.azgfd.gov/artman/uploads/100bhs-ram_jump_release-web.jpg
- http://www.rvforsaleguide.com/images/big-horn-sheep-picture.jpg

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About the author

Saige Munig is a 9 year old girl. She wrote this book because she went with her mom on a bighorn sheep capture. She wrote this book from a point of view of a bighorn sheep. She has written other books that she wants to publish soon.

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