

Desert Bighorn Council
56th Meeting
Alpine, TX
7-8 April 2021

Past, Present and Future Threats: disease, exotic ungulates, and a change in mindset



SANCTIONED BY THE WESTERN ASSOCIATION OF FISH AND WILDLIFE AGENCIES

HOSTED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT



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WILD SHEEP FOUNDATION AND TEXAS BIGHORN SOCIETY



**DESERT BIGHORN COUNCIL
2021**

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Historian: **Bruce Garlinger**
Awards: **Vern Bleich**



PROGRAM

Wednesday, 7 April 2021 (Note: all times are CST)

- All Day: Online Registration open
- 09:00 Welcome and opening remarks, *Froylán Hernández, Desert Bighorn Council Co-Chair*
- 09:05 Keynote speech, *Carter Smith, Texas Parks and Wildlife Department Executive Director*
- 09:25 Fallen TPWD Colleagues' Memorial (video)
- 09:30 Awards, *Vern Bleich, Desert Bighorn Council Awards Committee Chair*

FROYLÁN HERÁNDEZ, Texas Parks and Wildlife Department, Moderator

- 10:00 **A DBSC 2019 UPDATE: ARIZONA AND NEVADA MAINTAINING DESERT BIGHORN SHEEP HABITAT CONNECTIVITY AND PREVENT SHEEP-VEHICLE COLLISIONS: INTERSTATE-11'S BOULDER CITY BYPASS**
Chad Loberger
- 10:20 **A PROPOSAL FOR THE CONSERVATION OF THE BIGHORN SHEEP (*OVIS CANADENSIS*) IN THE INTERNATIONAL BORDER OF BAJA CALIFORNIA-CALIFORNIA**
Daniel Gregorio Maldonado Aguilar
- 10:40 **ENVIRONMENTAL-DRIVEN CHANGES IN DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*) MOVEMENT PATTERNS**
Grete Wilson-Henjum
- 11:00 **THE EFFECTS OF WILDLAND RECREATIONAL DISTURBANCE ON DESERT BIGHORN SHEEP IN WESTERN COLORADO**
Ashley D. Evans
- 11:20-11:30 **BREAK** (10 minutes)

MIKE JANIS, Texas Parks and Wildlife Department, Moderator

- 11:30 **QUANTIFYING BIRTH SITE SELECTION FOR BIGHORN SHEEP USING UNMANNED AERIAL VEHICLES**
Marcus E. Blum
- 11:50 **DESERT BIGHORN SHEEP POPULATION DYNAMICS IN THE SAN ANDRES MOUNTAINS OF NEW MEXICO**
Miranda Strasburg
- 12:10 **RESOURCE SELECTION OF DESERT BIGHORN SHEEP IN THE SAN ANDRES MOUNTAINS OF NEW MEXICO**
Miranda Strasburg
- 12:30-13:30 **LUNCH**

KRYSTA DEMERE, Texas Parks and Wildlife Department, Moderator

- 13:30 **GENETIC EVIDENCE OF HYBRIDIZATION BETWEEN DESERT AND ROCKY MOUNTAIN BIGHORN SHEEP IN NEVADA**
Joshua P. Jahner
- 13:50 **ASSESSMENT OF GENETIC VARIATION IN AOUDAD: IMPLICATIONS FOR BIODIVERSITY AND SUSCEPTIBILITY TO SCRAPIE**
Emily A. Wright
- 14:10 **UNDERSTANDING DISEASE DYNAMICS FOLLOWING *MYCOPLASMA OVIPNEUMONIAE* INTRODUCTION IN A FOCAL DESERT BIGHORN HERD**
Brianna Johnson
- 14:30 **EVALUATING AOUDAD AS A PNEUMONIA RISK TO BIGHORN SHEEP**
Logan Thomas
- 14:50-15:00 **BREAK** (10 minutes)

CODY MCENTIRE, Texas Parks and Wildlife Department, Moderator

- 15:00 **CHARACTERIZATION OF DESERT BIGHORN SHEEP MICROBIOMES IN TEXAS**
Rachael C. Wiedmeier
- 15:20 **INFLUENCE OF THE DENSITY OF MULE DEER IN THE PREDATION BY PUMA IN A REINTRODUCED POPULATION OF BIGHORN SHEEP AT COAHUILA, MEXICO**
Hugo Sotelo-Gallardo
- 15:40 **DO WATER DEVELOPMENTS INFLUENCE THE DISTRIBUTION OF PUMA KILLS?**
Hunter Prude
- 16:00 **EVALUATING WATER USE OF DESERT BIGHORN SHEEP AND AOUDAD IN THE SIERRA VIEJA MOUNTAINS, TEXAS**
Jose L. Etchart
- 16:20-16:30 **BREAK** (10 minutes)

TRAVIS SMITH, Texas Parks and Wildlife Department, Moderator

- 16:30 **HABITAT SELECTION OF AOUDAD, DESERT BIGHORN SHEEP, AND MULE DEER IN A CO-OCCUPIED LANDSCAPE**
Daniel C. Wilcox
- 16:50 **POTENTIAL OVERLAP OF AOUDAD, DESERT BIGHORN SHEEP, AND MULE DEER IN THE TRANS-PECOS REGION, TEXAS**
Olivia Gray

- 17:10 **MODELLING AOUDAD POPULATION GROWTH IN TEXAS**
Daniel C. Wilcox
- 17:30 **AOUDAD: AN INCREASING CHALLENGE IN DESERT BIGHORN SHEEP RESTORATION**
Froylán Hernández

Thursday, 8 April 2021 (Note: all times are CST)

09:00 **Morning welcome** (*Froylán Hernández*)

State Status Reports

MARK GARRETT, Texas Parks and Wildlife Department, Moderator

- 09:05 Texas (*Froylán Hernández*)
09:25 New Mexico (*Eric Rominger*)
09:45 Utah (*Riley Peck*)
10:05 Colorado (*Brad Weinmeister*)

10:25-10:35 **BREAK** (5 min)

FROYÁN HERNÁNDEZ, Texas Parks and Wildlife Department, Moderator

- 10:30 Arizona (*Rana Tucker*)
10:50 California (*Regina Vu*)
11:10 Mexico (*Ivonne Cassaigne*)
11:30 Nevada (*Mike Cox*)
- 11:50 Business Meeting
- 13:00 **Adjourn**

ABSTRACTS OF PRESENTED PAPERS (Alphabetically by First Author)

QUANTIFYING BIRTH SITE SELECTION FOR BIGHORN SHEEP USING UNMANNED AERIAL VEHICLES

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KELLEY M. STEWART, University of Nevada, Reno, 1664 N Virginia St, MS 186, Reno, NV, USA, 89557

Abstract: Desert bighorn sheep (*Ovis canadensis nelsoni*) have evolved to select habitat types in precipitous terrain during certain times of year. These behavioral adaptations allow individuals to increase their survival, and the likelihood of recruiting young into the population by staying in rugged terrain to evade predators. While terrain ruggedness and slope are commonly associated with bighorn lambing habitat, little is known about the effects of aerial and ground cover on selection of parturition sites or lamb rearing habitat. Recent studies demonstrated the importance of ground cover in the uphill and downhill directions in selection of birth-sites by bighorn sheep, however, measurements collected at these sites do not fully represent sightability or shrub-cover within the immediate area. We captured female bighorn sheep from January 2016 through June 2018 in west central Nevada. We also captured neonatal young and determined location of birth sites as well as information on survival. Following lambing season, we plotted all birth site locations from captured lambs and conducted unmanned aerial vehicle flights using a Mavic Pro. Imagery obtained from the transects were used to generate point clouds and develop viewsheds from birth sites and random locations. These viewsheds were used to quantify the relationship between aerial and ground cover with selection of birth sites. These methods offer a new, more accurate representation of vegetative cover in bighorn sheep habitat that inform our understanding of landscape features that contribute to selection of birthing areas for bighorn sheep.

Oral Presentation Presenter: Marcus Blum

EVALUTING WATER USE OF DESERT BIGHORN SHEEP AND AOUDAD IN THE SIERRA VIEJA MOUNTAINS, TEXAS

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Abstract: The distribution and size of aoudad (*Ammotragus lervia*) populations are increasing in west Texas and could impede restoration efforts for desert bighorn sheep (*Ovis canadensis* ssp.). In January 2014, desert bighorn sheep were transplanted from the Elephant Mountain Wildlife Management Area ($n = 61$) to the Sierra Vieja Mountains. Using camera traps, we monitored the use of wildlife water developments by desert bighorn sheep and aoudad between March 2014 and February 2017. A total of 27 wildlife species were identified utilizing water developments. Desert bighorn sheep accounted for 0.84% ($n = 301$ photos) of independent events, ranking tenth amongst 28 species documented utilizing the water sources. Peak use for desert bighorn occurred in May and June, and the peak time of day for use was at 1300-1400 hrs ($n = 27$ photos). Aoudad accounted for 16.09% (3,064 photos) of independent visitation events at water sources. Aoudad ranked second amongst the 28 species that we documented utilizing the water sources, with peak use occurring in October ($n = 47$ photos), September ($n = 220$ photos), and April ($n = 278$ photos) of 2014, 2015, and 2016, respectively. Peak water utilization by aoudad occurred at 1900-2000 hrs ($n = 389$ photos). Caution is advised when using man-made water sources for desert bighorn sheep restoration in areas also inhabited by aoudad. Construction of water developments could increase the likelihood of desert bighorn sheep and aoudad coming into proximity, increasing the probabilities of disease transmission and possible resource competition.

Oral Presentation Presenter: Jose L. Etchart

THE EFFECTS OF WILDLAND RECREATIONAL DISTURBANCE ON DESERT BIGHORN SHEEP IN WESTERN COLORADO

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Abstract: In recent decades, outdoor recreation in the United States has increased dramatically, with continued increases in both the number of outdoor recreation participants and the amount of time spent recreating projected in coming years. Recreational disturbance has been shown to

impact ungulate populations by altering activity budgets, increasing physiological stress, reducing optimal habitat, and causing avoidance of heavily trafficked areas. Desert bighorn sheep (*Ovis canadensis nelsoni*) are susceptible to the effects of long-term disturbance due to their life history characteristics including low recruitment rates, naturally fragmented and isolated distributions, and habitat specialization. Our goal is to determine the impacts of human recreation in the Dominguez-Escalante National Conservation Area on bighorn sheep. We will conduct behavioral observations to calculate activity budgets and foraging efficiency, and fecal glucocorticoid metabolites will be used to quantify physiological stress. We will use the GPS locations of 30 collared adult females to determine movement rates, space use, and habitat selection at varying spatial and temporal scales. The impacts of recreation at the population level will be measured using pregnancy rates, recruitment rates, and adult ewe survival. The results of this study can be used throughout the American Southwest to inform management decisions regarding the type, intensity, and seasonality of recreation in desert bighorn habitat to mitigate negative effects on this species. (Results will not be presented; field work began February 2021).

Oral Presentation Presenter: Ashley Evans

POTENTIAL OVERLAP OF AOUDAD, DESERT BIGHORN SHEEP, AND MULE DEER IN THE TRANS-PECOS REGION, TEXAS

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Abstract: Since the introduction of aoudad (*Ammotragus lervia*) into Texas, concern has grown about the ecological ramifications of the species across its recipient range. Current knowledge indicates a potential dietary overlap between aoudad and native ungulates such as desert bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*). However, little is known about the dietary composition of these species in co-occupied landscapes. Understanding dietary overlap amongst these species can distinguish potential avenues of resource competition and shed light on native ungulate's response to aoudad invasion. This project will investigate the dietary composition of co-existing aoudad, desert bighorn, and mule deer to address concerns of dietary overlap and potential for resource competition. Utilizing satellite collars on individuals of each species, we will obtain Global Positioning System coordinates to locate individuals and obtain fecal samples. Fecal samples will aid in the identification of vegetation consumed by ungulates by observing plant structures within the feces. Sampling will take place monthly over 12 months, with

five fecal samples collected per species each month. Samples of vegetation within the study area will be used to make reference images to identify plant species in fecal samples. I will compare fecal and vegetation samples to determine dietary composition. In addition, I will investigate temporal resource partitioning by examining cycles of resource use and determining whether they are similar or diverge among species. Information gained by this study will aid the management of ungulates by clarifying the nature and impacts of interactions between aoudad and native ungulates.

Oral Presentation Presenter: Olivia Gray

AOUDAD: AN INCREASING CHALLENGE IN DESERT BIGHORN SHEEP RESTORATION

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Abstract: The success TPWD's desert bighorn sheep restoration program is currently experiencing has not come easy. There have always been obstacles and challenges. And one emerging challenge that has been growing within the last several years is the Barbary sheep, or aoudad. Though aoudad populations are struggling in their north African native ranges, aoudad have done well in Texas. It is not uncommon to encounter herds of 50+ animals, and many groups easily surpassing 100. During October 2018 aoudad surveys, many groups of more than 200 animals were observed. These heavy concentrations or high densities can potentially negatively impact the habitat and thereby native ungulate species, including desert bighorn. These impacts may create competition for resources, including "usable space". Furthermore, they could pose a potential disease threat. Recently, TPWD initiated an aoudad disease monitoring and surveillance program to look for pathogens and/or diseases that could pose risks to desert bighorn sheep. Preliminary results are finding a pathogen in the same group of pathogens that leads to bighorn die-offs in some western states. Therefore, to protect the habitat, as well as the native wildlife populations that inhabit the land, aoudad populations need to be drastically reduced. But recognizing the growing popularity of aoudad hunting, this level of reduction will be difficult to achieve. Aoudad hunting continues to be a supplemental source of income for some landowners, which adds to the challenge. Until the detrimental impacts of high aoudad densities are better understood, it will be difficult to make progress.

Oral Presentation Presenter: Froylán Hernández

GENETIC EVIDENCE OF HYBRIDIZATION BETWEEN DESERT AND ROCKY MOUNTAIN BIGHORN SHEEP IN NEVADA

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Abstract: Over the past century, dozens of bighorn sheep populations have been reestablished via translocation, representing one of the most noteworthy conservation success stories in the history of North American wildlife management. In Nevada, translocations reestablished three bighorn sheep subspecies in relatively close proximity, allowing for the possibility of hybridization among genetically differentiated lineages. We generated DNA sequencing data for more than 1,000 California, desert, and Rocky Mountain bighorn sheep across Nevada to ask whether subspecies are genetically differentiated and if hybridization has occurred following the past 50 years of translocations. We find pronounced genetic differentiation among all subspecies and identify putative hybrids between desert and Rocky Mountain bighorn sheep. Surprisingly, one desert-Rocky hybrid herd is geographically distant from other desert bighorn herds, suggesting long individual movements across the landscape can result in meaningful genetic impacts that can complicate management decisions.

Oral Presentation Presenter: Joshua P. Jahner

A DBSC 2019 UPDATE: ARIZONA AND NEVADA MAINTAINING DESERT BIGHORN SHEEP HABITAT CONNECTIVITY AND PREVENT SHEEP-VEHICLE COLLISIONS: INTERSTATE-11'S BOULDER CITY BYPASS

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Abstract: A new section of Interstate-11, located south of Boulder City, Nevada near the Hoover Dam, opened August 9, 2018. This road passes through prime habitat for a disease recovering herd of desert bighorn sheep (*Ovis canadensis nelsoni*). Prior to completion, the Arizona Game and Fish Department (AGFD) worked collaboratively with the Nevada Department of Transportation (NDOT), Regional Transportation Commission of Southern Nevada (RTC), National Park Service (NPS), Nevada Department of Wildlife (NDOW) and others to mitigate habitat fragmentation and prevent desert bighorn sheep-vehicle collisions. The completed roadway includes 10 miles of

wildlife exclusionary fencing, 24 escape ramps, two doublewide crossing guards, two wildlife only concrete box culverts, and five desert bighorn sheep crossing structures: four large bridges and one overpass. Throughout the project (pre, during, and post-construction), AGFD has had GPS collars on sheep to gather movement data. In addition, since construction completion, AGFD has installed 40 Reconyx cameras to monitor the southern fence terminus, one doublewide cattle guard, two wildlife culverts, and all passage structures. Pre, during, and post-construction GPS movement data suggest sheep are able to access resources on either side of the completed roadway. As of January 2021, Reconyx cameras have documented 10,131 sheep, including 5,360 ewes, 2,779 rams, and 1,992 juveniles using the structures to safely cross under or over I-11. The number of documented juveniles, which were observed throughout the year, suggests that structure use is being passed to the next generation and the herd's population may be increasing. No sheep-vehicle collisions have been documented.

Oral Presentation Presenter: Chad Loberger

A PROPOSAL FOR THE CONSERVATION OF THE BIGHORN SHEEP (*OVIS CANADENSIS*) IN THE INTERNATIONAL BORDER OF BAJA CALIFORNIA-CALIFORNIA

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Abstract: The bighorn sheep (*Ovis canadensis*) in the mountainous habitat of La Rumorosa- Jacumba between the states of Baja California, Mexico and California, United States, has seen its home range reduced in recent years by the development of human infrastructure. The highways, the wind farms and aqueducts are some examples that cause habitat fragmentation in this area. While the U.S. Bureau of Land Management has been managing the Jacumba Wilderness, La Rumorosa has not seen a specific program of natural resource management. For the development of a Conservation Area in this zone it is important to have an integral vision of the local residents and which activities they develop in the area without leaving aside the needs of species like the bighorn sheep that needs resources at both sides of the border. The latest studies of the bighorn sheep in La Rumorosa by the UABC, San Diego Zoo, among other institutes provide the basis for the creation of an integral conservation program in the area. A conservation area can help raise

awareness of the needs of the bighorn sheep and other species, while providing a protection system to mitigate the impact of human infrastructure in the area and reduce the fragmentation of their habitat. Certain activities can also be carried out to maintain the program and the local populations, such as ecotourism.

Oral Presentation Presenter: Daniel Gregorio Maldonado Aguilar

DO WATER DEVELOPMENTS INFLUENCE THE DISTRIBUTION OF PUMA KILLS?

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Abstract: Man-made water sources have been developed for wildlife in arid regions since the mid-1900s. Although wildlife is generally considered to benefit from water development, there is very little known about how the provisioning of water influences predator-prey dynamics. It is possible that the increased abundance of prey and or the habitat features surrounding water developments increase predation risk by puma (*Puma concolor*). To examine this, puma kill data was compiled from seven study areas in the Chihuahuan and Sonoran deserts to determine the influence of water developments on puma habitat use and kill site locations. The proximities of ungulate kill sites to man-made water sources were compared with areas available within puma home ranges. Mixed effects logistic regression was used to determine if the probability of a site being a kill location was related to the proximity to water sources and or other habitat characteristics. While pumas did not appear to be exploiting the predictable prey visitation to man-made water sources, they were capitalizing on the restricted distribution of prey within 5 km of water sources. At the home range scale, puma used areas proximate to water sources that likely have increased prey abundance and higher probabilities of encountering prey for hunting. Within the home range, pumas select fine scale habitat features, such as woody cover, that enhance their ability to stalk, ambush, and effectively kill prey.

Oral Presentation Presenter: Hunter Prude

INFLUENCE OF THE DENSITY OF MULE DEER IN THE PREDATION BY PUMA IN A REINTRODUCED POPULATION OF BIGHORN SHEEP AT COAHUILA, MEXICO.

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Abstract: Recent studies have suggested that puma predation has important effects on population dynamics in reintroduced groups and native populations of bighorn sheep in areas sympatric with mule deer. The study was based on 69 bighorn sheep (28 M, 41 F) captured using a hand-held net gun fired from a helicopter; 43 sheep (3 M, 40 F) were fitted with radio telemetry collars and released in 3 periods between the years 2009, 2012 and 2014. We investigated puma predation on bighorn sheep through micromorts and the estimation of the density of mule deer through physical count of and relative puma abundance index through count tracks and signs in the years of 2009 to 2016. We analyzed the variables using a multiple regression model, finding an association between the variables and the pressure it exerts in the bighorn sheep population. Additionally, for the 2014 release, we evaluated and compared the puma predation rate in 12 bighorn sheep (2 M, 10 F) and 10 adult females of mule deer using a non-parametric Wilcoxon 95% I.C. The impact of predation in both populations of herbivores is evaluated through the estimation of densities of bighorn sheep and mule deer. The bighorn sheep being the prey most selected and the one most affected as the population with the lowest density.

Oral Presentation Presenter: Hugo Sotelo-Gallardo

DESERT BIGHORN SHEEP POPULATION DYNAMICS IN THE SAN ANDRES MOUNTAINS OF NEW MEXICO

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Abstract: San Andres National Wildlife Refuge provides essential habitat for desert bighorn sheep (*Ovis canadensis*), but even after its establishment, bighorn sheep population numbers have fluctuated in the region due to extreme drought and disease outbreaks. Using population estimates from yearly aerial surveys and vital rate estimates from similar bighorn sheep populations, we modeled population dynamics of desert bighorn sheep in the San Andres Mountains. We constructed a stage-based projection matrix for female bighorn sheep using three life-history stages — lamb, yearling, and adult— as these are the stages estimated during monitoring surveys for this population. We modeled population growth under two reproduction scenarios, low and high, to understand how recruitment influences population stability. Under the low reproduction scenario, we observed dramatic decreases in ewe abundance over time with this effect being mitigated under the high reproduction scenario. Likewise, under the high reproduction scenario, the finite rate of increase approaches 1 indicating a nearly stable population. Elasticity and sensitivities analyses revealed that ewe survival has the greatest impact on population growth. Indeed, if ewe survival is increased by 5%, the population is expected to grow. Given that ewes play the largest role in

population growth and stability, future monitoring efforts in this region should focus on ewe survival.

Oral Presentation Presenter: Miranda Strasburg

RESOURCE SELECTION OF DESERT BIGHORN SHEEP IN THE SAN ANDRES MOUNTAINS OF NEW MEXICO

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Abstract: The San Andres Mountains in south-central New Mexico represent one of the largest, contiguous, relatively undisturbed Chihuahuan Desert landmasses in the United States, and as such, serve as crucial habitat for desert bighorn sheep (*Ovis canadensis*). However, their vast range creates a challenge to managers attempting to monitor bighorn sheep abundance in the region. To help inform aerial survey routes, in 2017-2018, GPS collars were placed on 13 bighorn sheep (10 ewes and 3 rams) to identify their daily locations midday. We used these GPS locations 1) to determine how habitat use varies between ewes and rams, and across seasons; and 2) to develop a resource selection function model to determine areas preferentially used by bighorn sheep within the region. Overall, these bighorn sheep tended to use similar habitat regardless of sex, though ewes use steeper habitat closer to grasslands than rams. These bighorn sheep also display some shifts in habitat use depending on season. During rut, these bighorn sheep move away from escape terrain to areas that are less rugged and less steep, which suggests that breeding influences how these bighorn sheep use their habitat. The results of our resource selection function model suggest that topography generally plays a greater role in habitat selection than resource availability, though further analysis and monitoring is needed to verify if this is the case. Although these locations only represent a small snapshot in time, they provide some useful insights for how these bighorn sheep use their habitat.

Oral Presentation Presenter: Miranda Strasburg

EVALUATING AOUDAD AS A PNEUMONIA RISK TO BIGHORN SHEEP

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Abstract: Aoudad (*Ammotragus lervia*) and Desert Bighorn sheep (*Ovis canadensis nelsoni*) interact directly and indirectly through shared diet and habitat use patterns, which likely limits Desert Bighorn sheep populations. These known interactions warranted investigation of whether Aoudad can harbor, shed, and transmit *Mycoplasma ovipneumoniae* (*M. ovi*) and various *Pasteurellacea* species, which are major etiological agents in Bighorn sheep pneumonia epizootics. We conducted a captive study with wild-caught Aoudad and inoculated them with isolated *M. ovi* from cultured nasal swabs (*M. ovi* group, n=6), nasal washes from *M. ovi*-positive domestic sheep (*Ovis aries*) (wash group, n=5), or were not inoculated to serve as fenceline

controls (n=3). Throughout the study, 83-100% of the *M. ovi* group and 50-100% of the wash group shed *M. ovi* in nasal and/or tonsil swabs collected at frequent intervals after inoculation. We continued to detect *M. ovi* even after seroconversion with no significant differences in shedding rates between experimental groups. *Pasteurella* detection varied from 0-100% in both experimental groups and was significantly higher in the *M. ovi* group at one timepoint and significantly higher in the wash group at a later timepoint. *M. ovi* and *M. ovi*-specific antibodies were detected in two control animals, suggesting that shedding by experimental animals was at transmissible levels. Clinically, four *M. ovi* group, three wash group, and one control animal displayed gross and/or histological signs of *M. ovi*-induced pneumonia upon necropsy. Taken together, our results suggest Aoudad pose a disease risk to Bighorn sheep through their ability to transmit pneumonic pathogens.

Oral Presentation Presenter: Logan Thomas

CHARACTERIZATION OF DESERT BIGHORN SHEEP MICROBIOMES IN TEXAS

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Abstract: Bighorn sheep (*Ovis canadensis*) inhabit the western United States, northwestern Mexico, and some of southwestern British Columbia and Alberta. Many herds have encountered die-off events thought to be caused by a group of bacterial species referred to as the pneumonia complex, which are transmissible to bighorn sheep from domestic sheep (*Ovis aries*) and goats (*Capra hircus*). Transmission may also occur from aoudad (*Ammotragus lervia*), a non-native invasive species in Texas that are sympatric with desert bighorn sheep (*O. c. nelsoni*) in the Trans Pecos Ecoregion. Microbiome dispersal occurs among other species through social behavior and shared resource and may be a mechanism by which pathogens and other diseases are transmitted between aoudad and bighorn sheep. However respiratory microbiomes are unknown for bighorn sheep and aoudad in Texas. Characterizing healthy microbiome composition is important to understanding transmission risks as well as the baseline from which diseased state microbiomes depart. While studies have shown some members of the pneumonia complex are often found in healthy bighorn sheep, it is unknown how their presence influences overall microbial community structure. Here, nasal and throat microbiomes of bighorn sheep and aoudad are being characterized

for populations across Texas to help inform baseline information for disease surveillance and response for bighorn sheep in Texas.

Oral Presentation Presenter: Rachael C. Wiedmeier

HABITAT SELECTION OF Aoudad, Desert Bighorn Sheep, and Mule Deer in a Co-occupied Landscape

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Abstract: Desert bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) have experienced widespread declines in distribution and abundance in the Texas Trans-Pecos. While translocation efforts have been successful in reviving these species, the ongoing expansion of aoudad (*Ammotragus lervia*) populations across the region have raised concern for native species survival. However, little is known regarding the implications of aoudad invasions on recipient ecological communities. We initiated this study to fill gaps in the knowledge of aoudad's role in desert bighorn sheep and mule deer occupied landscapes. Specifically, the objectives of this study are to investigate overlap in habitat use and selection between the three species and how these dynamics change spatiotemporally. We used satellite collars and integrated step selection analyses to examine movement and habitat associations of 39 bighorn sheep, 48 mule deer, and 40 aoudad in the Van Horn Mountains, Texas. Results reveal similarities in habitat associations between the three species across broad spatial and temporal scales. This data suggests aoudad may present competitive pressure to desert bighorn sheep and mule deer in the Texas Trans-Pecos.

Oral Presentation Presenter: Daniel C. Wilcox

MODELLING Aoudad Population Growth in Texas

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Abstract: Aoudad (*Ammotragus lervia*) have experienced rapid population growth since their introduction to Texas in the mid 1900's. The expansion of aoudad into desert bighorn sheep and mule deer occupied territories has stimulated concern regarding potential niche overlap and competition between these three species. If resource competition is present, the aoudad's propensity for rapid population growth suggests a possible competitive advantage across invaded ranges. However, little is known regarding aoudad population dynamics in Texas. Data collected on invasive aoudad populations in Spain suggest the species possesses a suite of reproductive superiorities over desert bighorn sheep and mule deer. The objectives of this study are to: 1.) model aoudad population growth in Texas given the presence of these superior reproductive characteristics, and 2.) compare aoudad population growth scenarios to desert bighorn sheep and mule deer population growth models in Texas. Our results suggest aoudad can possess a reproductive potential far superior to desert bighorn sheep and mule deer. The implications of this study extend into projecting future aoudad population sizes as well as guiding management quotas for potential animal control efforts.

Oral Presentation Presenter: Daniel C. Wilcox

ENVIRONMENTAL-DRIVEN CHANGES IN DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*) MOVEMENT PATTERNS

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Abstract: Bighorn sheep (*Ovis canadensis*) face repeated spillover of the respiratory pathogen *Mycoplasma ovipneumoniae* from domestic livestock. To understand and constrain spillover risk, land managers model bighorn sheep seasonal space use — consisting of core home

range and foray movements — to assess risk of bighorn-to-bighorn or bighorn-to-domestic sheep contacts. The most widely used of these models was built using data from Rocky Mountain bighorn sheep (*O.c. canadensis*) populations in Idaho, Oregon, and Washington. These areas are characterized by consistent seasonal precipitation and subsequent vegetation patterns, which in turn might drive consistent bighorn sheep space use from one year to the next. In contrast, desert bighorn sheep (*O.c. nelsoni*) live in xeric environments characterized by high annual variance in precipitation and vegetation availability. Given this, we hypothesized that desert bighorn sheep movement patterns might exhibit higher annual variation in response to local variance in environmental context. We examined this hypothesis by modeling movement patterns over two years for six desert bighorn herds across southern Nevada. Local precipitation and vegetation availability varied among ranges and annually within herds, allowing us to compare how environmental context drive changes in movement patterns within and across herds. Our findings will help inform the broader suite of models assessing risk of contact with reservoir *M. ovipneumoniae* hosts in regions occupied by desert bighorn sheep.

Oral Presentation Presenter: Grete Wilson-Henjum

ASSESSMENT OF GENETIC VARIATION IN AOUDAD: IMPLICATIONS FOR BIODIVERSITY AND SUSCEPTIBILITY TO SCRAPIE

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Abstract: It appears that aoudad (*Ammotragus lervia*), an African exotic, was transplanted into the Texas landscape multiple times. Two mitochondrial markers (cytochrome-*b*, *Cyrb*; displacement loop, D-loop) and one nuclear gene (prion protein gene exon 3, *PRNP*) were used to assess genetic variation and provide genotypic characterization of susceptibility to prion disease (e.g., scrapie) among populations in Texas, California, and New Mexico. Genetic profiles identified two

disparate populations with genetic divergences of 5.23% and 12.59% for *Cytb* and D-loop, respectively; and provide evidence that the two subspecies in Texas may be *A. l. lervia* and *A. l. sahariensis*. In contrast to observations from other ungulates (e.g., *Odocoileus*, *Ovis*, and *Capra*), there was a lack of variation in *PRNP* in individuals of both putative subspecies, which is similar to that observed in *Axis*, *Capreolus*, and *Dama*. Further, all Texas aoudad are characterized by a *PRNP* genotype of A136, R154, and Q171, the most common genotype among domestic sheep and goats. The *PRNP* genotype displayed by both putative subspecies has been demonstrated to confer moderate susceptibility to scrapie and given the 100% sequence identity to Texas desert bighorn sheep (*Ovis canadensis*), there exists the potential for disease transmission, albeit a low risk of cross-species transmission in natural systems. Given the similar habitat requirements and sympatry of both species in the Trans-Pecos Region of Texas, aoudad may serve as a prion disease vector to bighorn sheep; therefore, it may be necessary to implement surveillance of scrapie in Chronic Wasting Disease zones in the Trans-Pecos Region.

Oral Presentation Presenter: Emily Wright

