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DESERT BIGHORN COUNCIL

2023

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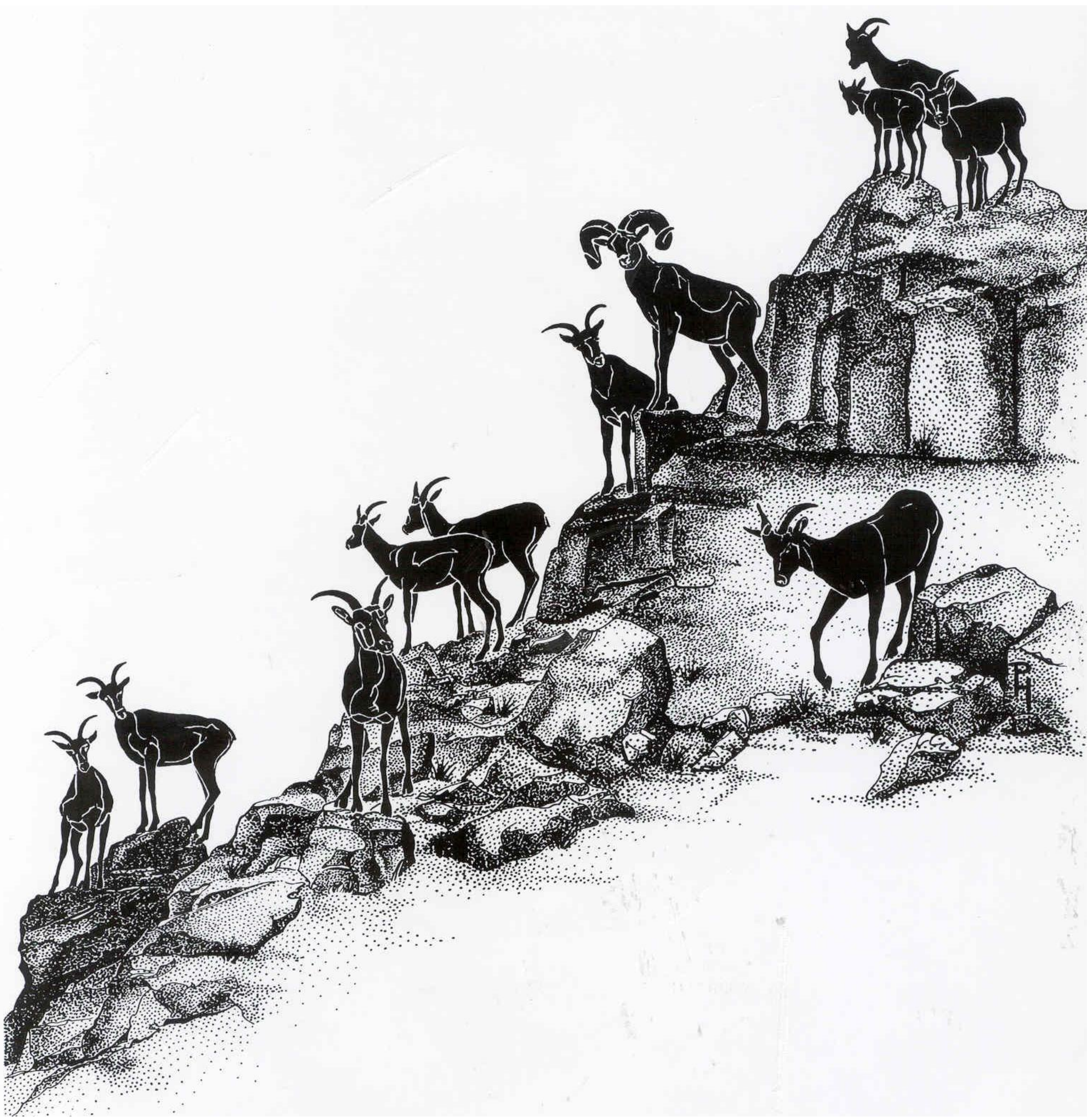
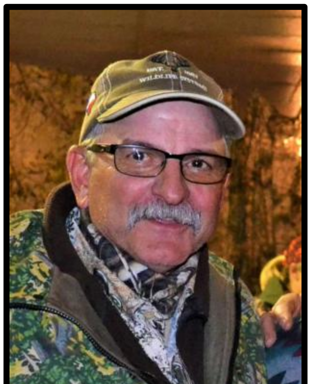


In Memoriam

Desert Bighorn Council Transactions 57:1

Three of our colleagues from the Texas Parks and Wildlife Department gave their all in a fatal helicopter crash on 8 August 2020 in Brewster County, Texas. Bob Ditmar, Dewey Stockbridge, and Brandon White perished while conducting a survey of desert bighorn sheep at the Black Gap Wildlife Management Area; the pilot, George Ezell, was a private contractor and survived the crash. “No words can begin to express the depth of sadness we feel for the loss of our colleagues in this tragic accident,” said Carter Smith, then current TPWD Executive Director. “These men were consummate professionals, deeply liked and highly regarded by their peers and partners alike for the immense passion, dedication and expertise they brought to their important work in wildlife management and veterinary medicine.



Robert Dittmar was the agency’s first-ever Staff Wildlife Veterinarian. Originally from Harper, Texas, he became a veterinarian to better serve his ranch and improve local wildlife and animal health. With 30 years of veterinary experience, “Dr. Bob” began work at TPWD in 2014, helping the agency diagnose and respond to the complexities of health and disease issues that affect Texas wildlife. He worked with bighorn sheep, pronghorn, white-tailed and mule deer, as well as small and nongame species. Dr. Bob worked closely with wildlife biologists, hunters and landowners to conserve and protect Texas wildlife. Dr. Bob and wife Bernadine were married nearly 41 years; he was about to retire.

Dewey Stockbridge, 36, was the Lead Wildlife Biologist at Elephant Mountain Wildlife Management Area, south of Alpine in Brewster County. His office was 23,000 acres of wild Trans-Pecos habitat, where he helped manage and conserve the wildlife. Originally from Mason, Texas, he began his career with the Texas Parks and Wildlife Department in 2005. Dewey was instrumental in restoring pronghorn and desert bighorn sheep to their native ranges. He was an avid outdoorsman, hunting and fishing with friends and family. As Dewey and wife Shannon began raising their two young children, son Jameson and daughter London, he passed that love of the outdoors and a respect for nature on to them.

Brandon White, 52, was a Fish And Wildlife Technician at Elephant Mountain Wildlife Management Area. Originally from Spur, Texas, Brandon was an avid outdoorsman from the time he learned to ride bareback on his horse Snapper as a boy. Brandon began his career with the Texas Parks and Wildlife Department in 2016 and played a vital role in preserving the health of Texas wildlife. He assisted with surveys and translocations for bighorn sheep and pronghorn, activities that are essential to ensuring these animal populations thrive for years to come. A tough man who worked from dawn to dusk, he loved and laughed just as fiercely and gave away more than he ever had. He leaves behind his wife Leti and children.

The *Desert Bighorn Council Transactions*: Past, Present, and Future?

Vernon C. Bleich

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Desert Bighorn Council Transactions 57:2–6

The *Desert Bighorn Council Transactions* (*Transactions*) had been published following all prior meetings of the Council, the first of which was held in 1957. As of 2021, 56 volumes had been produced but, following the 57th meeting of the Council in Alpine, Texas during 2023, the incoming editor failed to produce a volume. Needless to say, some members of the Desert Bighorn Council felt betrayed, and others were outraged because this situation could have been prevented if the individual had not accepted a job he could not accomplish.

As a result, 2 full years lapsed before I was approached by members of the Council's Technical Staff and asked to undertake production of volume 57 and also serve as Editor-in-Chief (EIC) for volume 58. It was with no small amount of trepidation that I agreed, and my hope is that these efforts will help reestablish the long-running series historically referred to as the *Desert Bighorn Council Transactions*. This has been a gratifying endeavor, albeit much more challenging than I had anticipated.

Much of my trepidation about accepting this responsibility was based on the fact that I do not have the background or technical skills to do the formatting and layout of the final copy. To that end, I informed the Technical Staff that I would serve as the EIC if the Council ensured that a skilled copy editor would be available to work with me on the final layout and production. To that end, the Technical Staff agreed, and contracted with Ms. Beverly Valdez, with whom I have worked on numerous articles over the years. Beverly has the requisite skill set and the experience to ensure a quality publication is the result of our joint effort. Council members that are familiar with *California Wild Sheep*, the quarterly magazine of the California Wild Sheep Foundation, will be familiar with the quality of Beverly's work.

Immediately after the Technical Staff agreed with the acquisition of a professional copy editor to assist with production, I applied for and received an International Standard Serial Number (ISSN) for the *Transactions*. The ISSN is an 8-digit code that uniquely identifies a serial publication on a global basis and is assigned by the Library of Congress. Whereas both print versions and electronic versions of the *Transactions* exist—and print versions could again be produced in the future—two ISSNs were obtained, and these appear on the first page of this volume and will continue in future volumes. The Desert Bighorn Council as a whole, those publishing their work in the *Transactions*, and bighorn sheep themselves will benefit immensely from these identifiers, as they will greatly enhance the ability of existing and future search engines to locate and index articles pertaining to the conservation of desert bighorn sheep. This will be of benefit to academicians, researchers, managers, and the interested public, despite the value the *Transactions* already have garnered in the professional literature (Krausman 1992).

Readers of this volume undoubtedly will note that it is more lengthy than most issues of the *Transactions*. Further, there are a number of sections or groupings of papers that likely have not been set off in the past. In part, this is because the EIC was scrambling to obtain submittals from authors to ensure there would be material available to justify publication. In the following paragraphs, I explain the rationale for the inclusion of these separate sections that, in part, were motivated by the absence of the call for papers and submission deadlines that I described earlier.

Most members of the Council are likely aware that 'Technical Reports' published in the *Transactions* have been peer reviewed. Nonetheless, it is probable that few others are aware that is the case. Peer-reviewed technical reports have been the Council's policy for decades (Krausman 1992), and these appear in the opening pages of each edition of the journal and are published separately from notes, status reports, discussions, opinion pieces, or other types of contributions. Three exceptions to this general rule exist, and include Obituaries, Tributes, or Epitaphs; the Keynote Address presented at the most recent meeting of the Council; and the Editor's Comments as they pertain to the current volume.

In the opening pages of this issue the Council acknowledges the sacrifices of three of our colleagues (Bob Ditmar, Dewey Stockbridge, and Brandon White) who were employees of the Texas Department of Parks and Wildlife (TPWD) and perished in a tragic helicopter accident during August of 2020. All such losses are to be recognized, and the risks involved in our work should not be overlooked. These brief obituaries are followed by the Editor's introduction to the issue, and then by the Keynote Address presented at the preceding Council meeting, in this case by Clay Brewer who is a retired TPWD employee and who knew and worked with those who died in that crash.

Technical Reports appear next, and five such contributions are included in this issue. The authors of these all are long-term researchers, managers, and conservationists involved with desert bighorn sheep and their habitat. Among these are three prior EICs that collectively produced 17 volumes of the *Transactions*, and for whom I have the greatest respect for their dedication to this journal.

The Technical Reports are followed by State Status Reports that were presented at the 2023 meeting. I owe a special debt of gratitude to these individuals for meeting the deadline for submitting their reports. First, to Pat Cummings who, at my request rode herd on the authors and reminded them on several occasions that the status reports were due 30 September, and also to the authors themselves, every one of which met that deadline. Thus, a very special *Thank You* to Rana Tucker (AZ); Alyssa Kircher, Brad Weinmeister, and Genevieve Fuller (CO); Mike Cox (NV); Froylan Hernandez (TX); and Rusty Robinson (UT) for your support.

It long has been apparent that a declining proportion of members of the Council, participants in Council meetings, or readers of the *Transactions* are familiar with the Council's lengthy history. To help reverse that, several important papers were posted on the Council's website, but likely have received little attention. When I was asked to assume the editorship, I indicated my desire to reprint some of those historical contributions and make them more readily visible than items that are several clicks away from being visible on the screen.

As a result, papers that I deem especially relevant to historical aspects of the Council's origins, mission, and intent, follow the state status reports. In addition to those currently on the web site, I have included several meaningful articles from 3 former EICs, and little-known background information on one of the most overlooked individuals that has contributed to the Council in important ways since shortly after its formation (Brigham 2000). Her name is Pat Hansen, and Pat's daughter Debi Hansen Clark has prepared a brief biography of Pat's accomplishments, in large part because many members have no idea who Pat is, or how and why she is involved with the Council. For the many that have wondered about Pat's involvement, it is noteworthy that she received the Desert Bighorn Council's Honor Plaque in 1969 (Kelly 1980). This biography is the first article in the section of historical papers.

Following these histories, I have reprinted two articles that I suspect have not been read by many Council members yet are relevant in context of the increasing use of technology in wildlife science. I further invited the preparation of a third paper that provides insight into the relationships between two prominent organizations and again has surfaced as a topic of interest.

The increasing popularity of developing complex models using data retrieved solely from computer screens was addressed by Krausman (2020), and with whose concerns I concur. The immediate application of novel or untested technologies has been substituted by many for the demands associated with intensive field work (Bleich 2018). Indeed, the ready availability of remote data gathering technologies and the advent of powerful analytical capabilities have allowed science to advance, but often with a near-absence of field work.

A consequence has been the development of two inversely related trends: (1) an apparent fascination with the methods and not necessarily the question(s) at hand, and (2) an increase in the isolation of wildlife biologists from the natural world who are abandoning opportunities to witness interactions among study subjects and their environment (Bleich 2018, Hornocker 2023). A number of my colleagues that have spent decades in the field have described such practitioners as "keyboard warriors", while others have referred to them as machine scientists (Guimer et al. 2020, Belikov et al. 2022). I prefer the moniker keyboard warriors, and it may be that the outcomes of such investigations are beginning to receive greater scrutiny (e.g., Crabtree et al. 2025, Richardson et al. 2025).

The second essay (Krausman 2023) addressed the potential for artificial intelligence to strongly influence the ways that science is explored or pursued, how articles are developed for publication, how management is conducted, and how results are interpreted; please recall the earlier reference to keyboard warriors and machine scientists. The third paper, by Daryl Lutz and Brent Lonner, provides insight into the historical and current relationships between the Desert Bighorn Council and the Western Association of Fish and Wildlife Agencies. I hope readers will find each of these contributions to be of value.

Following the aforementioned material, there are a number of items of interest to Council members. Among these miscellaneous items are an announcement of the 2023 recipients of the Desert Ram Award and the Honor Plaque; a summary of previous awards recipients; an historical compilation of past Council meetings that has been critically reviewed, corrected, and updated; the names and contact information for individuals that attended the 2023 meeting. Readers will note there is an absence of Instructions to authors in this volume.

I close this commentary with the following paragraphs because I believe the information is important and several of the papers that are cited postdate the Council's 2023 meeting but predate the release of Volume 58. During the recent past, there has been a notable proliferation of businesses that publish scientific material as a for-profit enterprise and are financially obligated to their shareholders; nonetheless, many reputable journals remain committed to the high ethical and professional standards for which they are known (Cox 2025). The proliferation of these for-profit ventures has resulted in >8,000,000 scholarly papers being published annually, with >1,000,000 in the life and biomedical sciences; moreover, ≥52 professional journals currently specialize in ecology, conservation, or related disciplines alone (Landuis 2016, Fire and Guestern 2019, Berger et al. 2024).

The new-found interest in the business of publishing as a for-profit enterprise has resulted in vast numbers of new journals being created by what are disparagingly referred to as paper mills or predatory journals (Landhuis 2016, Brainard 2025) that virtually guarantee an author's work will be published in a peer-reviewed journal. Thus, scientific publishing has changed substantially (Cox 2025), as have the risks associated with doing so (Richardson et al. 2025). As a result, the pressures of academia to publish or perish may not be as meaningful as in the past, and caution is advised. My colleague at the California Department of Fish and Game, Calvin Chun, insightfully cautioned that in the future those words might best be modified to read, publish *and* perish. Given the rapid increase in the number of predatory or papermill journals and the near guarantee of acceptance for publication, Calvin's words now may be more appropriate than in the past.

The ease of electronic submission, format-free manuscripts, promises of a rapid decision, guaranteed peer review, and automatic transfers of manuscripts to more 'appropriate' journals have contributed to the proliferation of these for-profit periodicals. Moreover, they have resulted in exorbitant publication fees and created virtually endless opportunities to pay and publish. Of course, there remains a heavy emphasis on a number of metrics (e.g., h-score, citation index, journal impact factor) that are meaningful in academic settings, and this may be exacerbated by the desires of some authors to list as many different journals as possible on their curriculum vitae—at least for the present. Indeed, the demands of academia, when combined with a bit of personal hubris, may serve as enticements to contributors with funds available and if there is no perceived risk to credibility. It is becoming evident, however, that the latter is no longer a certainty (Crabtree et al. 2025, Richardson et al. 2025).

To paraphrase Alison Cox (2025), "The primary purpose of the [*Desert Bighorn Council Transactions*] is to provide an outlet for science focused on improving [bighorn sheep conservation]". That was the primary goal of the founders of our organization, and it has remained important and meaningful. It is my hope that the *Transactions* will continue to be recognized for its roles in science and conservation pertaining specifically to desert bighorn sheep. I also believe the papers published in the *Transactions* will become a more important source of scientific and management information as the journal receives more widespread recognition. "Has the Council made a difference? YES!" (Brigham 2000:4).

This is Professional Paper 161 from the Eastern Sierra Center for Applied Population Ecology.

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2023 Desert Bighorn Council Keynote Address

Clay E. Brewer

Wild Sheep Foundation, Bozeman, MT 59718, USA

Desert Bighorn Council Transactions 57:7–10

I am truly honored to present the keynote address for the 2023 Desert Bighorn Council (DBC) conference. DBC has been a strong ally of the Texas Parks and Wildlife Department (TPWD) bighorn sheep program since the beginning of restoration efforts in the 1950s. Throughout the years, DBC has stood with Texas through the good times and the bad. DBC was there during the 1980s when the Texas bighorn sheep program was plagued by losses from both disease and predators, with funding drastically reduced for the bighorn sheep program by the Texas legislature. Desert bighorn sheep restoration in Texas was all but dead. Shortly after that in 1981, DBC passed a resolution that encouraged the state of Texas to re-initiate the desert bighorn "re-establishment program" and, combined with the efforts of the Texas Bighorn Society (TBS) which formed shortly after, helped write one of the greatest conservation success stories of all time.

Our program survived, and we have since restored bighorn numbers to population levels of the late 1800s. The professional contacts and friendships I've made through this organization have helped guide me throughout my career. For that, I'm truly thankful. It is especially gratifying to see landowners here today. Some of these represent five generations who have worked cooperatively with TPWD to help restore and manage desert bighorns since the early 1900s.

I remember meeting Ray Lee at my very first DBC conference. He walked up to me and said hello Clay, I'm Ray Lee from Arizona Game and Fish Department (AZGFD) and I'd like to remind you that Texas still owes us pronghorn from the trade we made for bighorns back in 1956, and then walked off. I remember thinking, what am I supposed *to do* about that. Several years later at a pronghorn workshop at Bismarck, North Dakota, Brian Wakeling who was working for AZGFD at the time, gave a paper called, "why do we transplant animals." The main point of his paper was, "do not move animals if you don't have a really good biological justification for doing so." When the time came for questions, I raised my hand and asked, "Bryan does this mean that Texas does not have to pay Arizona back the pronghorn we traded for bighorns back in the mid-50s?" He thought about it for a second and said, no, lets trade those for beer after the meeting. So, we did and the slate has been clean ever since.

As I began preparing this presentation, I thought about the past success and failures of the TX bighorn sheep program and the impact of disease and predation, both past and present, on bighorn populations in Texas. Our history is very similar to that of many other desert bighorn states. Bighorn numbers in Texas during the late 1800s were estimated as high as 1,500 animals, but they were gone by the early 1960s. Like other states, these declines resulted from a combination of factors but included the inability to cope with pathogens carried by domestic sheep.

What is different for us is the fact that 95% of Texas is privately owned, which comes with a unique set of challenges, but also tremendous opportunities. Honesty, trust, and respect are vital components of strong cooperative working relationships with landowners. Without it, wildlife restoration and management does not happen in this state. Sounds easy enough but I can tell you from experience, it's not. Over 3 decades ago TPWD conducted a round-table meeting comprised of various stakeholders, for the purpose of identifying and prioritizing bighorn sheep restoration and management issues and resolutions. The number one issue identified was lack of credibility of TPWD. So, when you hear about the good-old-days, they were not always so golden.

A few short years after that roundtable, I inherited management responsibilities for Sierra Diablo Wildlife Management Area (SDWMA). SDWMA was the very first WMA in Texas and was acquired in 1945 through the assistance of landowners, to serve as a sanctuary for the last remaining bighorns in Texas. Shortly after that I learned that I couldn't get to the management area I was responsible for because I had to go through several private ranches to get there and the landowners pretty much hated TPWD. I was at Austin headquarters a short time later when I ran into an old, seasoned wildlife biologist who immediately let the air out of my sail by saying, "The road to SDWMA is lined with the bones of biologists who have tried and failed to make that place work and I suspect that I will see your bleached bones alongside the others in the very near future."

Cell phones didn't exist at that time, so I went door to door to find out where things went wrong. I listened and learned that it was simple, somewhere along the lines we forgot how to be good neighbors and partners. So, I began to work on it. A million miles, 1,000 gallons of coffee, and 2 years later we had cooperative agreements in place that paved the way for positive working relations. I'm proud to say that some of those agreements are still in place today. Cooperative relations are hard earned and easily lost.

This also applies to conservation organizations. At my first Texas Bighorn Society work project one of the TPWD veterans pulled me off to the side and said, be careful what you say around those TBS guys–in fact, don't tell them anything. I never could figure out what we were doing that we wouldn't be proud of. We began working together and decades later, TBS became our strongest partner with 1000s of volunteer workhours and over $5M contributed towards BHS restoration since 1983.

Throughout the history of our program, our highest points were always when we worked cooperatively towards a common goal. Our lowest were when we failed to put the resource first above all else and pulled in opposite directions. I'll venture to say that it's probably the same for your programs.

Restoration efforts in Texas were initiated in 1954 with the development of a cooperative agreement between the U.S. Fish and Wildlife Service, Boone and Crockett Club, Wildlife Management Institute, AZGFD, and the Texas, Game, Fish and Oyster Commission (today's TPWD). Initial efforts focused on propagation of desert bighorn sheep in captivity to provide a source of stock for transplanting into suitable habitat. The first propagation facility was constructed on Black Gap WMA and was operational by 1959. As mentioned earlier, the facility was stocked with bighorns from Arizona that we traded pronghorn for. In the early years bighorn sheep resources were not for sale on every corner so we begged borrowed and traded for bighorns from wherever we could get them. For example, in 1984 TBS member Bill Leach purchased the Foundation for North American Wild Sheep (today's Wild Sheep Foundation) Utah desert bighorn tag and instead of harvesting a ram, he convinced state authorities to allow him to capture a ram for use in the TPWD's propagation facility. This action inspired the governor of Utah to donate an additional ewe to Texas. In another example, in 1998 several in this room including Pat Cummings, Mike Cox, Billy Pat McKinney and I trapped bighorns together on the side of a mountain in Nevada and less than 48 hours later we released them along the border at Black Gap WMA. That transplant was the result of a trade between Nevada and Texas of Rio Grande turkey for bighorns. A total of 155 bighorns have been transplanted to Texas from other states and Mexico, including 107-Nevada, 31-Arizona, 15-Mexico and 2-Utah. One common theme is reflected throughout our history and that is cooperative working relationships with landowners, conservation organizations, other state wildlife agencies, and TPWD.

Are the issues of the past the same as today? I'd like to give you a few comparisons between the past and today:

Disease - Information from the past regarding disease:

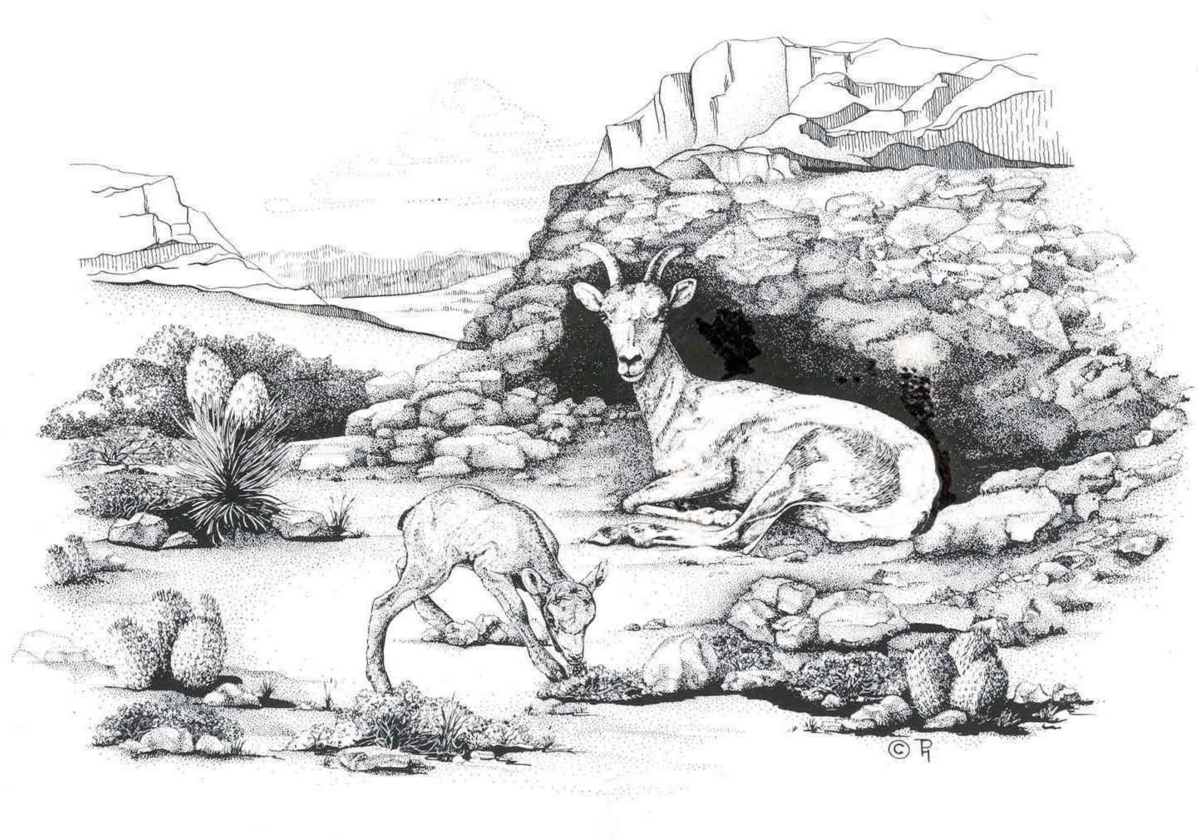
- Because bighorns seem to be highly susceptible to diseases of domestic sheep, wild sheep cannot succeed where their range is well stocked with domestic species.
- It is significant that the absence of bighorns in areas once occupied by them is directly correlated with a heavy population of domestic sheep.
  - Today we've lost a third of our population because of health-related issues associated with domestic goats in our southern bighorn range and aoudads throughout pretty much our entire bighorn range in Texas.

Predation – I offer some information from the past regarding predation:

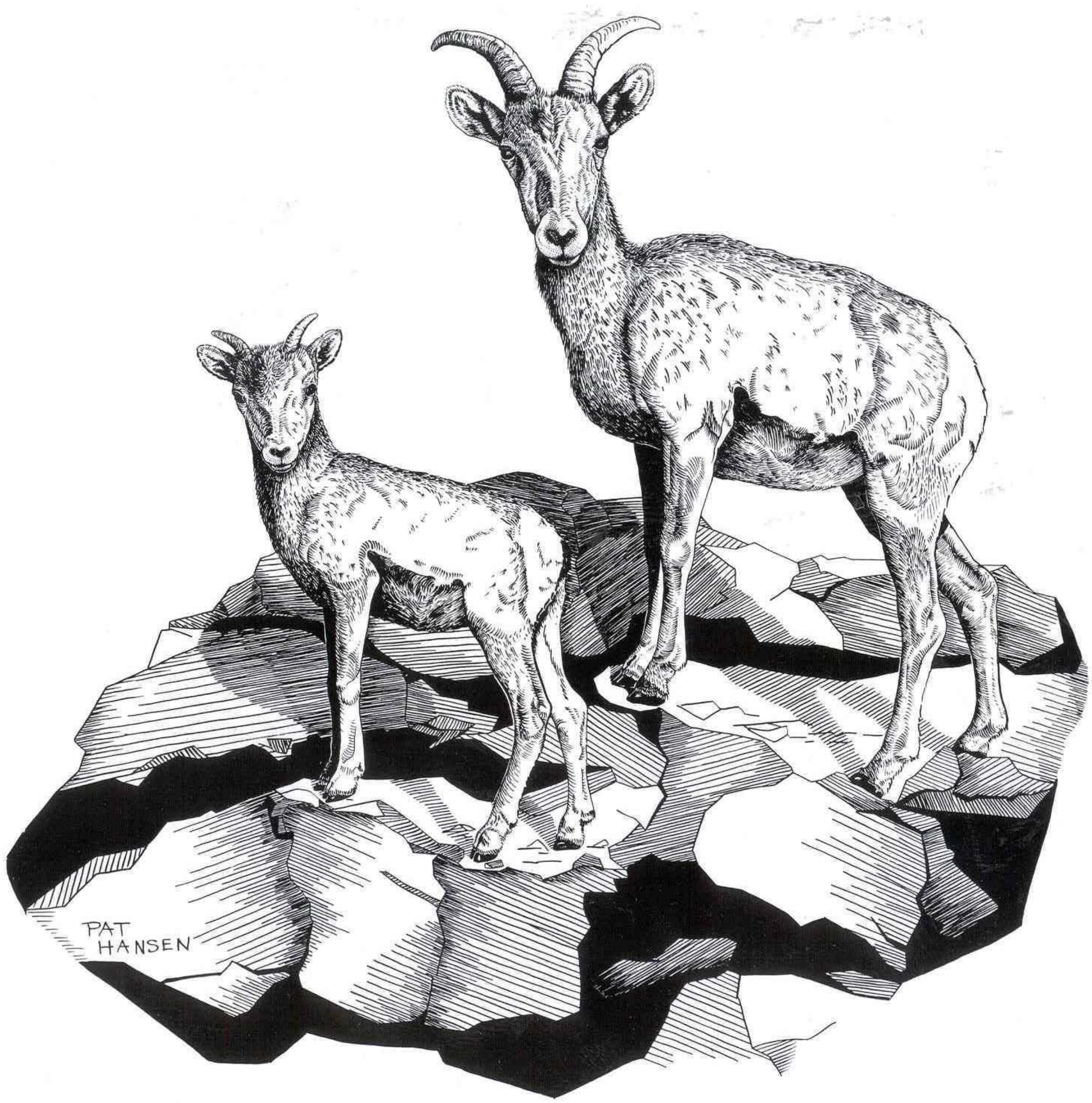
- The Guadalupe Mountains in Texas and New Mexico could easily support 1,000 bighorns and could be fully stocked if the range were protected, and its natural enemies destroyed.
- In some of the early DBC meetings Jack Kilpatrick reported on the adverse impacts of mountain lions on bighorn restoration efforts while other states didn't believe that lion predation was really an issue.
- Predator control and concerns related to exotics were also among the issues identified during the 1990 Roundtable that I described earlier.
- Efforts to change the status of mountain lion management in TX has occurred multiple times:
  - In 1975 a moratorium was placed on predator control by the TPWD Commission. From 1975 to 1977, a significant number of bighorns was lost to mountain lions in a 427-acre propagation facility at Black Gap WMA, which made it impossible to continue propagation efforts at that location.
  - In 1990 Sierra Club and the Alamo Chapter of Sierra Club petitioned the TPWD Commission to change the management status of mountain lions in Texas.
  - In 2000 Sierra Club and Defenders of Wildlife requested a halt to unregulated killing of mountain lions.
  - In June of 2022, the Texans for Mountain Lion Coalition requested that the TPWD Commission endorse 4 specific regulation changes and 2 non-regulatory initiatives relative to mountain lions.

Although similar to those of the past, the challenges we face in Texas today are tougher and more complex than ever, particularly those related to political and social issues. The world is certainly changing. The bighorn sheep restoration story in Texas is truly one that was built on the backs of landowners, hunters since 1937, conservation organizations like TBS, Wild Sheep Foundation, and others who cared enough to do something about restoring the natural heritage of Texas. Conservation success has in the past and will continue to rely heavily upon strong partnerships between those who were willing to work together towards a common goal. In Vernon Bailey's 1905 Biological Survey he wrote, "*It is with some hesitation that I make public these facts as to the abundance, distribution, and habits of mountain sheep in western Texas, and only in the hope that a full knowledge of the conditions and the importance of protective measures may result in the salvation instead of the extermination of the species.*"

Our hope remains the same—the primary goal of landowners, Texas Bighorn Society, Wild Sheep Foundation, universities, and TPWD must be to do what's best for desert bighorn sheep first, and above all else!



Technical Reports



The Desert Bighorn Council: A Partner in the Evolution of Science and Management

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Desert Bighorn Council Transactions 57:12–18

In the 1950s very little was known about the natural history, population status, or distribution of desert bighorn sheep (*Ovis canadensis* ssp.) in the southwestern United States and Mexico. At this time, there seemed to be little interest in the management of the species amongst state and federal agencies. In general, desert ecosystems were not a priority other than their use for mining and military practice. This history of neglect motivated several concerned agency biologists and university scientists to share information and discuss learning more about and conserving this charismatic species. The Desert Bighorn Council (DBC) was established in 1957 by wildlife professionals from natural resource agencies, conservation organizations, and research institutions throughout the western United States and Mexico with the purpose, “To provide for the exchange of information on needs and management of desert bighorns through meetings and published transactions, by means of which new or important information, ideas, techniques, and problems can be presented…” This places DBC among the oldest wildlife conservation organization in North America that has held annual or biennial meetings and also has published the transactions of those meetings. It truly is an international organization, with the Council’s meetings rotating among the 7 states and Mexico that are concerned with the management and conservation of desert bighorn sheep.

The founders of the organization (Figure 1) insightfully established a constitution in 1959 to include objectives and an organizational framework of leadership and bylaws to guide the Council while also allowing it to adapt as needed. The past and present role of the DBC has been to serve as an important forum supporting applied science, expertise, communication, mentorship, scholarship, and best management practices. Details of the DBC constitution and bylaws can be found on the website (www.desertbighorncouncil.com).

Figure 1. Photo of attendees at the 1959 meeting of the Desert Bighorn Council in Death Valley, California, during which the Council’s constitution was first prepared.

ORGANIZATIONAL HISTORY

To accomplish the DBC's stated purpose, the following objectives were established. (A) To stimulate studies in all phases of the life history, ecology, management and protection, recreational (use of)… including studies of species that may be seriously detrimental to desert bighorns; (B) To provide a clearing house of information among all agencies, organizations…through appointment of work committees, preparation of bibliographies and abstracts, and related methods, when desirable; (C) To function in a professional advisory capacity… involving management, conservation, and protection of desert bighorns, and to adopt such measures…to promote advancement of knowledge concerning desert bighorns and the long-term welfare of these animals; and (D), To recognize and commend outstanding work in the profession.

While these objectives were accomplished primarily through the annual meetings and published transactions, objective C was most discussed and debated. The founders viewed this measure as critical to best ensure that actions are taken to benefit desert bighorn conservation. In response the DBC established the Technical Committee in 1962.

The Technical Committee's role is generally defined by the following obligations. (A) It shall be the Technical Committee's responsibility to review and approve applications for funds collected in the Desert Bighorn Council Scholarship Funds. …will be guided by the Council's decision that these monies be donated to students or others for studies or research of the desert bighorn sheep. And (B) The Technical Committee will provide or obtain advisor assistance for persons or agencies requesting information or help in desert bighorn sheep research and management.

COMMENTARIES AND CRITIQUES HAVE VALUE

Despite these stated obligations, at the time there remained uncertainty about how best to provide an advisory role to agencies to help advance management. The importance of this issue was evident by critiques and challenges to the DBC in several commentaries published over the years. Examples of these assessments include (1) "Much information has been gathered together and presented here by the members in the hope of improving the management practices and improving and increasing the sheep populations. However, in spite of all the information and the suggestions made, I have seen little administrative action which has resulted in the improvement of the status of the sheep. Sheep numbers and conditions at best, are static, or are declining slowly but steadily" (Graf 1964:19); (2) "We would be derelict in our duties to the conservation of the desert bighorn and its habitat not to take a stand on issues" (Russo 1966:4); and (3) "…our first step into the future would be to accept, fully, our responsibility for doing something about what we have learned…" (Welles 1966:7).

These comments represent the views of members representing an academic institution, a state wildlife agency, and a federal land management agency, and voiced important concerns for the DBC's purpose, implementation, and vision, respectively. Early on it was apparent that implementing science and new knowledge into management actions is a substantial challenge. Publishing these self-critiques in the Transactions were important as they verify that the Council has remained focused on its stated purpose.

Recognizing the need for more information on the natural history of desert bighorn in the early 1960s, the DBC asked the Technical Committee (now the Technical

Staff) to "compile all pertinent knowledge on the ecology and management of desert bighorn sheep." This early vision resulted in publication of the Council's book, *The Desert Bighorn: Its Life History, Ecology and Management*, (Monson and Sumner 1980). This important work not only reviewed and summarized previously published information but also consolidated vast amounts of expertise from species experts.

RESOLUTIONS AND GUIDELINES HAVE VALUE

The Council also has contributed numerous important resolutions and guidelines, and through those it has gained national recognition for its efforts.

- 1962: The DBC Technical Committee (now the Technical Staff) was established to "...provide or obtain advisor assistance for…agencies requesting information or help in desert bighorn sheep research and management…".
- 1963: A resolution opposing the introduction of exotic ungulates without thorough environmental analysis was passed.
- 1967: A resolution endorsing retention of desert bighorn habitat in the Public Domain under the Classification and Multiple Use Act was passed.
- 1973, 1982: Guidelines for capturing and re-establishing desert bighorns were compiled and published.
- 1980: Habitat requirements and management recommendations for desert bighorn sheep were developed and published.
- 1981: A resolution supporting the reinitiation of the Texas desert bighorn sheep reestablishment program was passed.
- 1990: *Guidelines for Management of Domestic Sheep in Desert Bighorn Habitat* were developed and published.
- 1996: A resolution opposing propagation of desert bighorn sheep by interspecies embryo transfer using domestic ewes was passed.
- 1999: The Desert Bighorn Council began an affiliation with the Western Association of Fish and Wildlife Agencies.

These early resolutions and guidelines represent DBC's active role in addressing important issues to assist wildlife management agencies and benefit species conservation. All these resolutions served an important purpose. In particular, the 1990 *Guidelines for Management of Domestic Sheep in Desert Bighorn Habitat* served as a framework used by many agencies to support their management programs. These guidelines were the first of their kind and were based on the best information available. Many agencies adopted all or part of these recommendations, and they served as a starting point for refined practices as more science became available.

Desert bighorn sheep conservation is facing more important challenges (or stressors) that the DBC should consider. Two, in particular, are projects that potentially threaten opportunities for intermountain movements, and water development strategies to support long term persistence as needed to address climate change. The former frequently are referred to as movement corridors but, perhaps more appropriately should be referred to as movement conduits because of the uncertainty associated with paths traveled by individual animals (Jenks 2018).

THE COUNCIL'S COMMENTARIES AND ASSESSMENTS CONTINUE

Important commentaries have continued to be published in the DBC Transactions that showed commitment toward organizational self-assessment and included recommendations or needs. A few that are especially notable include the following.

- "The Desert Bighorn Council has been a leader, pusher, counselor and even occasionally an activist to meet and exceed the objectives as set forth in the Bylaws…" (Kelly 1982:101).
- "…renew our efforts to develop partnerships and coalitions with individuals, groups, and organizations that have not been our traditional supporters" (Ellenberger 1997).
- "Has the Council made a difference? Yes! Through the annual rotating meeting; the Technical Staff comments, position statements and guidelines…" (Brigham 2000:4).
- "Research and management—we need them both to guide wildlife conservation. Communicating this information is an important role that the Desert Bighorn Council Transactions played historically and continues to play today" (Wakeling 2011:no page number).

These commentaries are important because they document the evolving history of the Council as it reflected on its function, purpose, and challenges. They reflected on past conservation accomplishments and looked to continue success and identify needs in research and management. The Council addressed its function, including the need for modernization (e.g., website, email); the continuation of position statements, resolutions, and guidelines; the independence of the Council; objectivity, membership and participation; and the future. This story is interesting, and I encourage members to read these.

Kelly (1982) proudly highlighted the numerous publications contributed through the Council and their importance toward management. He also discussed the importance of the Council maintaining its objectivity, autonomy and independence from other organizations including the Western Association of Fish and Wildlife Agencies (WAFWA). He concluded this commentary by emphasizing the success of the Council at achieving its purpose and objectives.

Ellenberger (1997), in the spirit of acclaimed ecologist Aldo Leopold, emphasized the importance of creating partnerships with organizations "that have not been our traditional supporters." His words reflected the emerging appreciation by wildlife agencies for the "human dimensions of wildlife" science that was developing to help support wildlife management efforts and better communicate with the public. Indeed, Ellenberger (1997) noted that in the absence of broad support we will not be able to sustain current programs or implement new, aggressive programs to protect wildlife habitats or remove threats to wildlife. His words served as a reminder that desert bighorn sheep management programs need to demonstrate a diverse conservation ethic that doesn't appear to be solely defined by hunting.

Brigham (2000) provided another timely summary of the Council's role and accomplishments. Similar to past critiques from 35 years earlier, he mentioned the importance of the Council's role in "providing input" as part of the function of the Technical Staff. This is a Council function that has weakened in recent years. It needs to be re-emphasized as the increasing stressors of climate change, disease transmission increase, and the role of intermountain areas in the conservation of desert bighorn sheep receives greater attention.

Hansen (1967:80) provided the first publication specific to research needs at the time. He stated, "Pure research on bighorns is desired, but applied research is required. There is also a need for better communications between the research technician or scientist and others both outside and in the field of wildlife management." Wakeling's (2011:no page number) editor's note revisited the same topic 54 years later, and this is a challenge that we need to keep a focus on. As he noted, "Researchers and managers sometimes don't seem to speak the same language or at least don't care to speak with each other." This doesn't represent a new concern but one that will always need attention, and the Council can play an important role in addressing the need.

SOME ADDITIONAL THOUGHTS AND RECOMMENDATIONS

I believe that any objective observer of the conservation history of desert bighorn sheep will conclude that the Desert Bighorn Council has succeeded in its mission. Desert bighorn sheep are arguably the best managed large mammal species in the world, and the Council is to be credited for its role in keeping wildlife and land managers, scientists, and NGOs communicating and collaborating. The result has been objective, innovative and science-based management and conservation. This commentary will remind readers of the Transactions of the foundations of the organization and challenge us all to keep it actively functioning to best benefit species conservation. This challenge requires periodic self-critiques, discussions, and visioning to adapt to future challenges and stressors. This is what the DBC founders did, and it is up to us to continue its purpose and vision. Current actions that will help to continue the mission of the Council as envisioned by the founders include 'rebooting' the *Desert Bighorn Council Transactions* and increasing participation in the Desert Bighorn Council.

Historically the *Transactions* have served as a vital forum to communicate science, management, and collaboration. Unfortunately, publication was neglected by the 'editor' of volume 57, who did nothing for >2 years following the 2023 meeting in Alpine, Texas; as a result, Volume 57 will not be available until 2026. The *Transactions* will be revitalized with a new editor, Dr. Vern Bleich. The future of the *Transactions* is exciting, and this reboot will include more active solicitations of articles and commentaries, suggestions to reformat state and federal status reports to facilitate regular updates, support for field notes and works in progress, and strongly encourage recipients of projects supported by grants from the Council to publish at least some of their results in the *Transactions*.

As mentioned repeatedly in the commentaries and discussions cited above, the *Transactions* play an important role in the communication of science and management, and for memorializing historical data that are crucial for understanding desert bighorn sheep habitat requirements, distributions, and population status to help guide conservation strategies. The value and importance of memorializing historical information was emphasized by Diaz and Corti (2025) in their recent paper, *Ensuring the quality of historical data for wildlife conservation*. I encourage Council members to review past issues of the *Transactions* not only for interesting reading, but also to minimize the proliferation of what Fisher (2021) has termed "generational amnesia".

There also remains a need to document and understand participation in the

Council, and how and why it has changed over the years. During the 1960s and 1970s, membership and participation by federal employees was 60 percent. According to registration records from 2000 to 2023, however, federal participation has dropped to 10 percent. Recognizing the desert sheep resources that occur on federal lands (including military lands), the DBC should encourage all trustees of desert sheep landscapes to partner to increase collaboration. The Council is currently examining this issue and will report on findings and solicit discussion at the 2027 meeting in Colorado.

CONCLUDING REMARKS

The importance of applying science to management repeatedly has been emphasized historically and was brought up again by Wakeling (2011) as quoted above. Early in the Council's history, Bill Graf (1966:11) clearly recognized the profound value of the role of the Council to help apply new knowledge to the conservation of desert bighorn sheep when he wrote, "Can we influence the future by merely gathering and publishing information? Can this influence the critical and immediate present? The answer is, It MAY…". Graf then continued, "To be effective, the knowledge must be translated into decisive action, and this must be done when and where it is needed by those best qualified. The Council should, and must, see to it that this knowledge and its interpretation is carried out as quickly as possible, and must take whatever steps may be necessary to carry out their decisions."

I think we all share many of the views expressed in Dr. Graf's critique; we should help to ensure that desert bighorn sheep conservation advances as the Council continues carrying out its role and purpose. I will provide a detailed discussion of the history, status, and needs in "Part 2" of this commentary, which will be submitted to be considered for publication in the 2025 *Transactions* under the title, *From Field Notes to Policy: 65 Years of Science to Management in the Desert Bighorn Council Transactions*.

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[1]During the 3-year delay in production of the 2023 Transactions, this reference appeared in the literature and its inclusion in this paper is appropriate and timely—EDITOR.

The Desert Bighorn Council Transactions, Society, and Science

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Desert Bighorn Council Transactions 57:19–24

Abstract We examined the importance of a single outlet for information about desert bighorn sheep (*Ovis canadensis nelsoni*)—*The Desert Bighorn Council Transactions*. The first volume in this series was published in 1957 and it has been a peer-reviewed publication of scientific studies since the late 1970s. It is a repository and record of desert bighorn sheep ecology and management, serving as a commonly used reference source in the published literature on desert bighorn sheep. The Desert Bighorn Council Transactions remain a highly regarded source of information, as evidenced by 156 citations in over half of the chapters in a forthcoming book on mountain sheep (bighorn [*O. canadensis*], thinhorns [*O. dalli*]).

Key Words: desert bighorn sheep, history, knowledge, literature, natural history, *Ovis canadensis*, value

Among the natural resource challenges world-wide (e.g., climate change, extinctions, extirpations, disease epizootics), "science and society require nuanced, international solutions that are grounded in robust, interdisciplinary perspectives and data sets that span deep time" (Boldgiv et al. *in press*). Such data include natural history collections that contain material ranging from fossil records to modern biological specimens, and a written record of natural history and ecology to understand the life that shapes our modern world. Scientific journals; conference proceedings; transactions; federal, state, and non-governmental agency reports; and diaries and field notes of wildlife biologists play a pivotal role in preserving the written record of wildlife science and ecology. Records that are peer-reviewed are considered the gold standard, and the number of peer-reviewed journals continues to increase each year (Berger et al. In Press). Indeed, the scientific knowledge recorded in journals doubles about every 15-17 years (Tenopir and King 2001) and the value to science and society cannot be overstated.

SCIENTIFIC USE OF *THE DESERT BIGHORN COUNCIL TRANSACTIONS*

Scientific journals are the most important information resource for scientists and are widely read, with readership increasing each year across all fields of science. The Desert Bighorn Council Transactions remain a highly regarded source of information, as evidenced by 156 citations in over half of the chapters in a forthcoming book (Krausman and Jex *in press*) on mountain sheep (bighorn [*O. canadensis*], thinhorns [*O. dalli*]). The increase in journals is correlated to the number of scientists, and there are more practicing scientists today than at any other time in history. With few exceptions, the scientific papers published in the Desert Bighorn Council Transactions (*DBC*) adhere to the standard format for scientific papers in journals, which includes an introduction that outlines background and objectives, methods, results, and discussion (IMRAD; Krausman et al. 2016, Hua et al. 2018). The IMRAD format has been used since the 1800s, beginning with Louis Pasteur, and has been extensively used since the latter part of the 20th Century (Krausman et al. 2016). It is the most common format for scientific articles (Hua et al. 2018). Because readers of scientific journals recognize the IMRAD format, the *DBC* is easily recognized by readers as a scientific format. Because of the proliferation of journals, scientists can constantly be updated on scientific results. Overall, researchers spend an average of more than 100 hours/year reading scientific articles (Tenopir and King 2001). The exposure of scientific journals is an important component of their value to society. The exposure and availability of the *DBC* to other scientists will continue to increase because the editor of this volume has obtained an International Standard Serial Number for the *DBC*, which is a unique 8-digit code used to identify serial publications for cataloguing, indexing, and ordering.

Researchers are not the only group that is attracted to journals. Scientific journals are important to non-academicians, clinicians, consultants, communication specialists, practitioners, industry, government, personnel at national laboratories, and laymen looking for answers. In the life sciences, about 70% of all readings of scientific journals were by non-academicians, high school students, undergraduate and graduate students, or others who rely on scientific information for a variety of purposes (Tenopir and King 2001). These readers may not be able to judge the value of the articles, but they trust the peer review system as a filter for accuracy (Tenopir and King 2001). Simply put, more searches are conducted from more journals than ever before; thus, it is important that the articles be properly abstracted, indexed, and made available on numerous platforms so the information can be readily accessed (Tenopir and King 2001). The obtainment of the International Standard Serial Number for the *DBC* will facilitate access.

The *DBC* "are the most important part of the Desert Bighorn Council and they provide a service to the scientific community. The management of all species, including mountain sheep, will require information based upon research. The Transactions continue to play a role in that process" (Krausman 1992a:48). Providing scientific information about desert bighorn sheep continues to be a primary objective for the organization and has been successful. For example, during our tenure as editors of *DBC*, the Council published guidelines for the management of domestic sheep in the vicinity of bighorn habitat (Technical Staff of The Desert Bighorn Council 1990). This was important because the pathogens transferred from domestic stock to bighorn sheep resulted in high mortality of the latter. These were the first guidelines published related to this topic and were widely cited and used by federal agencies to limit interaction between wild and domestic sheep and goats (Bureau of Land Management 1992, 1998). While methods to address conflicts between wild and domestic sheep continue to evolve (Wakeling et al. *in press*), publication in the

DBC initiated the scientific management of the challenge.

The *DBC* have also been instrumental in presenting pioneering management techniques. The use of ultrasound is a common technique to determine pregnancy in large mammals today, but was untested for bighorn sheep decades ago. Nevertheless, the use of real-time ultrasound and blood progesterone levels to determine pregnancy in free-ranging bighorn sheep was a novel idea and was described in the *DBC* (Bunch et al. 1986). Surgical amputation of fractured limbs in the field for bighorn sheep injured during capture, a practice which remains rare today, was described in the *DBC* as well (Kreycik et al. 2005).

The *DBC* have also served as an easily accessible repository for important data and natural history observations that otherwise might have remained in agency files or a biologist's field notebooks, and likely would have remained unknown to others; in the worst cases, such observations would have been deemed to be of little interest by many newly minted wildlife biologists, as exemplified by Berger et al. (In Press) who point out, "We know more about wildlife and biodiversity than ever, and boots and binoculars are no longer what knowledge is about." Nevertheless, examples of potentially valuable information include a suspected case of caseous lymphadenitis in desert bighorn sheep (Bleich 2019); the distribution of observations of leucistic desert bighorn sheep in southeastern California and southwestern Nevada (Bleich 2017); the cross-border movements of desert bighorn sheep in the Big Bend region of Texas and Chihuahua, Mexico (Janke et al. 2019); and historical and contemporary records of occurrences of domestic goats and exotic caprines in or near desert bighorn sheep habitat in California—with some records dating back to the early 1900s—have been reported in the *DBC* (Bleich 2015). In addition, 50 years of bighorn sheep translocations in California, including source and release locations and a review of management challenges for bighorn sheep (Bleich et al. 2021) were first reported in the *DBC*.

Researchers often identify the importance of their work by enumerating citations of their publications. What this metric ignores, however, is the frequency with which a particular work is used for reference in classrooms, as a baseline for future activity in the field, or as an argument for management action in agency 'boardrooms'. Each of these are important as evidenced by the preparation of an articulated skeleton of a desert bighorn sheep for reference purposes (Pepper et al. 2005), providing insight into the periodicity of desert bighorn sheep use of water sources (Waddell et al. 2007), descriptions of the historical distribution of desert bighorn sheep (Heffelfinger and Marquez-Munoz 2005), and documentation of the restoration of bighorn sheep in Chihuahua, Mexico (Urango-Thomas and Valdez 2011). Others provided insights from experienced managers on the influence of predation (Brewer et al. 2013), or factors that have influenced the historical success of bighorn sheep restoration efforts while posing hypotheses to examine how to overcome future limitations (Wakeling et al. 2009). Another such example described trans-highway movements and the use of underpasses by desert bighorn sheep in western Arizona, finding that habitat quality for desert bighorn sheep and visibility through the underpass structure were associated with the frequency of crossings (Crabb and Bristow 2015). Each of these papers provides a basis for education, field activities, and management actions.

There are other important roles the *DBC* and related journals provide, and that are used members of the scientific and lay communities alike. These include systematic reviews (Meerphol et al. 2012); state status reports; historical accounts (Barrett 1965); providing a venue for biologists to interact about all things sheep; opportunities to learn more about the status of desert bighorn sheep and their competitors; case studies; panel discussions (Boyce 1992, Krausman 1992b); book reviews; obituaries; compilations of current literature; opportunities for all biologists—including those new to the field—to present and defend their findings; networking that often leads to lifelong relationships; opportunities for students to attend and participate in professional meetings; ideas, concepts, and policies that guide the conservation and management of desert bighorn sheep (Wehausen and Epps 2021); contact information for mountain sheep biologists; and comraderies among wildlifers that may advocate differing ideas or perspectives, but that share a common interest in the ecology, management, and conservation of desert bighorn sheep. Since the 1990s, the state status reports have provided demographic data in a consistent format, so the data are statistically more realistic than previous reporting, allowing for trends in distribution and abundance to be elucidated over time.

The *DBC* include all the sections that are included in major scientific journals related to wildlife and their ecology, and in some ways is more broad than in other journals. For example, invertebrates play a substantial role in the life histories of desert bighorn sheep, and are also included as topics in the *DBC* (Allen 1960) when few journals with a wildlife focus consider invertebrates (Grodsky et al. 2015). Further, contributors to the *DBC* span international borders, various cultures, and an array of approaches to management as advocated by state, federal, and tribal agencies, or non-governmental organizations. Embracing each component involved in the management and ecology of wildlife is important to obtain a full view of their effective management and understanding, especially as the world's wildlife faces serious challenges (Boldgiv et al. In Press). Finally, the *DBC* is an open access journal, making it available to scientists and anyone interested in desert bighorn sheep.

The *DBC* could justifiably be renamed *The Journal of Desert Bighorn Sheep Management and Ecology* in comparison to similar outlets for scientific information. Rebranding, but more so the reinvigoration and repositioning of *DBC* as a serious outlet for credible scientific information with the addition of the International Standard Serial Number obtained by the editor of this and future volumes, could increase the exposure of desert bighorn sheep management and ecology to the scientific community, increase submissions, and further perpetuate data related to the conservation of desert bighorn sheep. Regardless, the *DBC* have been a constant source of information for the management and understanding of desert bighorn sheep for decades, and with proper oversight and support, will remain so (Wakeling 2005).

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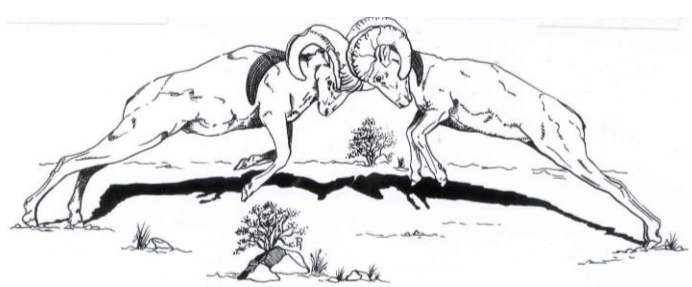

Cattle Grazing and Bighorn Sheep in the California Desert Conservation Area: A Chronology of Management Actions by the Bureau of Land Management

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ABSTRACT The Bureau of Land Management (BLM) has managed commercial livestock grazing and habitat for desert bighorn sheep (*Ovis canadensis nelsoni*) on public lands in the California Desert Conservation Area (CDCA) for the past 45 years, purportedly in compliance with provisions of the Bureau's CDCA Plan. From 1981 to 1988, BLM amended the CDCA Plan six times in response to proposals from commercial cattle ranchers holding BLM grazing permits and BLM Field Offices to expand grazing through increased allocation of forage and expansion of grazing allotments approved in the Plan. In this paper I provide a detailed account of management of cattle grazing and desert bighorn sheep habitat in the CDCA. I also provide recommendations for managing cattle grazing in allotments that overlap with habitats occupied by desert bighorn sheep that are consistent with the 1980 CDCA Plan.

Key words: bighorn sheep, FLPMA, grazing, land management planning, *Ovis canadensis*, public lands, Taylor Grazing Act

This paper will focus on actions of the Bureau of Land Management (BLM) in the context of (1) grazing of domestic cattle on public lands; (2) the management of public lands for desert bighorn sheep; and (3) the provisions of the California Desert Conservation Area (CDCA) as they relate to those two species.

The CDCA was designated by Congress in 1976 under Section 601 of the Federal Land Policy and Management Act (FLPMA), "...to provide for the immediate and future protection and administration of the public lands in the California desert within the framework of a program of multiple use and sustained yield, and the maintenance of environmental quality." In response, the BLM prepared the CDCA Plan while noting that, "Resolution of conflicts in the California Desert Plan requires innovative management approaches for everything from wilderness and wildlife to grazing and mineral development" (BLM 1980c:6).

In preparing the Environmental Impact Statement for the Plan, BLM was aware of the lack of information on the effects of cattle grazing on desert bighorn sheep, stating that:

The exact nature of the

> relationship or impact of cattle on bighorn sheep is not fully known. There are overlaps in diet and some competition for space, particularly around water. But the full degree of competition is not known, particularly as it relates to the CDCA. In order to understand these relationships better, a three to five-year research program is encouraged" (BLM 1980a:44).

The CDCA Plan included elements or chapters on Livestock Grazing, and Wildlife. In the Livestock Grazing Element, BLM (1980c:70–71) stated, "When bighorn sheep and livestock conflicts are identified, Allotment Management Plans (AMPs) will be developed with the specific objective of maintaining or improving bighorn numbers" and that, "During the determination of forage within the allotments where bighorn sheep occur, vegetation areas within the Critical Bighorn Habitat boundary were deleted from consideration for livestock allocation. During the development of individual Allotment Management Plans, the exclusion of these areas from allotments will be addressed."

The Wildlife Element posited numerous management goals and actions, such as:

> Give certain species, designated sensitive by the BLM [which BLM considered desert bighorn sheep to be], special consideration and attention in the planning process because of their present condition and status. The overall objective would be to manage these species and their habitats so as to minimize the potential for Federal or State listing (BLM 1980c:30);
>
> [and]
>
> As part of this Plan, the BLM will study the effects of livestock grazing on desert bighorn sheep in the eastern Mojave Desert (i.e., Kingston, Clark, New York, Providence, Granite, Piute, Woods, Hackberry, Kelso, Old Dad, Ivanpah, and Mescal Mountains, Midhills, and Castle Peaks) to determine (1) the number of bighorn sheep in each mountain range; (2) the health, condition, and population trends in each herd; and (3) the effects of livestock grazing on concentration areas and permanent and seasonal ranges. These studies will be initiated as soon as possible and might require 10 years to complete. If livestock grazing is found to have negative impacts on the bighorn sheep and grazing threatens the health and viability of herds, then changes will be made in grazing allotments so that healthy, viable herds of bighorn can continue to exist in this region (BLM 1980c:32).

Unspecified changes in cattle grazing practices were also required in several Planned Management Areas (Hunter-Cottonwood Mountains, Grapevine Canyon; Soldier Pass-Piper Mountains) where desert bighorn sheep occurred. Other ranges with desert bighorn sheep (Cady Mountains; Old Woman Mountains) were not included because cattle grazing was excluded and did not require special management. The CDCA Plan also required development of Habitat Management Plans (HMPs) for sensitive desert-wide species, including desert bighorn sheep (BLM 1980c:32). There is, however, no record of BLM developing such a plan for those specialized ungulates.

BACKGROUND

The CDCA Plan was developed over a period of four years by the Desert Planning Staff (DPS) based in Riverside, California, and was comprised of experts and scientists in the disciplines of biology, botany, ecology, and rangeland management. The DPS provided BLM managers with final recommendations for management of domestic livestock grazing in allotments (Figure 1) based on an analysis of compatibility with existing BLM policies for management of desert bighorn sheep in the CDCA (BLM 1980a:44–46).

From 1981 to 1988, BLM amended the final CDCA Plan six times in response to local ranchers requesting increased domestic livestock grazing through expansions of existing allotments, designations of additional allotments, and increased forage allocations.

HISTORY OF BLM'S DEVELOPMENT OF THE CDCA PLAN AND MANAGEMENT OF DOMESTIC CATTLE GRAZING IN THE CDCA

Livestock grazing by domestic cattle and sheep on a large portion of public lands in the CDCA has occurred since approximately 1900 (BLM 1980a:15–26). Those areas were identified as formal grazing allotments by the U.S. Grazing Service (established in 1939, and the predecessor of BLM) under provisions of the Taylor Grazing Act of 1934. In 1946, Congress consolidated the General Land Office and the U.S. Grazing Service and established the Bureau of Land Management.

Desert Planning Staff began development of the CDCA Plan with a review of domestic livestock grazing on existing allotments from 1975 to 1980, which was completed prior to finalization of the Plan. During that period, approximately 14,000 domestic cattle grazed on 37 allotments totaling 3,615,922 acres of public lands in the CDCA (BLM 1980a:15–26). The DPS provided findings and recommendations for each allotment (i.e., retain, eliminate, modify; range condition based on field investigations; forage allocations and season of use for cattle and sheep; and allocation of native forage to bighorn sheep and mule deer). No increases in allocations of the existing livestock forage were recommended. When existing forage allocations were greater than the allotment carrying capacity calculated by DPS, the final recommended allocations were lowered to that level.

The DPS conferred with personnel from the California Department of Fish and Game (CDFG; subsequently changed to the California Department of Fish and Wildlife [CDFW]) regarding compatibility of livestock grazing and potential effects on bighorn sheep and mule deer. CDFG representatives included Richard A. Weaver (a recognized bighorn sheep biologist, deceased) and Jerry Mensch (former habitat improvement supervisory biologist, retired).

Desert Planning Staff vegetation and rangeland science specialists calculated total vegetation production in each existing and proposed new grazing allotment based on a combination of ground-sampling and remotely sensed data using Landsat imagery (BLM 1980b:29–37). Perennial vegetation was differentiated by forage and non-forage species; forage production was measured through clipping and weighing air-dried samples, and renewable forage production was calculated based on established 'proper use factors' (i.e., removal of annual growth by domestic livestock) for each plant species. Annual forage allocated to livestock for each allotment was converted to Animal Unit Months (AUMs) by dividing the total weight of livestock forage by 990 pounds, the amount of forage needed to sustain one cow and calf pair, or five domestic sheep, for one month.

Landsat imagery from 1976 to 1980 used in calculating available amounts of vegetation and forage was acquired during a time when vegetation mass was considered above normal due to above-average precipitation. Thus, there was concern among DPS that recommended livestock forage allocations were higher than what could be sustained on each allotment over time (BLM 1980d:68). A priority was placed on monitoring range forage conditions when the CDCA Plan was implemented, with adjustments (decreases) in forage allocations

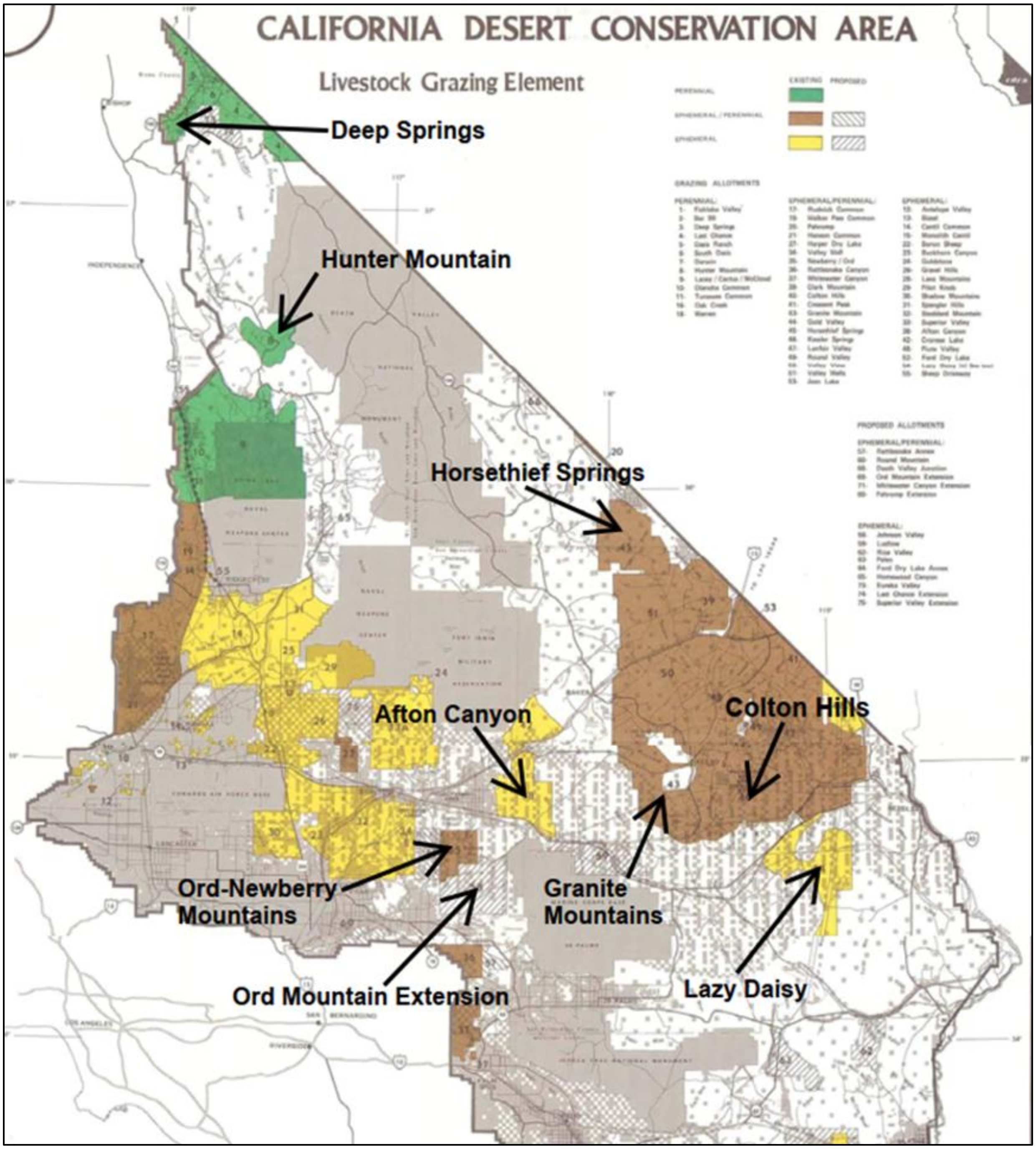

Figure 1. Livestock grazing allotments on public lands in the California Desert Conservation Area and administered by the Bureau of Land Management in 1980.

likely so that range conditions would be maintained or improved to good condition over time. Forage allocations on allotments determined to be in fair or poor condition in 1980 were reduced by 25 and 50 percent, respectively.

Staff also established land-slope classes within each allotment; slopes of 50 percent or greater were considered unsuitable for livestock grazing, resulting in further reductions in livestock forage allocations. Additionally, areas within allotments producing less than 31 pounds/acre of livestock forage were excluded from forage allocations due to negligible use by cattle. Moreover, areas known to be 4 miles or more from water sources were excluded from forage allocations because they were considered out of range of free-roaming cattle.

Utilization levels (i.e., proper use of forage plants) not exceeding 50 percent of current yearly growth of perennial species were used in developing cattle forage allocations. The first forage allocated within allotments was for existing wildlife populations known to occur therein. No increases of livestock forage over existing authorized use for perennial or ephemeral-perennial allotments were made, and when existing use exceeded the adjusted forage allocation for livestock, the allocation accordingly was reduced to that level. Future increases in livestock forage allocations were to be based only on the results of monitoring that verified an increase was warranted. Any additional perennial forage becoming available within an allotment would be allocated first to wildlife, followed by livestock.

FINAL RECOMMENDATIONS AND DECISIONS ON CATTLE GRAZING IN THE CDCA

After conferring with CDFG representatives, DPS analyzed the compatibility of cattle grazing and its effect on wildlife within CDCA grazing allotments and provided BLM managers with its recommendations. Those recommendations were considered by BLM managers when the proposed CDCA Plan was prepared, subsequently were reviewed and approved by the Assistant Secretary for Land and Water Resources in the Department of the Interior and concurred with by Secretary Cecil Andrus on 17 December 1980. Regarding cattle grazing, the final decisions (BLM 1980b:20–22) included (1) no AUM allocation for livestock within Crucial Desert Bighorn Sheep Habitat; (2) eliminate livestock grazing within desert bighorn sheep ranges south of Interstate 40; (3) fence water sources to eliminate competition and stress with desert bighorn sheep; (4) initiate a stewardship program under the guidance of the multiple use advisory council to focus on management; (5) begin a major research program on impacts; and (6) a specific effort should be made to mitigate the effect of these decisions on any livestock operator who's operation will suffer major detriment.

The final Plan clarified these final decisions in the Wildlife Element under Monitoring, noting that:

> BLM will study the effects of livestock grazing on desert bighorn sheep in the eastern Mojave Desert (i.e., Kingston, Clark, New York, Providence, Granite, Piute, Woods, Hackberry, Kelso, Old Dad, Ivanpah, and Mescal mountains, Midhills, and Castle Peaks), and determine (1) the number of bighorn sheep in each mountain range; (2) the health, condition, and population trends in each herd; and (3) the effects of livestock grazing on concentration areas and permanent

> and seasonal ranges. These studies will be initiated as soon as possible and might require 10 years to complete. If livestock grazing is found to have negative impacts on the bighorn sheep and grazing threatens the health and viability of herds, then changes will be made in grazing allotments so that healthy, viable herds of bighorn can continue to exist in this region (BLM 1980c:32).

In the Livestock Grazing Element under Management Prescriptions, the final Plan stated:

> When bighorn sheep and livestock conflicts are identified, Allotment Management Plans (AMPs) will be developed with the specific objective of maintaining or improving bighorn numbers (BLM 1980c:70)
>
> [and]
>
> During the determination of forage within the allotments where bighorn sheep occur, vegetation areas within the Critical Bighorn Habitat boundary were deleted from consideration for livestock allocation [the phrase Critical Bighorn Habitat is misused here; only Crucial Habitat for bighorn sheep was identified and mapped in the final CDCA Plan]. During the development of individual Allotment Management Plans, the exclusion of these areas from allotments will be addressed. The proposed livestock grazing decisions will be issued to the appropriate livestock operators within one year following the effective date of this Plan. The proposed decision will allow 15 days after delivery for the operator to protest it. All decisions will become final and become effective the following grazing season. **Some reductions may be implemented over a five-year period, depending on severity of the reduction** [emphasis added]. No bighorn sheep forage allocation was made on proposed allotments because boundary adjustments have been made to eliminate any conflicts (BLM 1980c:71–72).

AMENDMENTS TO LIVESTOCK GRAZING DECISIONS APPROVED IN THE 1980 CDCA PLAN

Beginning in 1981—less than one year after the CDCA Plan was completed—the agency initiated a series of amendments to expand cattle grazing through (1) increased forage allocations in existing allotments; (2) designating new and expanding existing allotments; and (3) removing some of the special bighorn sheep protection measures included in the final decision on livestock grazing in the Plan. These amendments (Appendix A) affected the Afton Canyon, Colton Hills, Deep Springs, Granite Mountains, Horsethief Springs, Lazy Daisy, and Ord-Newberry Mountains grazing allotments, and are detailed below.

Afton Canyon Allotment

From 1975 to 1980, the Afton Canyon Allotment was grazed by an average of 120 cattle on a seasonal or ephemeral basis (spring season) which were allocated 359 AUMs of forage. It was rated in fair condition due to impacts from off-road vehicle use and other forms of recreation. The primary water source for cattle was the Mojave River, located at the northern portion of the allotment in Afton Canyon. No forage was allocated to bighorn sheep (BLM 1980c:77).

The final 1980 CDCA Plan included

bighorn sheep goals for the Cady Mountains, and wherein BLM stated:

> There are a few isolated herds which are not viable due to resource conflicts and past land use decisions. The populations in these herds will probably not be perpetuated. These herds should probably be monitored. If decline continues, BLM will review with the California Department of Fish and Game the possibilities of relocation or reintroduction. The following herds will be monitored for this purpose: Cady Mountains.

In 1982, the BLM California Desert District Manager sent a letter to the public inviting individuals and other entities, including livestock interests, to review the CDCA Plan and submit comments and recommendations for changing or amending the plan for the purpose of *helping BLM manage your public lands*. As a result, BLM accepted proposed amendment #9 for further consideration. That proposed amendment would change the classification of the Afton Canyon Allotment from Ephemeral (seasonal grazing) to Ephemeral/Perennial (year-long grazing) with an allocation of 2,059 AUMs of forage to cattle and 37 AUMs to support an estimated population of 25 desert bighorn sheep. In its analysis of the proposed amendment, BLM wrote:

> Recent field examinations have shown there is a good base of perennial grasses in the allotment. No increase or decrease in livestock use would occur that would not occur in any case if this allotment remained an Ephemeral allotment. This is just a bookkeeping change to reflect the actual on-the-ground situation (BLM 1982b:4-31–4-33).

The allocation of 2,059 AUMs to cattle was a nearly six-fold increase over the 359 AUMs allocated in the 1980 CDCA Plan. In its analysis of the proposed amendment, BLM acknowledged that cattle grazing exceeded what was authorized in the grazing permit, and that the increase in forage allocation was merely a *bookkeeping error*. The Afton Canyon Allotment overlapped Wilderness Study Areas 251 and 252. The increased forage allocation to cattle would not occur until Congress decided on wilderness designation for the area. Until that time, increased AUMs allocated to cattle would be on a temporary, non-renewable basis. BLM also accepted proposed amendment #10 to expand the Afton Canyon Allotment to the east and to abut the proposed Granite Mountain Allotment expansion, totaling 64,000 acres. In its analysis of proposed amendment #10, BLM noted:

> Recent field examinations indicated that a good amount of forage exists to the east of the present allotment. No arrangement for leasing intermingled private lands has been made. Amendment proponent has made arrangements for leasing the intermingled private lands for livestock use. In addition, acceptance of a smaller Granite Mountain Allotment expansion eliminates the need to create a manageable, abutting boundary with the Afton Canyon Allotment. The expanded allotment will be established but livestock grazing will be allowed on a temporary, non-renewable basis and only in years of good forage production. A livestock water distribution plan will be required prior to authorizing grazing in the expanded allotment (BLM 1982b:4-31–4-33).

BLM also analyzed the impact of the proposed amendments on desert bighorn sheep and stated further:

> The proposed expansion includes portions of the Cady Mountains

> which provide habitat for an estimated population of 25 bighorn sheep. The expansion area is probably used by bighorn passing between mountain ranges. Expansion would result in increased competition between bighorn and cattle for forage, space, and water. This may cause the continuation of past declines in herd numbers. Overall wildlife density and biomass would be reduced due to loss of forage (BLM 1982b:4-33).

The Bureau approved both amendments on 17 May 1983 (BLM 1983a:52–53).

Colton Hills Allotment

The Colton Hills Allotment is located in the eastern Mojave Desert and had been grazed by cattle year-long for many decades prior to 1980. From 1975 to 1980 the allotment was grazed by 240 cattle year-long. BLM designated the allotment in the 1980 CDCA Plan, allocated 2,880 AUMs of forage to cattle and 35 AUMs of forage to desert bighorn sheep, and rated the allotment in good condition (BLM 1980c:76).

In 1985, BLM accepted proposed amendment #1985 #17 from the CDFG to delete the portion of the allotment south of Interstate Highway 40 totaling 8,379 acres. CDFG was concerned over the potential for desert bighorn sheep to be adversely impacted by viral diseases of cattle. In its analysis of the proposed amendment BLM stated, "...only inconclusive evidence exists that cattle in this allotment carry livestock-related diseases to bighorn sheep, but elimination of grazing would ensure that this ... will not occur" (BLM 1985:1–12). The agency approved proposed amendment #17 on 15 January 1987, stating that "Separating desert bighorn ... from livestock would also be beneficial for research being conducted by the CDFG on the effect of grazing on bighorn herds" (BLM 1987b:46).

Deep Springs Allotment

The Deep Springs Allotment is located in Deep Springs Valley in the northern Mojave Desert and is adjacent to the Inyo Mountains. From 1975 to 1980 the Deep Springs Allotment was grazed by 104 cattle and allocated 1,250 AUMs of forage. Range condition was rated as poor, resulting in a reduction of AUMs to 1018 (BLM 1980c:75). The BLM Ridgecrest Field Office submitted proposed amendment #18 in 1981 to change the range condition from poor to good and to allocate 1,250 AUMs for cattle (BLM 1981:33). BLM approved the amendment in 1982 (BLM 1982a:20).

Granite Mountains Allotment

Heavy cattle grazing occurred in the Granite Mountains beginning prior to 1900 (BLM 1980a:21). From approximately 1975 to 1980, the Granite Mountains Allotment was grazed year-long by 395 cattle that were allocated 4,923 AUMs of forage. The Granite Mountains Allotment was retained in the final CDCA Plan, rated in good condition, and was determined to have a perennial forage carrying capacity of 4,145 AUMs. Of those, 4,003 were allocated to cattle, 104 to desert bighorn sheep, and 38 AUMs to mule deer (BLM1980c:76). This revised forage allocation to cattle was a reduction of 902 AUMs from previous use, and that portion of the Granite Mountains occupied by desert bighorn sheep was removed from the allotment.

In 1982, the Bureau accepted a proposed plan amendment from the grazing permitee and BLM Needles Field Office to expand cattle grazing in the Granite Mountains Allotment (BLM 1982b:4-32–4-37). Amendment #12 proposed increasing forage allocated to cattle by 2,304 AUMs, for a total of 6,307 AUMs and expanding the size of the allotment by 28,500 acres to include the Granite Mountains. In accepting the proposed amendments, BLM explained that, "This expansion would result in a 50 percent increase in operator income. The operator would be able to borrow additional money based on the increased preference."

The term preference was used to indicate forage allocated to livestock but has since changed to indicate priority standing for a livestock operator qualified to hold a grazing permit. Ultimately, the Bureau adopted an alternative that excluded 13,440 acres of occupied bighorn sheep range and reduced the requested cattle forage allocation from 2,304 AUMs to 1,048 AUMs, which resulted in a total of 5,451 AUMs—still an increase of 23.8%—allocated to livestock. In adopting this alternative BLM (1983a:56–57) stated, "[T]he 1,048 AUM increase would result in a 25 percent increase in operator income."

Ord-Newberry Mountains Allotment

Cattle grazing in the Ord and Newberry mountains began about 1915 (BLM 1980a:26). Cattle use of the Ord Mountains is believed to have occurred sporadically until about the 1960s, while the Newberry Mountains were grazed consistently by cattle from about 1900 onward.

From approximately 1975 to 1980, the Ord Mountain-Newberry Mountains Allotment was grazed year-long by 108 cattle and was rated in fair range condition due to unauthorized or high levels of historical grazing, off-road vehicle use, and mining. The average forage consumed by cattle from 1975 to 1980 was 1,062 AUMs on an ephemeral (i.e., seasonal) basis (BLM 1980c:76). The amount of forage available to livestock was calculated by DPS staff at 1,031 AUMs, and no forage was allocated to desert bighorn sheep. Due to the range condition rating as fair, 258 AUMs of forage were deducted from the cattle allocation, resulting in a final livestock allocation of 773 AUMs. The allotment was reclassified from ephemeral to ephemeral-perennial after DPS determined that a significant amount of perennial livestock forage existed on the allotment. The Ord Mountain Allotment extension also was approved in the CDCA Plan, which added 41,100 acres to the allotment and included an allocation of 1,572 AUMs of forage for cattle. During preparation of the Plan, DPS conferred with CDFG staff and determined there were no conflicts with bighorn sheep within the allotment, and that the allotment extension did not overlap bighorn sheep range as recognized at the time.

In 1983, BLM accepted proposed CDCA Plan amendment #11 to expand the Ord-Newberry Mountains Allotment to include Southern Pacific Railroad lands surrounding the then current allotment (BLM 1983b:4-24–4-27). In so doing, the analysis considered four alternatives to the proposed amendment including those to (1) expand the allotment to the western boundary of the Twentynine Palms Marine Corps Base; (2) same as 1 but excluding the Rodman Mountains; (3) same as 1 but excluding a part of the Rodman Mountains; and (4) no allotment expansion, and noted that:

> The proposed allotment expansion would allow the livestock operator to use acquired leases on the Southern Pacific Railroad lands. Alternative 3, which excludes many sensitive wildlife and cultural sites in the Rodman Mountains, would avoid many negative impacts of the proposed amendment. However, it would include areas containing a majority of the available forage which are excluded under Alternative 2. Several miles of

fencing would be required to extend natural barriers to keep livestock out of the excluded area. By moving the allotment boundary one-mile north, however, the amount of fencing required would be significantly reduced through the use of natural features. Since part of the proposed expansion lies within the Rodman Mountains Wilderness Study Area, AUMs allocated to livestock would be on a temporary, non-renewable basis until Congress makes a decision on wilderness designation. If it is designated as the Rodman Mountains Wilderness, increased forage allocated to livestock would not occur.

Delaying a decision until an Allotment Management Plan is prepared would allow BLM to consider additional information **on the newly identified bighorn sheep population in the Newberry Mountains** [emphasis added] when the Allotment Management Plan livestock management plans are developed. The CDCA Plan requires that where bighorn sheep and livestock conflicts are identified, Allotment Management Plans will be developed with the specific objective of maintaining or improving bighorn sheep populations. **This is especially important in the proposed allotment expansion area due to the provision in the CDCA Plan that livestock be eliminated in bighorn sheep ranges south of Interstate 40** [emphasis added].

The southern portion of the proposed allotment expansion would be within the Johnson Valley [OHV] Open Area. Existing use of the Open Area would be given priority if conflicts with livestock occur. The livestock operator would also assume full responsibility for livestock which may drift across the eastern boundary and into the Marine Corps Base.

The decision is to approve alternative 3 with modifications. The boundary of the expanded allotment would be extended one-mile to the north in the eastern portion of the expansion area. The expansion would not be implemented until after development of an Allotment Management Plan for the Ord Mountain Allotment (scheduled for completion October 1984). It will include measures to ensure bighorn sheep numbers are maintained. In addition, part of the expanded allotment is within the Rodman Mountains Wilderness Study Area. Increased forage allocation to livestock would not be granted until after Congress makes a decision on wilderness designation. Until that time, livestock forage allocation would be on a temporary, non-renewable basis.

The proposed amendment, as modified, was approved in 1984 (BLM 1984:22–24) and an allotment management plan was prepared in 1985. That plan combined the initial Ord-Newberry Mountains Allotment with the West and East Ord Mountain Allotment extensions and renamed the newly defined area the Ord Mountain Allotment.

Lazy Daisy Allotment

Beginning in approximately 1900, cattle grazing became a permanent activity in and near the Old Woman and Turtle mountains due to the presence of natural water sources and adequate forage, and domestic sheep grazing likely occurred in areas lacking water sources (BLM 1980a:16). The Lazy Daisy Allotment was established as an ephemeral (spring season) cattle allotment in the 1980 CDCA Plan and is located east of the Old Woman Mountains and outside of bighorn sheep range. No forage allocation for bighorn was defined because the allotment boundary was modified to exclude the Old Woman Mountains at that time.

From 1975 to 1980, the Lazy Daisy Allotment was grazed yearlong by 266 cattle and overlapped with occupied desert bighorn sheep habitat throughout the Old Woman Mountains (BLM 1980c:77). The final decision on livestock grazing addressed this allotment, and specifically the issue of effects of cattle on desert bighorn sheep, noting that:

> The allotments south of I-40 will be managed to maximize [bighorn] sheep populations. The conflicts are less here, and the goal has the greatest chance for achievement. This means that the Lazy Daisy [Allotment] lease will be converted to ephemeral with no grazing permitted in the bighorn sheep range in the Old Woman Mountains.

This reclassification (i.e., from ephemeral-perennial to ephemeral) was implemented to reduce cattle grazing impacts on the desert tortoise. At that time no conflict with bighorn sheep existed because of the decision to exclude cattle grazing from the Old Woman Mountains wherein the bighorn sheep occurred.

In 1981, the grazing permit holder and the BLM Needles Field Office submitted proposed amendment #21 to reclassify (restore) the allotment to ephemeral-perennial, expand the allotment boundary to include the Old Woman Mountains where perennial forage exists, and change the grazing season to yearlong (BLM 1981:35–36). This amendment was approved in 1982 and resulted in overlapping of the allotment with occupied bighorn sheep habitat (BLM 1982a:23).

In 1987, CDFG submitted proposed amendment #17 to defer cattle grazing for a period of 5 years to allow for the completion of studies on the effects of cattle on desert bighorn sheep, including competition for forage and the transmission of viral diseases from cattle to those native ungulates (BLM 1987a:Appendix B-10). BLM elected to defer consideration of the amendment, noting that, "By 1987, reanalyze bighorn sheep population and range condition. If ... grazing ... impacts bighorn sheep ..., elimination or reduction of cattle range will be considered." (BLM 1988:Appendix B-10). The Director of the California Department of Fish and Game responded:

> The Department [of Fish and Game] disagrees with BLM's decision to defer this amendment. Our position remains that adequate studies of the type referenced on page B-10 of the plan amendment's EA have been completed, and that these studies indicate the desirability of removing livestock in an effort to lessen adverse impacts to bighorn sheep caused by interaction with cattle. To defer a decision on this amendment is, in our opinion, not in the best interest of wildlife, and particularly not in the best interest of bighorn sheep conservation and management efforts (California Department of Fish and Game 1987).

The Bureau responded, "Studies are still underway in this area. When they are completed, the proposal will be reevaluated to determine if an amendment is warranted" (BLM 1988:Appendix B-10).

Horsethief Springs Allotment

The area that includes the Horsethief Springs Allotment has a long history of cattle grazing dating from approximately 1900, where cattle occurred in the valleys surrounding the Kingston Range during the winter and spring seasons, and in the mountains during the summer (BLM 1980a:19).

The Horsethief Springs Allotment was designated by BLM in 1980 and was grazed year-long by 202 cattle that were allocated 2,424 AUMs of forage; desert bighorn sheep were allocated 9 AUMs . The allotment was classified as ephemeral-perennial range and designation of the allotment and livestock forage allocation was based on use of the allotment from 1975 to 1980; range condition was rated as fair (BLM 1980c:76).

In 2011, BLM prepared an EA for public review and comment on the effects of renewing the cattle grazing lease for 10 years (BLM 2011). The allotment was divided into several fenced pastures, each with livestock water developments. Regarding bighorn sheep, the Bureau stated in the EA:

> The Kingston Range supports a population of desert bighorn sheep (*Ovis canadensis nelsoni*) and portions of the [Horsethief Springs Allotment] are suitable desert bighorn habitat. The desert bighorn is a BLM sensitive species. Bighorn sheep typically occupy steep, mountainous, open terrain, although migration between mountain ranges through valleys has been documented (Bleich et al. 1990). The California Department of Fish and Game (CDFG) manages this species and periodically performs aerial and telemetry surveys on the bighorn sheep population in the Kingston Range. Survey results indicate that bighorn sheep also inhabit the neighboring Mesquite Mountains. Due to frequent travel between these two ranges, the bighorn sheep which may occupy portions of the Allotment are individuals belonging to the Kingston-Mesquite bighorn sheep population (Jaeger 1994).
>
> Desert bighorn and cattle primarily interact at water sources (Wehausen and Hansen 1986), where if such interaction were to occur there is the potential for the spread of diseases from cattle to desert bighorn. Disease, including bluetongue, epizootic hemorrhagic disease and influenza have been implicated in bighorn sheep lamb mortality. While cattle were once thought to be the reservoir for bluetongue, that theory has been disproven and studies show that the viruses are gnat-born (Barrat-Boyes and MacLaughlin 1995). The extent of any potential to spread disease from cattle and how it impacts the desert bighorn population as a whole is unknown, due to small sample sizes in studies and the presence of other factors impacting the sheep populations.

The response that cattle are not the reservoir for bluetongue virus is contrary to the information in the cited literature (Barrat-Boyes and MacLaughlin 1995:1323). Those authors stated clearly, “Cattle are considered to be natural reservoir hosts of BTV, because infection of cattle in BTV-endemic areas is common and inapparent.”

CONCLUSIONS

The California Desert Conservation Area Plan was prepared to comply with Section 601 of FLPMA in order, “...to provide for the immediate and future protection and administration of the public lands in the California desert within the framework of a program of multiple use and sustained yield, and the maintenance of environmental quality."

The final Plan (BLM 1980c) provided for stabilizing and increasing desert bighorn sheep populations and their habitats by ensuring relief from known and potential deleterious effects of cattle. It succeeded in this regard because the subject-matter experts within the Desert Planning Staff had prepared the proposed plan in coordination with bighorn sheep biologists in the CDFG. An additional requirement—that the Bureau prepare a CDCA-wide habitat management plan for desert bighorn sheep—also was included but that plan was never completed.

Beginning in 1981, the BLM solicited, accepted, analyzed and approved numerous amendments to the CDCA Plan that expanded cattle grazing by restoring that permitted activity to the levels existing in several allotments prior to 1980, and expanding the size of others. These amendments effectively eliminated several of the actions contained in the CDCA Plan (BLM 1980c), including (1) no allocation of AUMs for livestock within desert bighorn sheep habitat; (2) elimination of livestock grazing within desert bighorn sheep ranges south of Interstate 40; (3) initiation of a stewardship program under the guidance of the multiple use advisory council to focus on management; (4) initiate a major research program on impacts of livestock grazing on desert bighorn sheep; and (5) mitigate the effects of these decisions on any livestock operator that will suffer a major detriment to their operation.

As written, the 1980 CDCA Plan was short-lived due to subsequent amendments and likely was influenced by changes in the federal administration during 1981. Those changes also resulted in the appointment of new members to the California Desert Advisory Council, which fully supported all of the subsequent amendments and resulting modifications. The Bureau repeatedly approved amendments that were (1) biased against desert bighorn sheep; (2) biased in favor of cattle grazing; and (3) made decisions based on classic reverse-logic arguments—known also as 'justification and rationalization based on false premises'. This history has placed BLM planning in the CDCA in a poor light as being unreliable and has cast the agency as not credible.

This chronology describes details associated largely with the earliest modifications to the CDCA Plan, but management actions having adverse effects on desert bighorn sheep within the California Desert Conservation Area continue. A follow-up paper currently in preparation will review what is known about the effects of cattle on bighorn sheep and include recommendations for future research on this important question.

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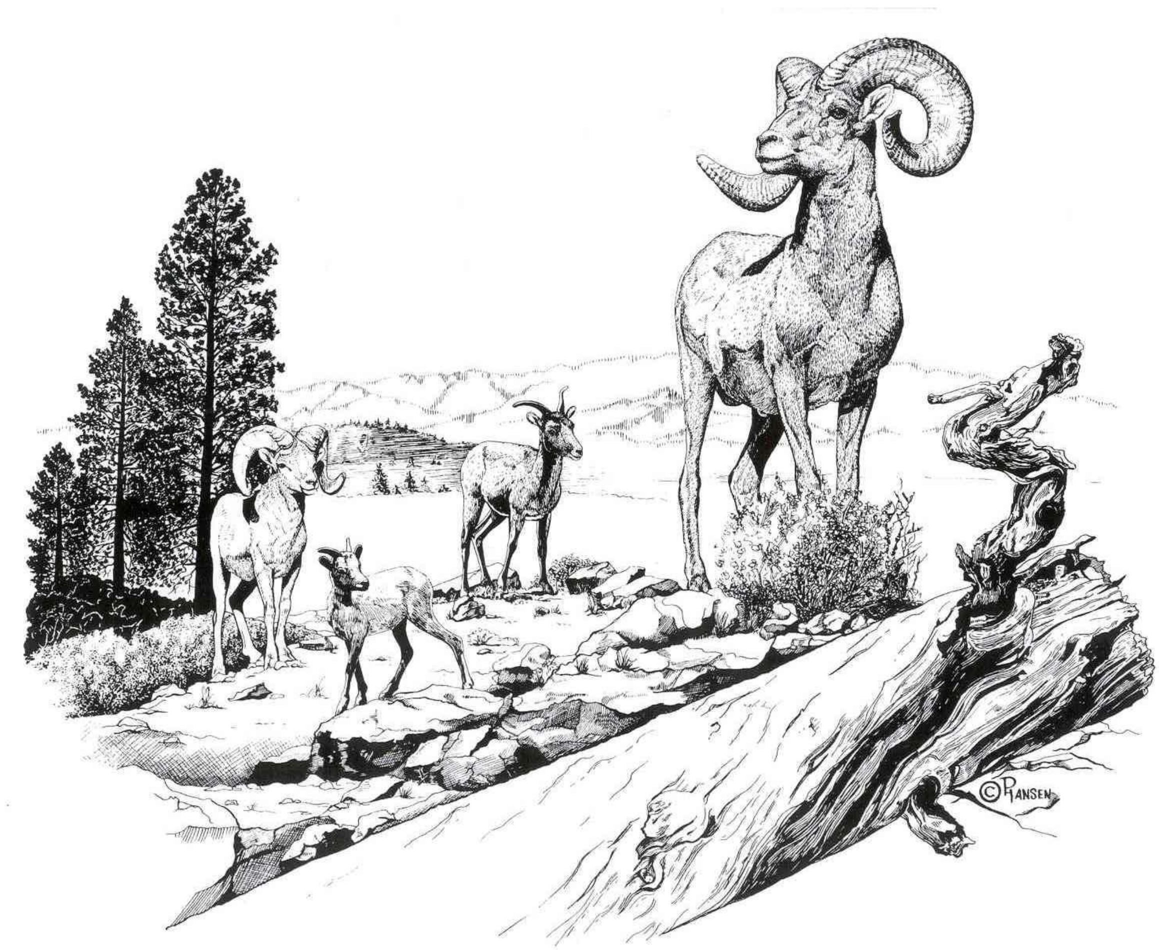


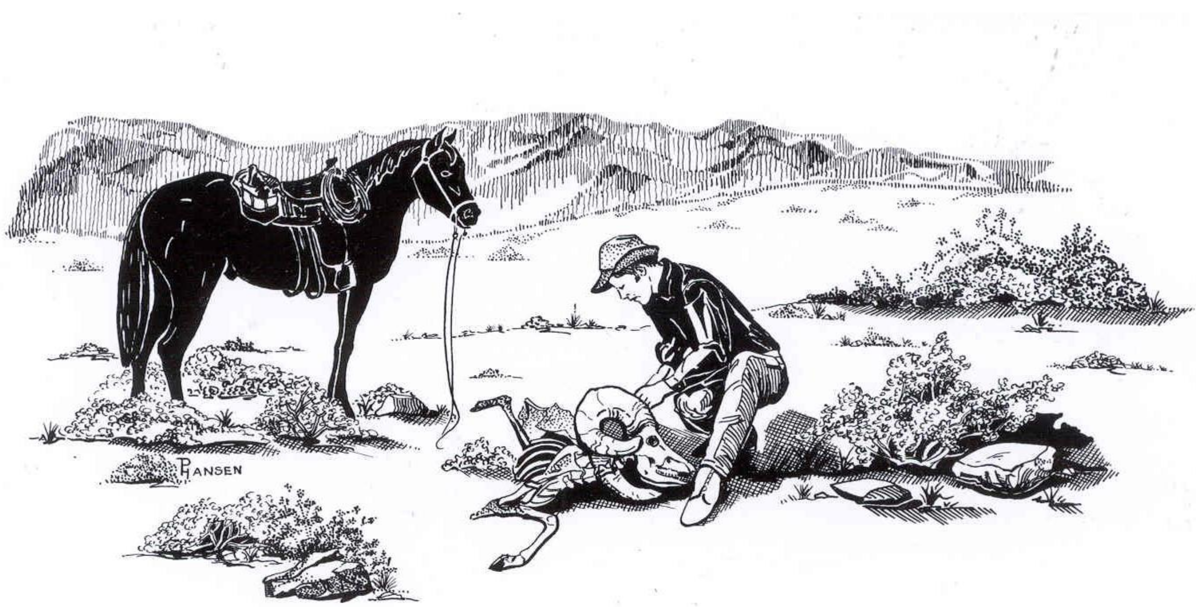
Appendix A. Summary of cattle grazing allotments, desert bighorn sheep populations, forage allocations, amendments proposed to the California Desert Conservation Area Plan (BLM 1980a), subsequent decisions, and appropriate sources of documentation.

Allotment (Acres)	1980 CDCA Plan				Proposed Amendments and Subsequent Decisions	Sources
	Cattle		Bighorn Sheep			
	Number	AUMs	Number	AUMs		
Afton Canyon (41,825)	N/A[1]	359[2]	0	0	1982 #9: Changed from seasonal to year-long use; allocated 2,059 AUMs to cattle and 37 AUMs to bighorn sheep to support an estimated 25 individuals. 1982 #10: Expanded allotment to 64,000 acres and eastward to abut proposed Granite Mountain Allotment; allowed cattle when adequate forage is available.	BLM 1982:4-31–4-33; BLM 1983a:52–53
Colton Hills (147,827)	156	2,880	175	35	1985 #17: Deleted the portion of the allotment south of Interstate Highway 40 totaling 8,379 acres. "*...only inconclusive evidence exists that cattle in this allotment carry livestock-related diseases to bighorn sheep, but elimination of grazing would ensure that this ... will not occur.*"	BLM 1985:1-12; BLM 1987b:46

					1987 #17: "*Separating desert bighorn ... from livestock would also be beneficial for research being conducted by the CDFG on the effect of grazing on bighorn herds ... .*" The proposed amendment was approved by BLM on 15 January 1987.	
Deep Springs (44,062)	N/A	1,018	0	0	1981 #18: Changed allotment condition class from poor to good and allocated 1,250 AUMs for cattle.	BLM 1981:33; BLM 1982a:20
Granite Mountains (276,000)	395	4,003	21	104	1982 #12: Expanded the allotment by 15,060 acres; allocated an additional 1,048 AUMs for cattle; and excluded 13,440 acres from occupied desert bighorn sheep habitat in the Bristol Mountains.	BLM 1982b:4-32–4-37; BLM 1983a:56–57
Horsethief Springs (137,418)	202	2,424	45	9	No amendments affecting this allotment were proposed to the original CDCA plan	BLM 1980
Lazy Daisy (451,617)	N/A	1,353[3]	0[4]	0	1981 #21: Changed allotment from seasonal to year-long use; allocated 3,192 AUM for	BLM 1981:35–36; BLM 1982a:23

					cattle; allowed cattle into bighorn sheep habitat in Old Woman Mountains; required water exploration and development and monitoring of bighorn sheep population and range conditions. "*By 1987, reanalyze bighorn sheep population and range condition. If … grazing … impacts bighorn sheep …, elimination or reduction of cattle range will be considered.*"	
Ord and Newberry Mountains (25,503)	64	773[5]	0	0	1983 #11: Expanded the Ord Mountain allotment to include Southern Pacific Railroad land surrounding the current allotment and excluded the Newberry Mountains.[6]	BLM 1983b:4-24–4-27; BLM 1984:22–24
Ord Mountain Extension (41,000)	131	1,572	0	0	No amendments affecting this allotment were proposed to the original CDCA Plan	BLM 1980

Lazy Daisy (451,617)	266	3,192	0	0	1987 #17: Proposed that cattle grazing in the Old Woman Mountains be eliminated for ≥5 years to study the effects of cattle on desert bighorn sheep, especially viral diseases harbored by cattle. 1988 #17: Deferred consideration of the proposed amendment until 1987 when a full reanalysis of the bighorn populations and range conditions will be completed.[7]	BLM 1987a; BLM 1988: Appendix B-10[7]



Transactions of the North American Wildlife and Natural Resources Conference: An Underutilized Source of Information On North American Wild Sheep

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ABSTRACT Since 1936, the Wildlife Management Institute (WMI) has published papers presented at its annual conference in a series best known as Transactions of the North American Wildlife and Natural Resources Conference (*WMI Transactions*). Papers therein were, until recently, difficult to obtain and represented an underutilized source of information on North American wild sheep (*Ovis dalli*, *Ovis canadensis*). Included in this bibliography are references to 145 papers pertaining to the conservation, management, or ecology of North American wild sheep in the volumes currently available from the WMI. The bibliography will be updated as additional volumes are published on the WMI website.

KEY WORDS bibliography, citations, *Ovis canadensis*, *Ovis dalli*, references, Wildlife Management Institute

Desert Bighorn Council Transactions 57:44–57

The Wildlife Management Institute (WMI) was founded in 1911 by sportsmen and businessmen out of concern for declining wildlife populations. These dedicated conservationists recognized the need for the services of dedicated professionals to address this problem, and established that small, independent organization with a focus on habitat conservation and wildlife restoration (Wildlife Management Institute 2025a). Since 1936, WMI has memorialized the papers presented at its annual conference in a series of formal publications. The first issue was titled, *Proceedings of the North American Wildlife Conference, Wildlife Restoration and Conservation* (International Union for the Conservation of Nature 2025). Thereafter, the publication was renamed *Transactions of the North American Wildlife Conference*, and since 1960 the publication has continued as the *Transactions of the North American Wildlife and Natural Resources Conference* (Wildlife Management Institute 2025b); collectively, these titles are referred to as the *WMI Transactions* throughout the text.

Since its founding, this long-running series (ISSN 0078-1355) has been published on an annual basis, and includes a wealth of information on North American wild sheep. Readers will note quickly that the references provided in this paper do not represent a subject matter bibliography (Warburton 1969), an annotated bibliography (McGlinchy et al. 1971, Krausman et al. 1984), or a topical literature review (Sawyer and Lindzey 2002) that many investigators have found to be useful. Nonetheless, the majority of papers in the *WMI Transactions* listed in the bibliography include abstracts that are easily retrieved if a title is of interest. The primary objective of this review is to call attention to this underutilized source of historical publications specific to the conservation of North American wild sheep, and many of which addressed or foretold the very challenges and issues with which managers are confronted today. A secondary purpose is to make managers and researchers aware that much of the material published in *WMI Transactions* recently has become readily available in electronic format.

METHODS

I searched all issues of the *WMI Transactions* currently available on the Wildlife Management Institute website (https://wildlifemanagement.institute/conference/transactions) for words, or variants thereof, potentially associated with the biology, conservation, or management of North American wild sheep (Table 1). Among these were sheep, desert, mountain, bighorn, thinhorn, *Ovis*, stone, Dall, and wild; Table 1). When one of these was identified in an issue of the *WMI Transactions*, I reviewed the article in which the term appeared to ascertain the context in which it appeared. If it pertained directly to some aspect of the biology, conservation, or management of either bighorn sheep (*Ovis canadensis*) or thinhorn sheep (*Ovis dalli*), the full citation was recorded and included in this bibliography. If it was in reference to the biology, conservation, or management of another taxon but mentioned either species of North American wild sheep for comparative purposes, the citation also appears in this bibliography. If not mentioned in either of those contexts, the reference was not included.

RESULTS

The Wildlife Management Institute website now (2023) includes downloadable versions of the majority of the *WMI Transactions* (Table 1). As of the present, 61 of the 88 (70%) volumes published to date are available as searchable PDFs, and 52 of the searchable volumes contained a total of 145 papers germane to research on or management of North American wild sheep (Appendix A). Of the volumes currently available, 85% included papers on thinhorn sheep or bighorn sheep in the context of management, conservation, or ecology. Those volumes not available at the time this bibliography was prepared are being scanned and will be added to the WMI website (T. Wasley, WMI, personal communication). This bibliography will be updated accordingly

DISCUSSION

Numerous important papers published by early students of North American wild sheep have appeared in the *WMI Transactions*, many of which I previously had not been aware of but wish I had been. Although this phenomenon may be in part what Fisher (2021) described as 'generational amnesia', perhaps a more reasonable explanation involves the heretofore limited distribution or availability of the *WMI Transactions*. Some recent papers that failed to make reference to important works published in that series include Whiting et al. (2023), who reviewed the status of translocations of wild sheep with an emphasis on the challenges that continue to haunt that conservation strategy. Many issues concerning the conservation of North American wild sheep resurrected by Whiting et al. (2023) had been posited much earlier, and were published in the *WMI Transactions* by Murie (1940) or Kennamer and Braun (1990)—who had addressed the use of appropriate source stock for translocations long before others did so (Ramey 1995, Wehausen 1989, Wiedmann and Sargeant 2014, Brewer et al. 2014, Bleich et al. 2018, Brewer and Bleich 2023).

Table 1. A total of 88 volumes of the *WMI Transactions* was produced from 1936 to 2023, and 61 (69%) of those were available on the Wildlife Management Institute (WMI) website. Listed below are the volumes not yet available, those with negative results for wild sheep, and the search terms used.

Year (Volume) Not Available For Review	Reviewed But With No Information On NA Wild Sheep	Search Terms
1936 (1)	1959 (24)	bighorn
1937 (2)	1962 (27)	big horn
1938 (3)	1965 (30)	Dall
1939 (4)	1970 (35)	Dall's
1942 (7)	1995 (60)	mountain
1943 (8)	2010 (75)	Ovis
1944 (9)	2013 (78)	*Ovis*
1948 (13)	2014 (79)	sheep
1949 (14)	2018 (83)	Stone
1950 (15)		Stone's
1951 (16)		thinhorn
1952 (17)		thin horn
1957 (22)		wild
1967 (32)		
1968 (33)		
1978 (43)		
1987 (52)		
1998 (63)		
1999 (64)		
2001 (66)		
2006 (71)		
2011 (76)		
2012 (77)		
2020 (85)		
2021 (86)		
2022 (87)		
2023 (88)		

In another example, Hunter et al. (1946) shed light on trapping and translocating bighorn sheep many years before specific guidelines or recommendations (Wilson et al. 1975, Schmidt et al. 1978, Remington and Fuller 1989, Foster 2001, George et al. 2008, Wyoming Game and Fish Department 2022) became generally available.

Other examples include an important paper (Cowan 1947) that largely has been missed by other investigators and addressed interspecific competition between native bighorn sheep and sympatric herbivores, and Krausman and Leopold (1986) emphasized the value of small populations of wild sheep just as, or shortly before other investigators (Schwartz et al. 1986, Bleich et al. 1990, 1996) suggested the disjunct distributions of wild sheep on the landscape functioned as metapopulations. Further, pertinent information on the impacts of feral equids (Johnson and Petroelli 1969) appeared in the *WMI Transactions* prior to passage of the Wild and Free-Roaming Wild Horses and Burros Act of 1971, and shortly thereafter Carothers et al. (1976) emphasized many of the issues pertaining to the impacts of free-ranging horses and burros on native species, a topic that continues to generate concern and receive increasing attention (Bleich et al. 2021, Rubin 2021, Rubin et al. 2021, Bleich 2022).

Many other papers germane to the ecology, management, and conservation of North American wild sheep have appeared in the *WMI Transactions*, and have been missed by previous authors. Now that these volumes are becoming available in a searchable electronic format, future investigators will have far greater access to these early and, frankly, historical publications on native mountain ungulates. I intend to update this bibliography as additional *WMI Transactions* become available in a searchable format, and present the results in future *Transactions.*

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Eastern Sierra Mountain Lion Population Dynamics and Effects on Sierra Nevada Bighorn Sheep: A Half Century History

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ABSTRACT The mountain lion population in California increased rapidly following the 1959–63 termination of more than half a century of efforts to eliminate that predator. Intensive field efforts documented the beginning of a rapid surge in predation of Sierra Nevada bighorn sheep (SNBS) that began at the end of the 1970s. The local mountain lion population that overlapped the range of these sheep peaked in the late 1980s, then experienced a major crash in the 1990s following a similar crash of the local deer population during the second half of the previous decade. Efforts at the beginning of this century to protect SNBS from excessive lion predation greatly delayed the recovery of the mountain lion population, which then increased rapidly when that population control was relaxed, and now is similar to its size in the late 1980s. The population dynamics of SNBS clearly have been greatly affected by the dynamics of the local mountain lion population. This paper traces that history, including the influence of management decisions on those dynamics. This past history makes clear that the future of these sheep will be dependent on timely removal of lions preying on them until an ecosystem change perhaps occurs that significantly reduces what appears to be an unnaturally high mountain lion population.

KEY WORDS mountain lion, *Puma concolor*, bighorn sheep, *Ovis canadensis*, California, population dynamics, predation, predation management, Sierra Nevada bighorn sheep, endangered

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Over the past four decades, data have accumulated from Texas and New Mexico (Rominger 2018) to southern Alberta (Festa-Bianchet et al. 2006, Pelletier et al. 2006) documenting that mountain lion (*Puma concolor*) predation on bighorn sheep (*Ovis canadensis*) can cause declining population trends. SNBS is one such population (Wehausen 1996), a separate subspecies (*O. c. sierrae*) native only to the southern and central Sierra Nevada (Wehausen and Ramey 2000, Wehausen et al. 2005). SNBS are most closely related to desert bighorn sheep (*O. c. nelsoni*; Ramey 1995), but once were thought to be part of the California subspecies further north (Cowan 1940).

Festa-Bianchet et al. (2006) characterized mountain lion predation on bighorn sheep in southern Alberta as a stochastic demographic force because of an apparent temporal unpredictability. In contrast, Gammons et al. (2021) found for SNBS that predation levels were correlated with the size of the regional mountain lion population, thus predictable and readily amenable to management. Given this influence of the size of the mountain lion population along the eastern base of the Sierra Nevada, in and immediately adjacent to SNBS habitat (Figure 1), here we trace the dynamics of that lion population over the past half century, and the interplay between those dynamics and the population dynamics of SNBS. Lion numbers near SNBS habitat have been tracked closely this century as part of the recovery program for SNBS since they were listed as endangered (Davis et al. 2012). We extend our history prior to that recovery program using various data sources, including close monitoring of the lions using Round Valley, which began late in 1991. Round Valley is situated between Highway 395 and the northern half of the Wheeler Ridge herd polygon west of Bishop (Figure 1). We also trace the history of predation management relative to SNBS.

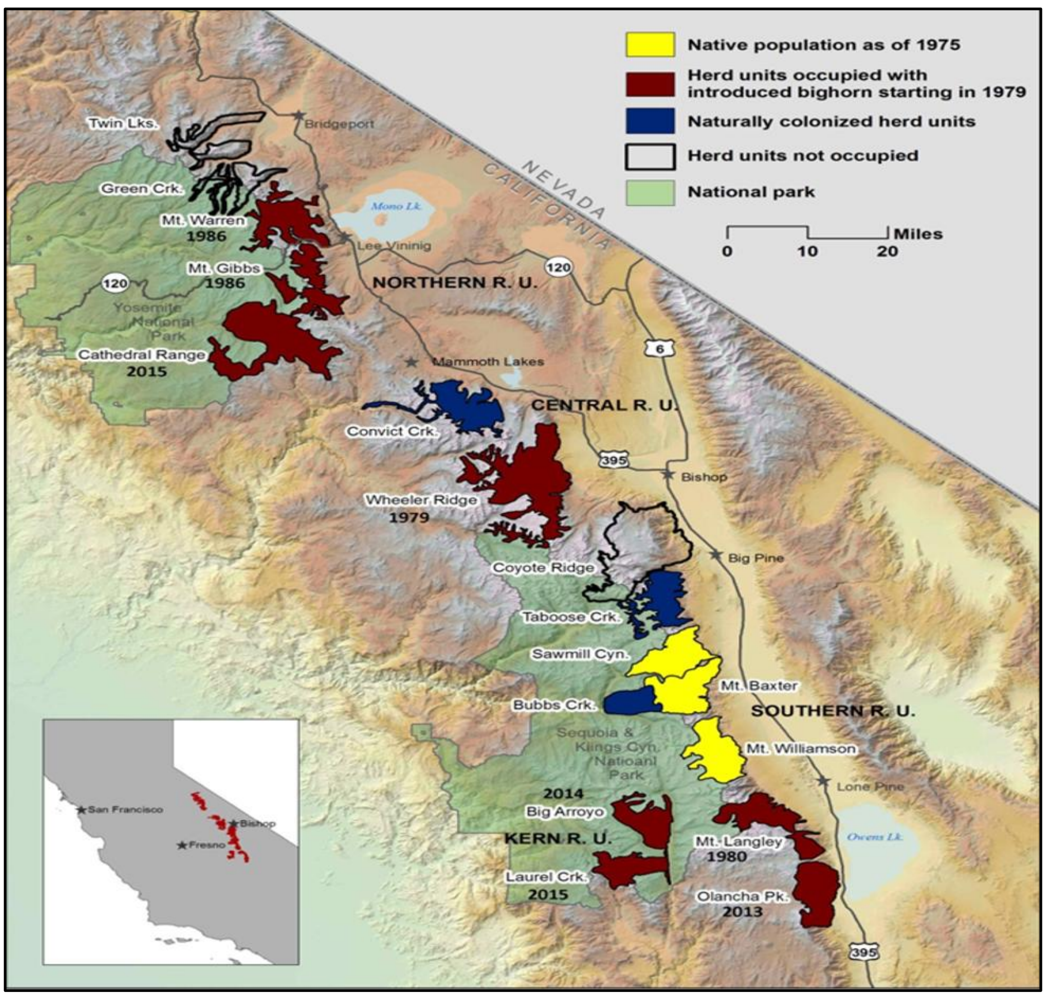

Figure 1. Distribution of Sierra Nevada bighorn sheep herd units in 2022 and their histories relative to sources of occupation (native, re-introduced, naturally colonized, and unoccupied), and the year of initiation for re-introduced herds. The four Recovery Units also are identified.

EARLY MOUNTAIN LION HISTORY

Bounties for mountain lions were initiated in California in 1906 (Dellinger and Torres 2020), giving the public the opportunity to be paid for lions killed. That timing may have reflected an earlier decimation of wolves in California. The absence of wolves in much of California would have provided mountain lions the opportunity to greatly expand the habitat they used (Ruth et al. 2019), leading to major population increases. Bounties on mountain lions were likely a response to an evident increase in livestock and deer losses to lion predation, to which state professional lion hunters also were added. A retrospective population analysis (Dellinger and Torres 2020) estimated that more than half a century of those efforts to eliminate mountain lions in California successfully reduced the California lion population to about one thousand.

In the eastern Sierra there was a famous lion hunter named Charlie Tant who lived in Benton at the base of the northern White Mountains. He took advantage of those bounties and probably played a key role in reducing the local lion population to a low level. We cannot know how low that level was, but there is a small amount of information indicating that at least periodically some lions were present. Given about a thousand lions still remaining in California in 1963, with many in the western Sierra Nevada, lions would be expected to have periodically migrated to the eastern Sierra.

Bounties were terminated in California in 1963 (Dellinger and Torres 2020), as were state lion hunters in 1959 (Sitton 1972). Sport hunting was terminated in 1972 for 15 years by legislative action, then permanently in 1991 by a voter initiative (Dellinger and Torres 2020). Together, those changes released a significantly depressed mountain lion population into a prey base of high deer numbers, allowing the lion population to expand geographically and in size.

THE PAST HALF CENTURY

The first author put in intensive field work on the three surviving herds of SNBS in the winters of 1975-76 and 1976-77 when these bighorn sheep were concentrated on low elevation winter ranges along the escarpment base in the southern Owens Valley, where they overlap winter concentrations of deer. In those first two winters he found no evidence of mountain lion predation. In the next two winters of similarly intensive field work, he encountered three lion kills, one in each of the three surviving bighorn sheep herds (Figure 1). Lion kills of SNBS on those winter ranges then accelerated rapidly (Wehausen 1996). By 1983 lion predation was clearly competing for sheep needed by the SNBS restoration program that began in 1979 (Bleich et al. 2021). Those changes apparently reflected a rapidly increasing mountain lion population in the Eastern Sierra, consistent with a rapidly increasing statewide trend in lion numbers at that time (Dellinger and Torres 2020).

The mountain lion population grew to peak numbers in the eastern Sierra in the second half of the 1980s. In that half decade the local mule deer (*Odocoileus hemionus*) population experienced a steep decline that was documented to be 84% in Round Valley (Pierce et al. 2012). Six consecutive years of winter drought that began in 1987 likely contributed to that population crash, but the decline began three years before the effects of that drought might have influenced that mule deer population (Monteith et al. 2014). What also coincided with that high mountain lion population was the widespread decline of SNBS (Figure 2). Then, throughout the decade of the 1990s the eastern Sierra mountain lion population declined steadily and steeply, documented in Round Valley to be a 90% decline in six years (Pierce et al. 2012). Underlying that decline in Round Valley was very low reproductive success in which most young were dead before dispersal age. Only two females survived to adulthood, but both died very young at 2.5 and 3.4 years of age. Low availability of prey likely caused this overall very low survivorship (Logan 2019). It is unlikely that any female offspring successfully reproduced.

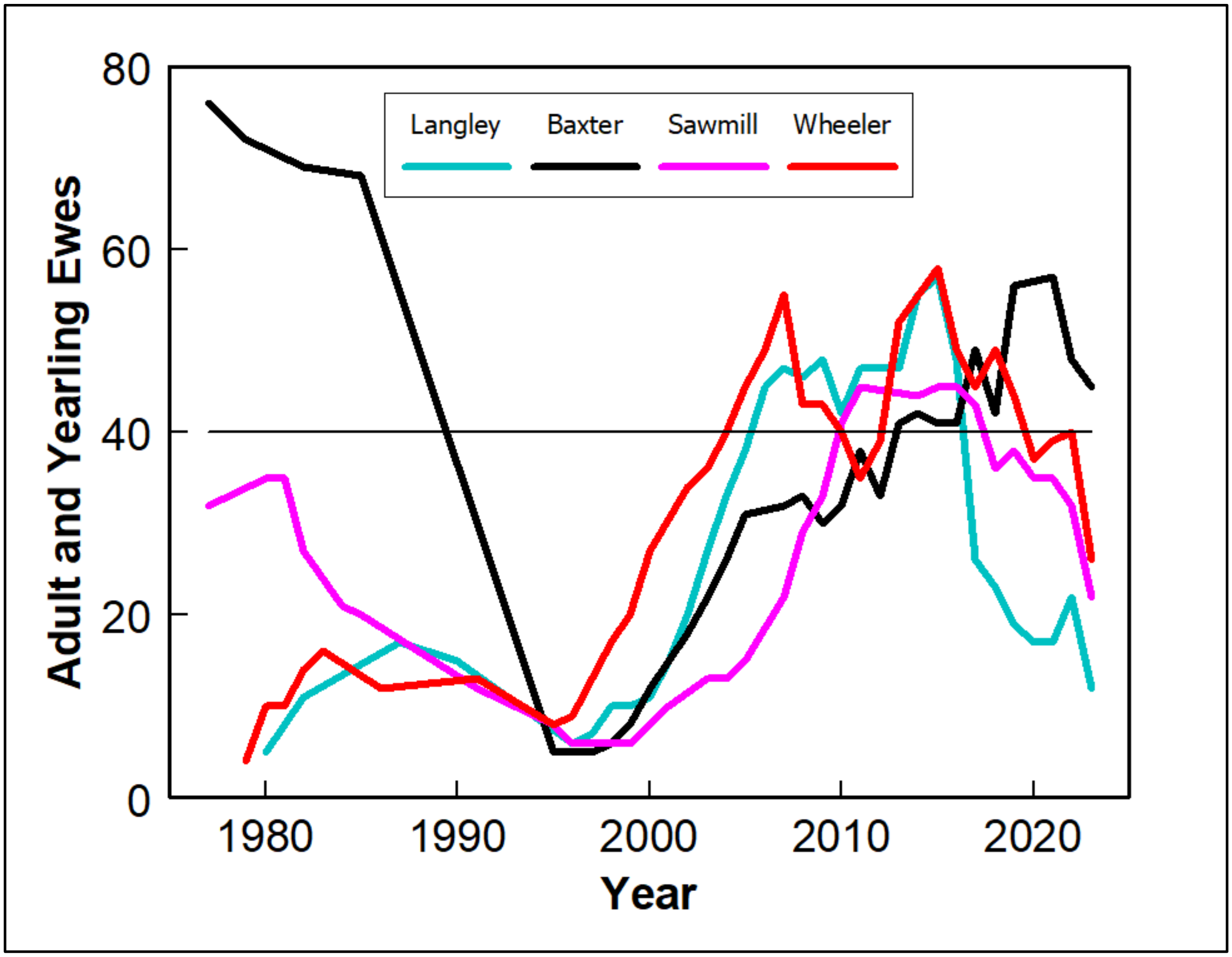

Figure 2. Dynamics of the reproductive base of the four largest populations of Sierra Nevada bighorn sheep, 1978-2023, two of which are native populations (Mount Baxter and Sawmill Canyon herds), and two of which (Wheeler Ridge and Mount Langley herds) were reintroduced, respectively, in 1979 and 1980. Data since 2000 largely were generated by the CDFW Sierra Nevada Bighorn Sheep Recovery Program, available in these annual reports: Stephenson et al. 2011, 2022; Few et al. 2012, 2013; Runcie et al. 2014, 2015; Greene et al. 2016, 2017, 2018, 2019, 2020, 2021. The horizontal line at 40 ewes is the minimum population size established for translocation removals. Data are minimum population sizes from surveys that typically find most of the population.

The mountain lion population reached its low point in 1999–2000 (Pierce et al. 2012, Davis et al. 2012), coincident with when SNBS received endangered status (USFWS 2007). The end of that lion population decline correlated with when SNBS populations began increasing (Figure 2). Lion removals to protect SNBS as an endangered species in the first decade of this century slowed, and even temporarily reversed, the increasing trend of the mountain lion population (Davis et al. 2012). That limitation of predation losses allowed the SNBS population to grow to its largest size in at least half a century (Figure 2). It took, however, only a few years lapse in lion removals to allow the eastern Sierra mountain lion population to make large gains. Since 2017 that lion population has resembled what it was in the late 1980s. For local lion subpopulations in three defined zones that overlap SNBS herds, the total lion population grew from 13 in 2000 (Davis et al. 2012) to 55 in 2022 (Stephenson et al. 2022). For Round Valley, which overlaps the Wheeler Ridge bighorn sheep herd (Figure 1), the reproductive base of the mountain lions that use that valley in the cool season has grown from 1 female in 2000 (Davis et al. 2012) to 11 in recent years.

Local mule deer in the Owens Valley region have seen a steep decline in annual survivorship since 2014 correlated with increasing mortalities from mountain lion predation (McKeever et al. 2023). The associated mule deer population decline, however, has not been as steep as it was in the second half of the 1980s, perhaps because this decline began at about half the deer density of 1985 (Monteith et al. 2014).

While numerous lions have been translocated in recent years to protect SNBS, those removals have been readily replaced and have not adequately protected SNBS until very recently. Unlike the 1990s, the eastern Sierra mountain lion population has shown no indication of declining reproductive success at its current high population level and a declining deer population.

Mountain lions in the eastern Sierra can be thought of as a subsidized predator. In the Mono Basin adjacent to the northern recovery unit (Figure 1), a population of feral horses (*Equus ferus caballus*) has increased in size in recent years, as has their use as prey by mountain lions. In the Owens Valley, the lion prey base includes tule elk (*Cervus elaphus nannodes*) which, like the horses, are not native. Additionally, there is the absence of wolves (*Canis lupus*). Mountain lions in North America evolved under natural persecution from wolves, black bears (*Ursus americanus*), and grizzly bears (*Ursus arctos horribilis*); all are behaviorally dominant to lions and sometimes consume their kills (Elbroch et al. 2020). Wolves are also direct competitors with mountain lions for the same prey, and they kill lions, especially kittens (Elbroch et al. 2020). Elbroch et al. (2020) concluded: “Historically, wolves may have limited pumas across North America and dictated puma scarcity in systems lacking sufficient refugia to mitigate the effects of competition”, a relationship that Rominger (2018) corroborated with historical anecdotal information. As an ambush predator that can negotiate steep, rocky terrain, mountain lions are an effective predator of bighorn sheep, in contrast to wolves and bears (Rominger 2018).

Between feral horses, tule elk, and the absence of wolves, the eastern Sierra ecosystem appears to be significantly altered in ways that greatly benefit mountain lions. The finding by Gammons et al. (2021) that the level of predation losses of SNBS was correlated with the size of the local mountain lion population highlights the fundamental conservation issue between these two native species that is driven by a seemingly unnaturally high population of lions.

PREDATION MANAGEMENT

There are now multiple examples from the eastern Sierra documenting that SNBS populations can thrive when mountain lion predation is adequately reduced, whether by a natural decline in lion numbers or by human removal of lions to protect SNBS. In contrast to extreme winters as a population depressing factor for SNBS, there is a management option available to mitigate losses to lion predation, thus its emphasis in the Recovery Plan for these sheep (USFWS 2007). Above we have summarized the huge dynamics in the lion population over the past half century — dynamics that have greatly influenced the dynamics of SNBS populations. In 1984, the Sierra Nevada Bighorn Sheep Interagency Advisory Group produced the first recovery and conservation plan for these sheep, 15 years before they were listed as endangered. That plan set a goal of creating two additional large populations of SNBS that could serve as sources of translocation stock to restore these sheep to vacant historic habitat or augment small populations (Bleich et al. 1991). It took 29 years to reach that goal (Figure 2), largely due to mountain lion predation that was mostly unmitigated in the final two decades of last century prior to endangered listing. Inadequate regulatory mechanisms relative to the management of mountain lion predation in California was a primary reason why SNBS received federal endangered status (USFWS 2007). That management limitation also was the primary reason why the federal government was petitioned to list these sheep as endangered, to allow federal law to supersede state law derived from the 1990 voter initiative that made mountain lions in California a specially protected mammal. That initiative itself had superseded prior authority of the California Department of Fish and Wildlife (CDFW) to remove lions to protect bighorn sheep or other species.

The Recovery Plan for SNBS (USFWS 2007) called for the needed mitigation of mountain lion predation on those sheep. That plan also specifically called for giving consideration to the viability of the local mountain lion population (USFWS 2007). Over the history of the recovery program since 2000, there has been no indication that the viability of the local mountain lion population has been compromised (Gammons et al. 2021).

CDFW has been the lead agency of the recovery program for SNBS since the California State Legislature created and funded that program in 1999. Beginning about 2013, the Sacramento CDFW office began shifting the focus of the SNBS recovery program from those endangered sheep to mountain lions in multiple ways. First, decision-making authority relative to removal of mountain lions to protect SNBS was shifted from the local CDFW office to the Sacramento headquarters, requiring requests for permission to remove lions documented to be killing SNBS. Second, culling of lions killing SNBS was shifted to translocating lions. Third, a predator management plan called for in the Recovery Plan for SNBS (USFWS 2007) was not approved by the Sacramento CDFW office, and thus could not be implemented. Those management policy changes took place with no consultation with the 26 governmental and nongovernmental stakeholder organizations listed in the Recovery Plan (USFWS 2007) that all signed off on the final draft of that plan, understanding that some mountain lions would have to be culled to protect SNBS. The time lags inserted into the predation management system by these policy changes had major negative effects on the dynamics of SNBS due to excessive predation losses (Figure 1). It has taken outside pressure from the first author (e.g. Wehausen 2024) to shift focus away from a predator that still numbered about a thousand in California after more than half a century of intense culling by humans (Dellinger and Torres 2020), and return the focus to the viability of SNBS as a unique, endangered animal with very limited distribution. Mountain lions preying on SNBS are now removed in a timely manner based on local decisions, and the predator management plan has been revised and approved. Now, however, it will take numerous years for key SNBS populations to recover from the effects of recent years of excessive lion predation to again reach the goal set in the 1984 Plan. The future dynamics of SNBS populations affected by lion predation will be a critical test of how well the current CDFW predation management approach is working.

The Recovery Plan for SNBS (USFWS 2007) set its recovery goal for bighorn sheep numbers at a minimum of 305 ewes in a specific distribution across the four recovery units (Figure 1). Once that goal is reached, downlisting to threatened status is possible, and a hands-off approach will be initiated for one sheep generation (7 years). Recovery units will have to maintain sheep numbers during that time period for delisting to be considered (USFWS 2007). The change in approach to lion removal that began around 2013 effectively created that "hands-off" experiment, even though it was not entirely "hands-off". The lesson that should be learned from that episode is that a "hands-off" approach to the management of SNBS is not currently a viable option. That may change if wolves colonize the eastern Sierra, but how wolves might alter the local mountain lion population is unknown. In the absence of a major ecosystem change that significantly reduces lion predation on SNBS, delisting of SNBS appears not to be an option. Gammons et al. (2021:465) made that clear with the statement that "predation monitoring and management are likely going to be a part of the management toolbox for SNBS for the foreseeable future". To project a different future is to allow wishful thinking to override a considerable body of past evidence.

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State Status Reports

Status of Bighorn Sheep in Arizona—2022

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Desert Bighorn Council Transactions 57:68–72

POPULATIONS

Estimates of Arizona's desert bighorn sheep (*Ovis canadensis mexicana* and *O. c. nelsoni*) populations have remained relatively stable statewide. Ram:100 ewes and lamb:100 ewe ratios averaged 62:100:22 in 2022 with 1,979 bighorns observed. Arizona currently has an estimated population of 5,000–5,500 desert bighorn sheep based on survey data.

The desert bighorn sheep population in the Kofa Mountains (Units 45A, 45B, and 45C) in southwestern Arizona remains strong and once again surpassed the recovery threshold met in 2019. The 2021 aerial survey resulted in a population estimate of 963 bighorn sheep, exceeding the pre-crash estimate of 800 in 2000. The Black Mountains (Units 15A, 15B, 15C, and 15D) of northwestern Arizona experienced a disease outbreak which resulted in a 53% decrease in the number of bighorn sheep observed on a survey in 2016 and 2017. Even though Unit 15D is somewhat isolated from the rest of the Black Mountains by Highway 68, the disease crossed the highway and impacted that portion of the population. Aerial surveys in 2022 showed signs of recovery in Unit 15C, but a slight decline in Unit 15BW and 15D.

Rocky Mountain bighorn sheep (*O. c. canadensis*) continue to prosper in Arizona. This population is estimated at 1,200 animals. Ram:100 ewes:lamb ratios averaged 60:100:30 in 2022 with 601 observed. Arizona surveys about one third of the Rocky Mountain and desert bighorn populations annually, although some areas of specific concern or recent translocations are surveyed annually. No aerial surveys were conducted in 2020 due to human safety concerns associated with Covid-19.

RESEARCH

Disease Monitoring and Corridor Studies

A total of 173 samples were collected from bighorn sheep in 2021 through capture, hunter submission during check-in, roadkill inspection, or other encounters and tested for disease agents. In 2022, 115 were submitted. Results showed the presence of *Mycoplasma ovipneumoniae* (*M. ovi*) in Units 12BE, 15C, 15D, 16A, 16B, 39W, 40A, 40B, 43B, 44B, and 46B. All of these are units with known or suspected endemic populations. The positive sample in unit 39W was collected from a domestic goat.

Region 6 staff obtained permission through an MRDG/EA to complete several capture efforts over a 5-year period within FS Wilderness on the Tonto National Forest to monitor for disease and track movements in response to fires. Special conditions included restricting helicopter landings to less than 30 in a 1-year period. In 2021, 21 collars were deployed in or near the approved Wilderness Areas; 10 collars were deployed in 2022 on the Tonto National Forest in Units 23 and northern 24A. Monitoring the movements of these collared bighorns have allowed Department staff to modify their aerial survey routes, thereby producing more effective surveys.

In February of 2022, 26 bighorn sheep (9 rams, 17 ewes) were captured across 5 mountain ranges in Unit 16A. All were collared to aid in survey efforts, and sampled to establish a disease profile for Unit 16A. Four mortalities occurred in the first 6 months following deployment; the 4 collars were redeployed in November, 2022. The data collected by these collars revealed long-range movements by bighorns from this herd into other units (Unit 44A) as suspected; eleven of the 26 bighorn sheep tested were positive for *M. ovi*. Knowledge of their increased distribution led to the addition of 10 hours of aerial survey time for a total of 28 hours to sufficiently monitor this population.Five desert bighorn (3 rams, 2 ewes) were captured and collared in Unit 43B in Nov 2022 to monitor catchment selection and seasonal corridor movements in the Yuma Proving Grounds. This information will prioritize water hauling activities during the limited windows of accessibility into the restricted airspace, as well as guide decisions about permit allocations for the accessible hunt areas.

Galiuro FireScape Project

In 2016, the Safford District of the United States Forest Service (USFS) began implementing the Galiuro FireScape, an 8-year plan to treat 137,000 acres of USFS land in the Galiuro Mountains (Units 31/32) with prescribed fire. The long-term goal of the Galiuro Firescape is the return of the historical natural fire regime. The treatment area was divided into 8 burn units, one unit treated each year. As of February 2022, over 70,000 acres have been treated.

In conjunction with this project, the Department augmented populations of desert bighorn sheep in areas with suitable conditions in Aravaipa and Redfield canyons in 2016 (n = 31); 2 rams and 8 ewes were fitted with GPS-transmitting collars to evaluate the post-release success of populations and response to the prescribed burns. The collars deployed in 2016 reached the end of their life expectancy before prescribed burns were completed in currently utilized habitat, so the Department collared an additional 9 rams and 1 ewe in November 2019. The data from the ewe collared in 2019 showed longer periods of use in an area treated with prescribed fire in February of 2022.

As part of an augmentation in 2021, another 8 collars were deployed (3 rams, 5 ewes). Five of those collars remained active through summer 2022; one of the collared rams moved farther north than any known collared ram from 2015 to 2022.

Maintaining active collars on this landscape has allowed for the accumulation of GPS data identifying the home range and habitat use by bighorns in occupied habitat before and after prescribed burn efforts. Unused desert bighorn sheep habitat and a potential corridor between the 2 existing desert bighorn sheep populations have been identified, as the gap between the Aravaipa and Redfield bighorn sheep populations has closed from 30 km to 11 km.

The existing collars will continue to gather post-treatment home range data and habitat use, thereby allowing for the comparison of pre- and post-treatment habitat use by bighorn sheep in the Galiuro ecosystem. Current and anticipated data collected from the collared animals is helping direct the implementation of the Galiuro Firescape. As the burn units between and adjacent to the 2 populations continue to be treated, it is possible that connections between the herds and an expansion into restored habitat may occur, negating the need for future translocations into the Galiuro

Mountains. In addition, this study could be developed into a model to predict other areas where prescribed fire may be used to improve habitat quality for bighorn sheep.

HABITAT

The Department works with private organizations (primarily the Arizona Desert Bighorn Sheep Society (ADBSS) and the Wild Sheep Foundation (WSF)) and federal agencies to achieve habitat improvements for bighorn sheep. In 2021, Development Branch and the ADBSS teamed up to repair 2 catchments in bighorn sheep habitat in Unit 28. The same collaboration produced repairs to another bighorn sheep rainwater catchment in Unit 32 in 2022.

Several large fires burned within bighorn sheep habitat in the east-central part of Arizona in 2021. The Telegraph and Mescal Fires burned an estimated 180,757 acres combined in Unit 24A in June of 2021 impacting large swaths of bighorn habitat in the Mescal Mountains. The Backbone Fire burned 41,924 acres in the Mazatzal Mountains, including bighorn habitat within and outside of the Mazatzal Wilderness Area (Units 22/24A). Special surveys and collaring efforts are being conducted to monitor the effects of these large wildfires on bighorn populations in these units.

Water hauling due to extended periods of drought has become regular practice in many parts of the state, with Region 4 (SW AZ) bearing the brunt of the activity due to the high number of catchments on the landscape. In 2021, Regional staff, Volunteers, and Development Branch staff delivered a staggering 710,226 gallons of water to catchments, many of which solely benefit bighorn sheep. About 110,000 were delivered by helicopter to catchments inaccessible to water trucks. Drought levels improved slightly in 2022, resulting in a reduction in demand for hauling and helicopter delivery however, 268,560 gallons were delivered to Region 4 catchments, again mostly benefiting bighorn sheep alone, due to the location of the catchments and lack of deer or other wildlife in those areas. The Department is actively working to improve collection and storage capacity at many of these waters so the demand for hauling water is continually reduced.

HARVEST

Bighorn sheep permits remain the most sought-after hunting permits in Arizona. In 2022, 25,115 individuals applied for the 140 desert and Rocky Mountain bighorn sheep permits available for draw.

During the 2022 season, 143 hunters participated (including 3 auction tag-holders), harvesting 135 rams in 726 days of hunting. Hunt success was 96%. The age of harvested rams ranged from 3 to 10.5 ($\overline{x}$ = 7.7), and horns green-scored from 116 4/8 to 191 6/8 ($\overline{x}$ = 163 5/8 B&C).

In 2021, 125 permits were issued to those drawn from the pool of 25,098 applicants. Four of those drawn did not hunt, and only one of 3 Special Big Game Tag holders (as described below) hunted during the 2021 season, the other 2 choosing to hunt during other parts of the 365-day period allotted to them. Of the 122 hunters in the field, 93.4% were successful, with a combined total of 708 hunter days in the field. Average age of harvested rams in 2021 was 7.8 years; B&C green-scores ranged from 127 to 184 5/8 with an average of 163 6/8.

Continuing a long history, the Arizona Game and Fish Commission awarded the Special Big Game Tags for bighorn sheep (2 tags per year) to ADBSS in 2022, with a third tag to the Arizona Big Game Super Raffle (AZBGSR). Each year, ADBSS has traditionally partnered with the WSF to auction 1 tag and auctions the second at their fundraising banquet; the third is raffled through AZBGSR. In 2022, a total of $560,000 was raised via these Special License Tag Sales. 100% of the proceeds of all 3 tags come back to the Arizona Game and Fish Department to fund the conservation and management of bighorn sheep in Arizona. Since its inception (1984-2020), the Arizona Bighorn Sheep Special Tags have brought in more than $13.8 million USD to support bighorn sheep management in Arizona.

TRANSLOCATIONS

Picacho Mountains

In 2019, irregular monsoon patterns resulted in the dispersal of the source herd scheduled for a follow-up translocation into the Picacho Mountains (Unit 37AN), where 30 desert bighorns had been placed in 2018. No bighorns were moved into that unit in 2019 as a result. Due to human safety concerns associated with Covid-19, no translocations occurred in 2020 either.

When the translocation needs were reassessed in 2021, it was decided that only 10 more bighorns were needed in the Picachos instead of the 20 from the Silverbells (Unit 37AS) and 20 from Canyon Lake (Unit 24AB), as originally slated for the captures postponed in 2020. The source was changed to the Canyon Lake herd in Units 24A/B, and 10 bighorns (9 ewes, 1 yearling ram) were translocated into the Picacho Mountains in Oct 2021. Seven GPS collars were deployed during this translocation, and revealed more extensive use of the mountain range than the 2018 transplants.

Galiuro Mountains

The 2021 augmentation planned for the Picachos from the Silverbells was redirected to augment the Galiuros herd in Unit 32. Eight GPS collars were deployed as a result of this translocation on 8 of the 3 rams and 15 ewes released into Redfield Canyon. Both of these translocations were funded by KUIU Conservation Direct, who also brought volunteer staff to assist with the projects, and solicited donations with the assistance of the ADBSS to purchase the collars.

Harcuvar Mountains

A project to expand the desert bighorn herd in the Harcuvar Mountains in Unit 44A into unoccupied portions of their range was initiated in 2021. A total of 23 bighorns (20 ewes, 3 rams) were captured and translocated from the Plomosa Mountains in Unit 44B and translocated to the Harcuvar Mountains in November of 2021. Twenty-two collars were deployed during this event. A follow-up translocation of an additional 30 bighorns (3 rams, 27 ewes) from the Trigo Mountains (Unit 43B) to the Harcuvar Mountains was conducted in 2022. An additional 25 collars were deployed during this event.

Rocky Mountain Bighorn Sheep (RMBS)

Efforts to relocate RMBS from the Morenci Mine area in Units 27S and 28N continued in 2021-23 with drop-net and darting operations resulting in the capture of 45 bighorn sheep. Thirty (5 rams, 25 ewes) were translocated to East Clear Creek (Units 4A-5A) to complete reestablishment of a herd there in Oct 2021; 7 rams and 8 ewes were released in the Upper Blue River area between Dec 2021 and March 2023.

An additional 30 RMBS were captured in and around the Morenci Mine in October of 2022 and transferred to the Utah Division of Wildlife to reestablish a population on Antelope Island, Utah. This brings the total of bighorn sheep captured and translocated in Arizona to 2,748.

SANTA CATALINA MOUNTAINS PROJECT

Department personnel flew helicopter surveys in the Catalina Mountains over 2 days in September 2022 for 8.2 hours. This effort was conducted in conjunction with ground crews at 12 stations spotting bighorns from the ground and relaying their location to the helicopter to classify. A total of 27 bighorn sheep were observed, including 13 rams (0 Class I, 3 Class II, 8 Class III, 1 Class IV), 6 ewes, 5 lambs, 1 yearling ram, and 3 unclassified (the 3 unclassified were sheep spotted by ground observers but missed by the helicopter, including 2 ewes and one ram). There are no functioning collars in the herd, making a mark-recapture population estimate impossible to calculate.

This unit was scheduled to be surveyed in 2021 then moved to a 3-year rotation, but a large wildfire burned through the Pusch Ridge Bighorn Management Area in June 2020, and severe drought conditions persisted into 2021. While bighorn surveys were not conducted in 2020 due to Covid-19 related flight restrictions, it was deemed necessary to survey the unit at least biennially to monitor the effects of the wildfire on the small population. The 2021 survey was conducted in September, with 6.6 hours of flight time across 2 days, resulting in a total of 35 bighorns observed, and a sharp drop in ewe:rams. The number of rams observed (n=19) was consistent with the 2019 survey (n=17), but the ewes observed dropped from 20 to 9. On a positive note, a total of 5 yearlings were observed on this flight, and 27 of the 35 bighorns observed were unmarked.

The concern with the ewe:ram ratios observed in 2021 drove the decision to augment the survey with ground observations rather than following the traditional survey protocol. This herd seems to have acclimated to the urban-wildland interface. Rams are frequently observed and photographed by the public. Two ewes were observed exiting an urban area during the survey, and complaints about rams breaking windows on houses is becoming a common occurrence. It is likely some bighorns are taking advantage of available resources in neighborhoods, and thus not available for detection on survey. Discussions with the Coronado National Forest's Catalina Ranger District about collaring additional bighorns on the mountain have begun. We hope to collar 10 bighorns prior to the next survey to inform us on detectability during survey, as it appears vegetation conditions have changed. Abundant rainfall during the monsoon season of 2021 and 2022 have likely led to a much denser vegetation community, providing more hiding cover for bighorn sheep.

BIGHORN SHEEP AND DOMESTIC SHEEP AND GOAT INTERACTIONS

The Department regularly responds to reports of domestic sheep or goats in areas that create the potential for interactions with bighorn sheep. In 2021, a domestic sheep was located in bighorn habitat in Unit 15C. The animal died during handling and was discovered to have multiple apparent infections. Testing revealed infection with Leukotoxin A positive *B. trehalosi.* A domestic goat was also located in unit 39 and tested positive for *M. ovi*. No interactions or potential threats were documented in FY22 necessitating special testing outside of routine monitoring conducted annually on harvested rams, roadkills, captured bighorns, or other mortalities of unknown causes.

Status of Bighorn Sheep in Colorado—2023

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Desert Bighorn Council Transactions 57:73–75

POPULATION STATUS

Colorado's bighorn sheep herds have been increasing over the last 2 years. The estimated post-hunt population of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*), the predominant bighorn subspecies in Colorado, was 7,475 in 2022. This was more sheep than has been recorded in the last decade. Over the last couple of years, Colorado's Desert bighorn (*Ovis canadensis nelsoni*) populations have been largely stable. The 2022 post-hunt population estimate for all desert bighorn herds was 500, with little change over the last 10 years (Figure 1). This follows an increase in population size that began in 2005. Colorado's desert bighorn sheep occur in 3 different populations: the Black Ridge herd (Game Management Unit [GMU] S-56) in Mesa County near Grand Junction, the Uncompahgre/Dominguez herd (GMU S-62) on the northeast corner of the Uncompahgre Plateau northeast of Montrose, and the Dolores River herd (GMUs S-63 and S-64) along the Dolores River from Dove Creek to Bedrock (Figure 2). The Black Ridge herd has declined to about 150 bighorns. The Uncompahgre herd is stable to increasing at 165. The Dolores River population (comprising the Upper and Middle Dolores herds) has also been stable to increasing with a post-hunt population estimate of 185 in 2022.

HARVEST STATUS

Conservative hunter harvest occurs in all of Colorado's desert bighorn populations. The Black Ridge herd (S-56) currently has 4 ram licenses, with license allocation at 2% of the population and a 3-year average hunter success rate of 100%. The 3-year average growth rings measured from the harvested rams in S-56 was 7.3, which has been stable in recent years. Five ram licenses were allocated in the Uncompahgre herd (S-62) at 3% of the population, with a 3-year average hunter success rate of 93%. The average rams harvested in S-62 have 6.6 growth rings measured on a 3-year average. The Dolores River population license allocation is 6 ram licenses per year, which is 3.2% of the population estimate. Licenses in the Dolores River population are allocated separately to GMUs S-63 (2 licenses) and S-64 (3 licenses). The 3-year harvest success rate was 94% with the 3-year average growth rings measured from harvested rams being 5.8.

COLLABORATIVE PROJECTS AND MANAGEMENT

DNCA Recreation Study

A study was initiated in the Dominguez Escalante National Conservation Area DNCA with the goal of determining the impacts of outdoor recreation and associated disturbance on desert bighorn sheep. This is a collaborative effort with New Mexico State University graduate student Ashley Evans, Colorado Parks and Wildlife, and the Bureau of Land Management. Field work began in December 2020 with 30 ewes captured and fitted with ear tags and GPS collars. In 2021, 18 additional ewes were captured to expand the sample. Additionally, 80 camera traps have been installed throughout the study area to quantify trail use by recreational users and wildlife. Moreover, stress hormones are being measured using fecal glucocorticoid metabolites from fresh fecal pellets collected from marked individuals. In combination, these three methods will allow individual sheep behavior to be monitored in response to outdoor recreation. This project will be wrapping up in 2024.

Disease Management

Mycoplasma ovipneumoniae, Pasteurella multocida, and sinus tumors have been detected in desert bighorn sheep in Colorado. S-56 and S-62 have higher prevalence of these diseases, and there are concerns these pathogens may be affecting lamb recruitment. Greater concern of these diseases in Colorado's Rocky Mountain bighorn sheep herds have led to increased monitoring efforts, and proposals to study respiratory pathogen strain types in all of the bighorn herds across the state.

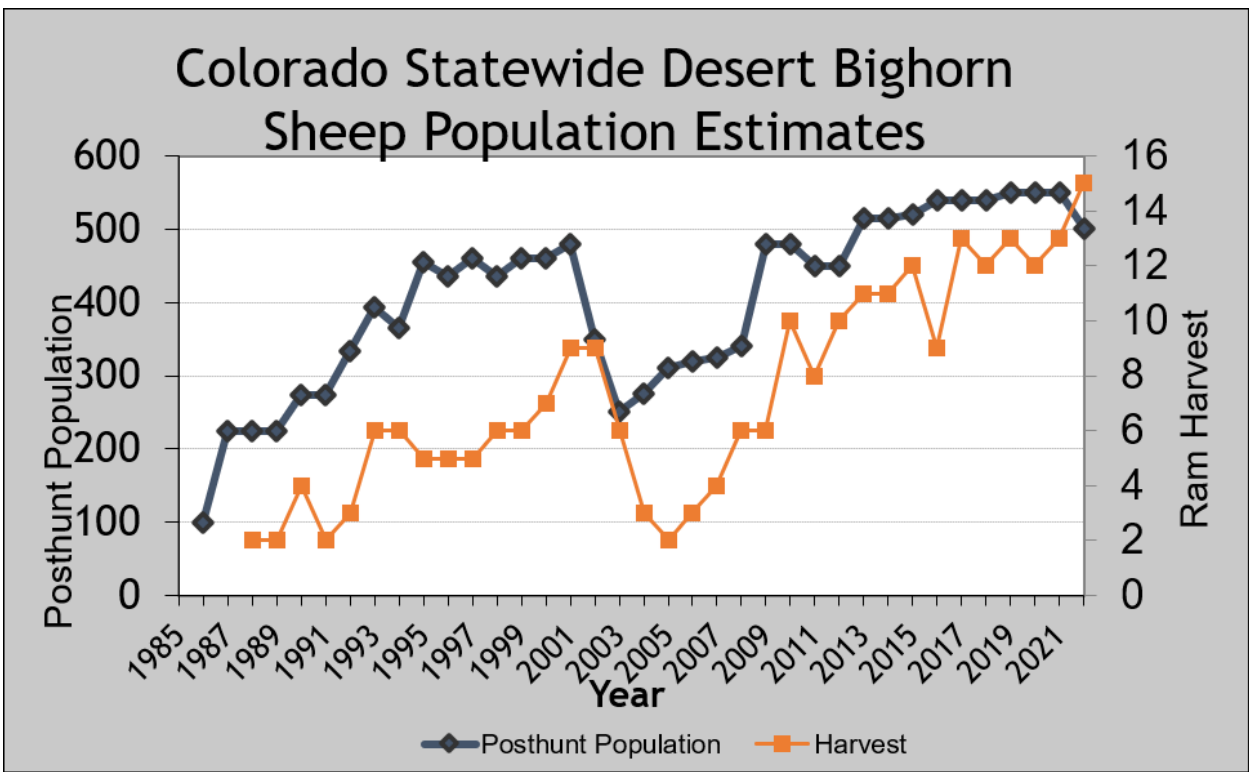


Figure 1. Desert bighorn sheep population estimates and ram license numbers in Colorado, USA, 1985–2022.

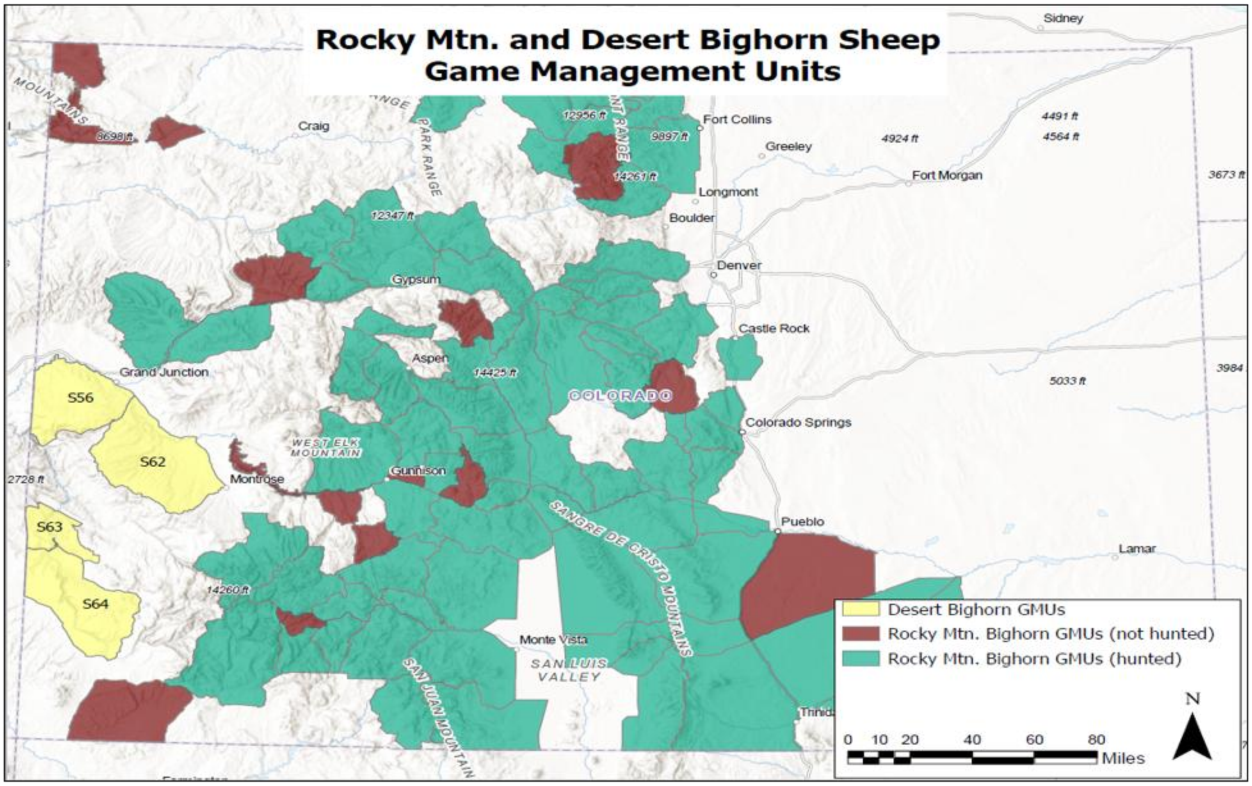
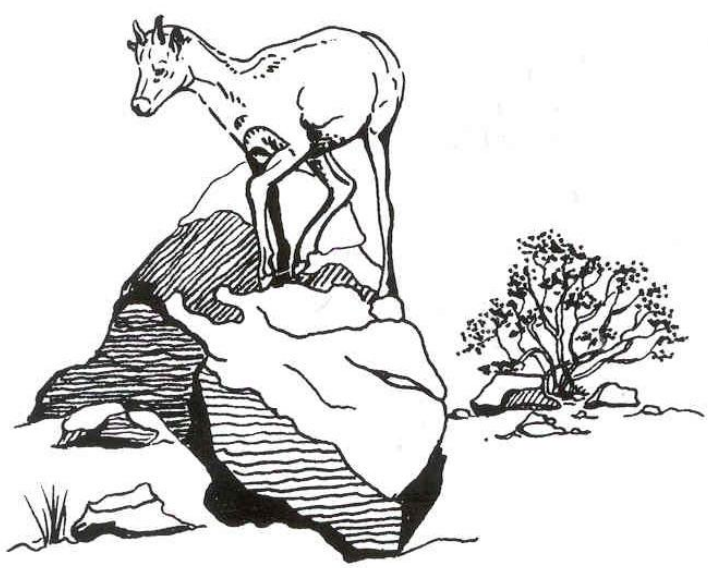


Figure 2. Distribution of Rocky Mountain and Desert Bighorn Sheep management units in Colorado, USA, 2022.



Status of Desert Bighorn Sheep in Nevada, 2021–2022

Mike Cox

Nevada Department of Wildlife, Reno, NV 89511, USA

Desert Bighorn Council Transactions 57:76–84

POPULATIONS

There are 63 desert bighorn herds currently in Nevada. Subdivided by origin, there are 20 remnant, 29 reintroduced, and 14 pioneered herds. Estimates for each herd are generated from deterministic spreadsheet models that reconstruct population dynamics based on known production and recruitment every other year, known ages of harvested rams, estimated adult survival, and egress or ingress.

POPULATION MANAGEMENT AND ENVIRONMENTAL IMPACTS

The 2022 statewide lamb ratio of 23 lambs:100 ewes from aerial and ground surveys was near the record low lamb ratios from 2021 and 2020 (recorded since 1990), and still well below recruitment rates necessary to maintain a stable population (Figure 1). Combined with above-normal adult mortality in some herds during 2022, we experienced the largest annual decline in Nevada's desert bighorn population since 1965. Nevada's desert bighorn numbers have seen an alarming 31% decline from its peak in 2019 at 10,300 to the 2023 statewide estimate of 7,100 adults (Figure 2). The majority of this decline is attributable to continued high lamb mortality and elevated adult mortality from respiratory disease events in several desert bighorn herds. Other contributing factors elevating mortality rates are the multi-year drought (Figure 3) and competition at and destruction of critical riparian areas or water sources from excessive numbers of feral horses and burros (Figures 4 and 5). On the positive side, the winter and spring of 2022-2023 brought great rains, snapping the multi-year drought.

Fifty percent of the 63 desert bighorn herds currently are battling active infections of the bacterium *Mycoplasma ovipneumoniae* (*M. ovi*). Several bighorn herds were evaluated to identify metapopulations that were somewhat isolated, had reasonable data on initial exposure, and access to capture and test animals over time. In November 2021, a decision to begin a Test and Remove project was implemented in the metapopulation involving the Nevada Test and Training Range (NTTR) Stonewall and Bare mountains. We started by capturing and testing 27 ewes and rams with 1 ram and 1 ewe testing positive for *M. ovi*, and both were euthanized. In Fall 2022 another 36 bighorn were tested with only 1 ewe testing positive. Plans are to conduct additional captures in the Stonewall Mountain area in June 2023 in an effort to find the few chronic shedders suspected of remaining. The project will likely expand into adjacent herds known to have connectivity with NTTR, including the Specter Range and the Nevada National Security Site bighorn herds.

Based on historical accounts,

archeological evidence, paleontological evidence, and geospatial analyses of areas of adequate bighorn habitat features and resources, it is estimated that the statewide bighorn population in 1860 exceeded 30,000 animals (Cox et. al. 2001). It was first acknowledged in the 2001 Nevada Bighorn Sheep Management Plan that the entire state of Nevada—the heart of the Great Basin—was a single but diverse metapopulation of desert bighorn sheep (Ramey 1993, 1999; Wehausen and Ramey 2000). The plan also recognized the decades of successful translocations of Rocky Mountain and California bighorn sheep that began in the late 1960s, albeit without the full appreciation of bighorn sheep ecology or genetics, and the challenges of managing 3 subspecies in the absence of geographic boundaries (Figure 6).

The most recent desert bighorn translocation occurred in early 2016. The lack of distance from domestic sheep and of barriers to long-distance bighorn forays, widespread distribution of domestic sheep operations on public land and private land farm flocks, and continued detections of domestic sheep that have strayed from permitted areas have stymied translocations over the last decade. There are still many unoccupied areas of historical bighorn habitat in Nevada. There are some opportunities and efforts to mediate these risks currently in play, but additional land-use planning and negotiations must occur and be completed before viable and successful translocation sites again are available.

HARVEST

A total of 285 desert bighorn ram tags in 2022 were issued to residents and nonresidents (90:10 split) through a restricted tag draw process that includes 5 "specialty" tags (2 auction tags and 3 raffle tags) and 9 archery-only tags. This was a decline of 11% from 2021 and the first time since 2014 the total was below 300 tags. Hunter success (83%) was the lowest in 20 years. Quality of rams was less than most years, with only 7 rams scoring above 170 B&C points, and the average score of 150 1/8 was the lowest since 2007. Statewide, the average number of days hunted was 6.0, only slightly above long-term average of 5.3 days. Yet, the average age of harvested rams was strong at 6.8 years and was the second highest average age recorded over the last 30 years. Recent drought years likely played a role in reducing horn growth. Demand for desert bighorn ram hunting continues to rise each year. There were 12,248 resident and 13,655 nonresident ram tag applicants in 2022 compared to 7,087 and 6,533 applicants, respectively, in 2012.

A new one-horn ram hunt was instituted for the first time in early 2023, with 12 tags available. This was a novel idea intended to take advantage of rams with broken horns that hunters normally don't have the desire to harvest but they are typically 8 – 12 years-of-age. The season was during January and February 2023 after all standard ram hunts had ended. Four hunters were successful; the average age of those animals was 9.8 years.

The need for ewe hunts has drastically declined due to mortalities caused by respiratory disease having reduced herd sizes to levels well below habitat carrying capacity. Only 41 ewes were harvested from 2 herds (Mt Jefferson and Muddy Mountains), with just over 50% hunter success. Herds that previously had supported ewe hunts all experienced dieoffs. Though ewe removal reduces herd density, it does little, if anything, to reduce threats of pathogen spillovers from neighboring domestic sheep sources or expanding bighorn herds without ewe hunts.

PATHOGEN EXPOSURE AND HERD PERFORMANCE

Polymicrobial upper respiratory disease events and die-offs continue to impact Nevada's desert bighorn herds. Figure 7 displays the various *M. ovi.* strains detected since 2011, including several herds exposed to more than 1 strain. Still, several herds have known exposure histories but have not yet been strain-typed. With the broad and connected distribution of bighorn populations, the ability to isolate or stop pathogen transmission among bighorn herds is extremely difficult. For example, Figure 8 focuses on a desert bighorn metapopulation in the northwest portion of their distribution and illustrates the spatial and temporal movement of the "Fairview" strain through bighorn to bighorn exposure and the demographic impacts to each herd related primarily to mortalities resulting from respiratory disease.

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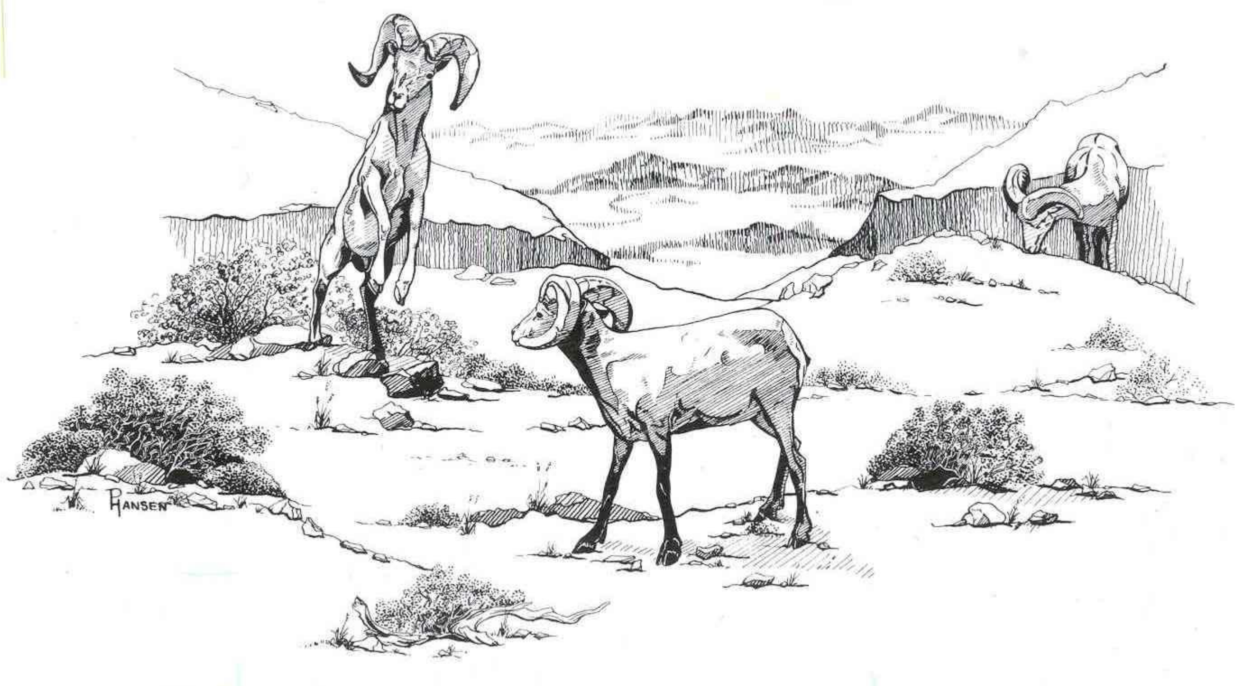


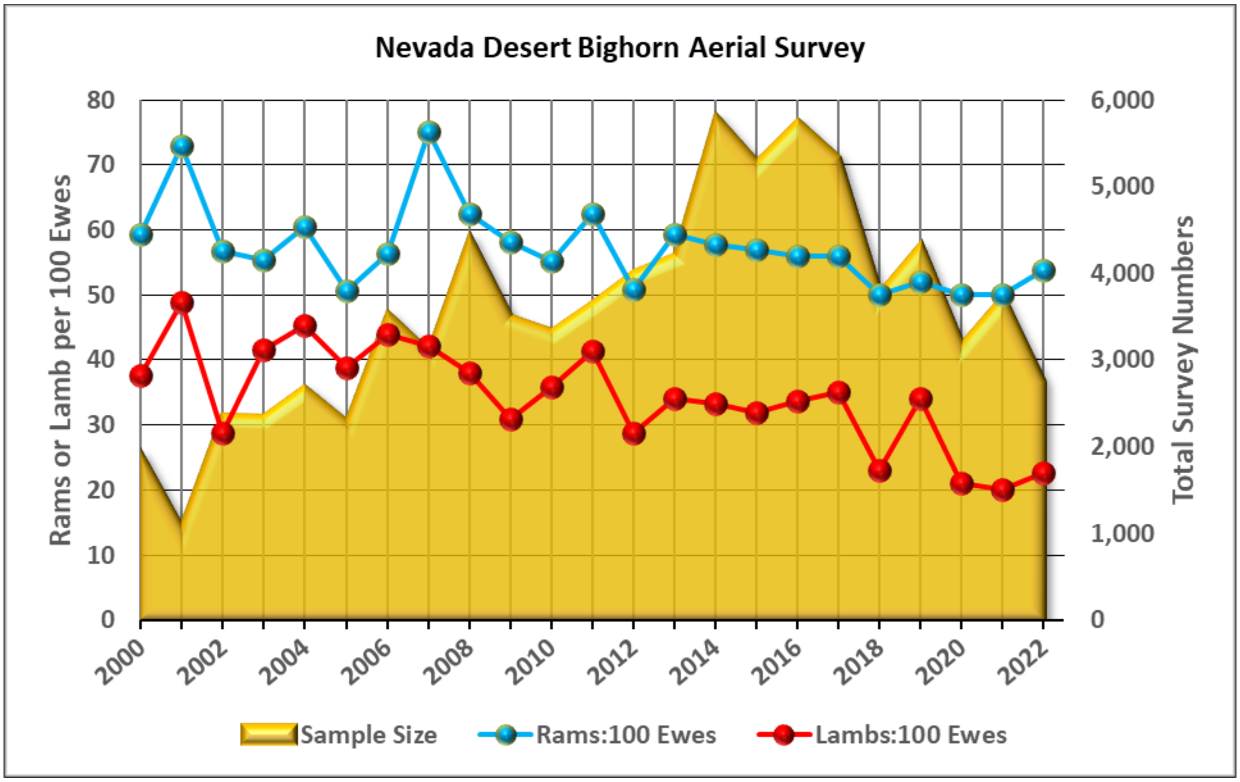


Figure 1. Results of helicopter composition surveys via directed search method 2000–2022 including sample size, and ram ratios and lamb ratios per 100 ewes.

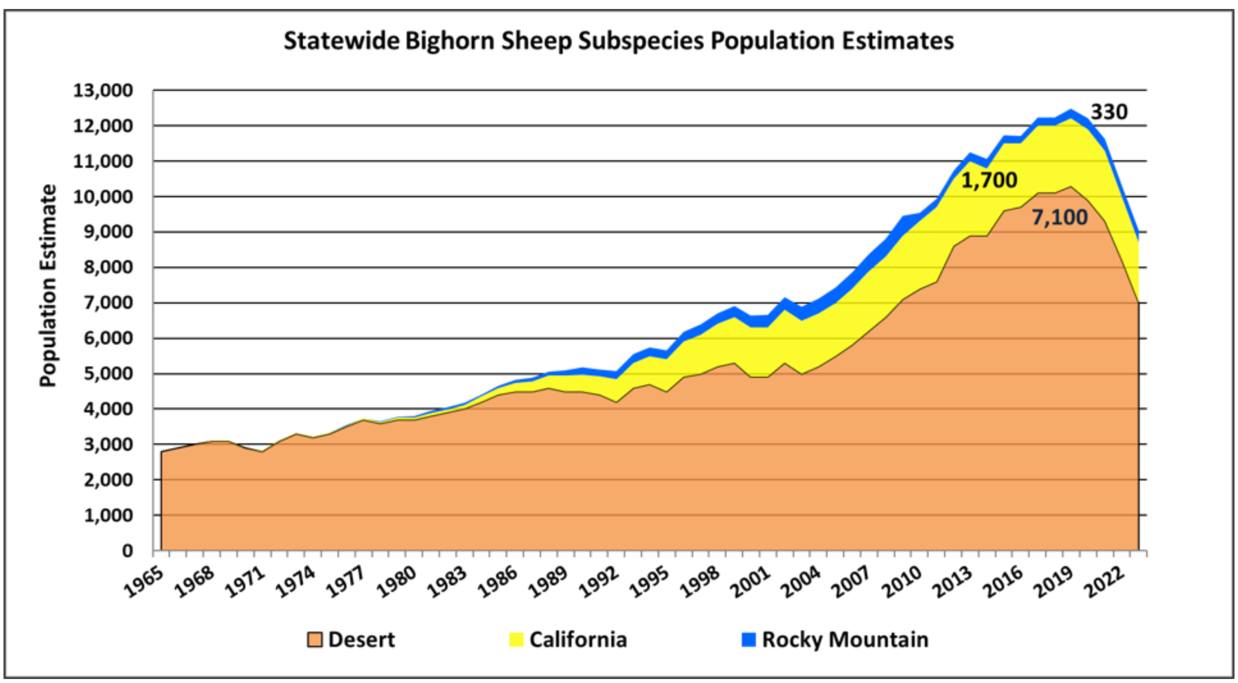


Figure 2. Nevada bighorn sheep population estimates by subspecies, 1965–2023.

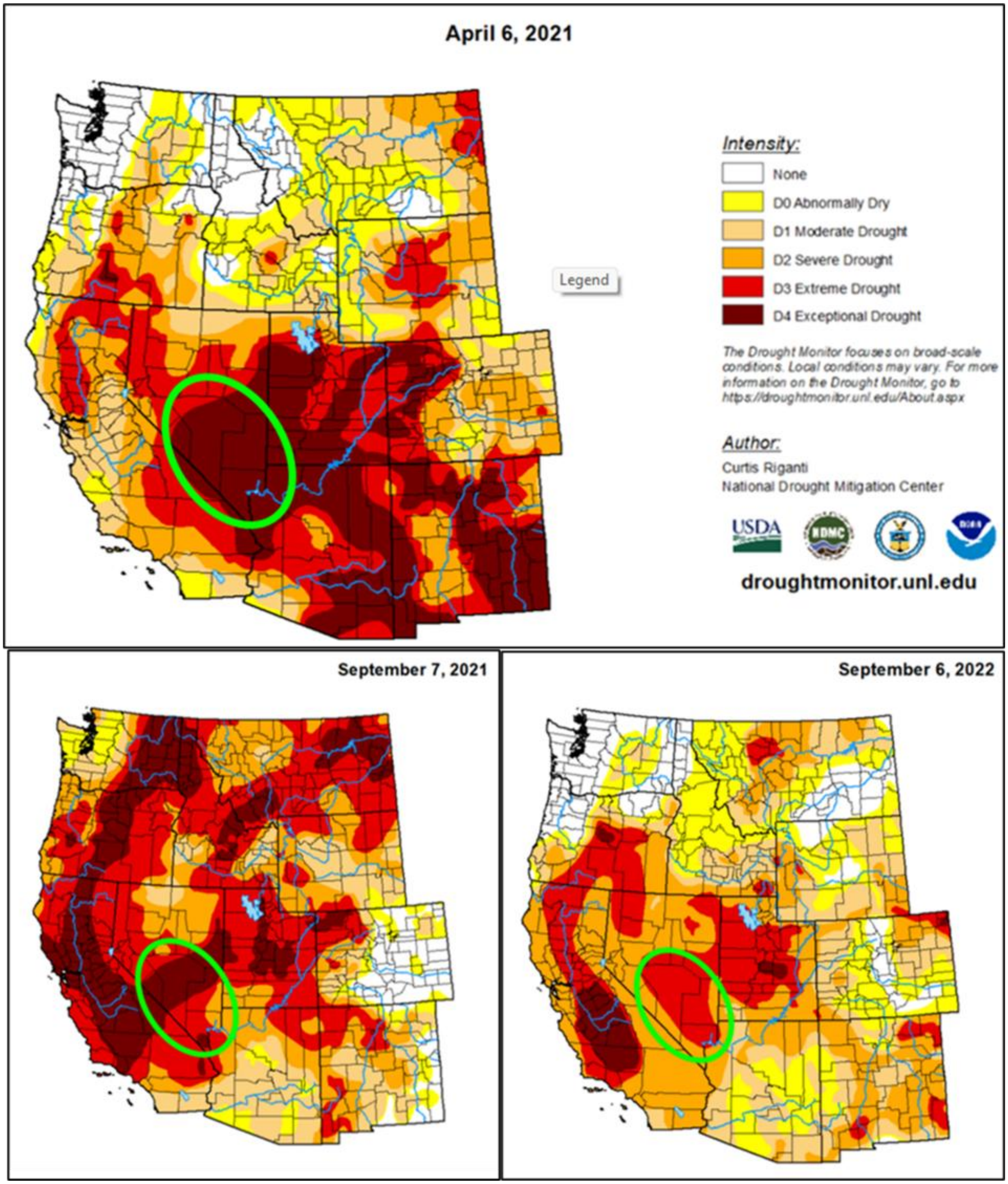


Figure 3. Series of western U.S. USDA/NOAA drought index maps from spring 2021 through summer 2022 showing the extreme and exceptional levels of drought over the majority of the desert bighorn distribution in Nevada (green halo depicting desert bighorn distribution in Nevada) causing entire plant community desiccation and many water developments to go dry.


Figure 4. Photos of common occurrences of spring complexes and foraging areas used by desert bighorn sheep decimated by feral horses and burros.

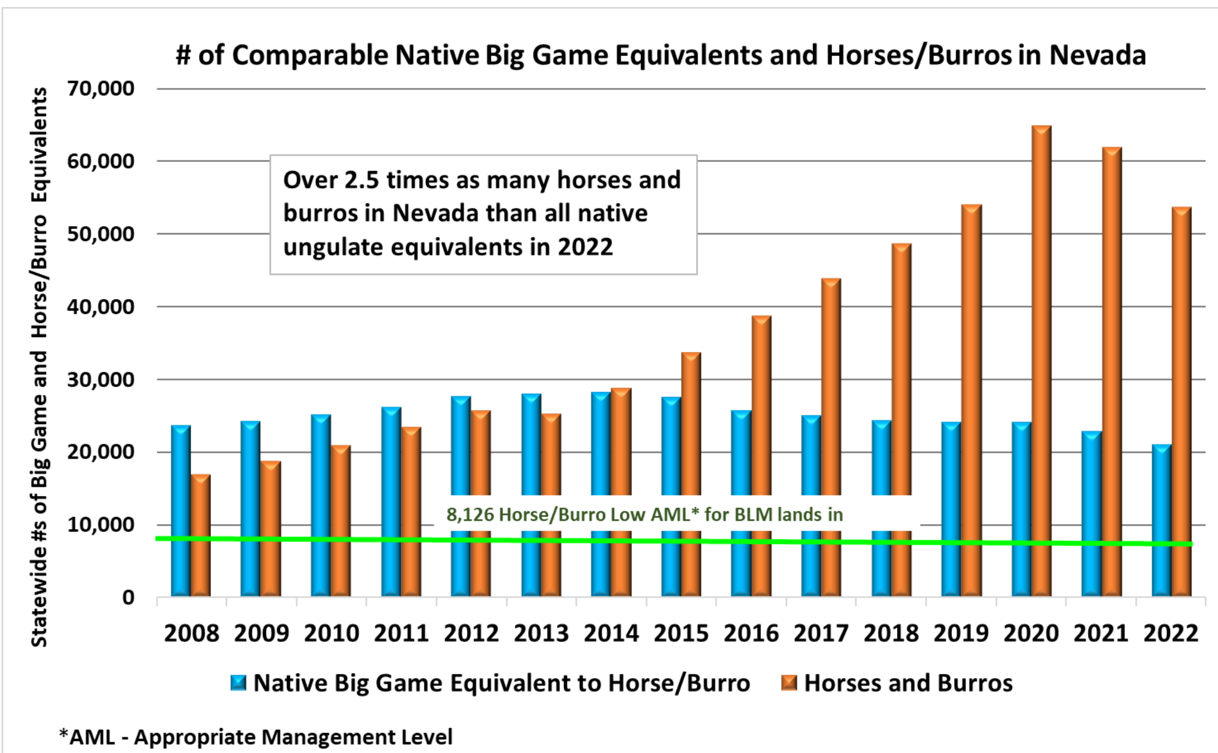


Figure 5. Graph depicting statewide comparison (2008−2022) of estimated number of free-roaming horses and burros to the biomass equivalent of all native big game animals in Nevada. The graph uses the best available values and rates of body weight, forage consumption, and water intake among the 2 groups to compare forage and water use of the equivalent number of native ungulates to that of a horse/burro. The green horizontal line is the BLM's statewide Appropriate Management Level (AML) if horses and burros were managed in a "thriving natural ecological balance with the habitat" as required by The Wild Free-Roaming Horses and Burros Act of 1971.

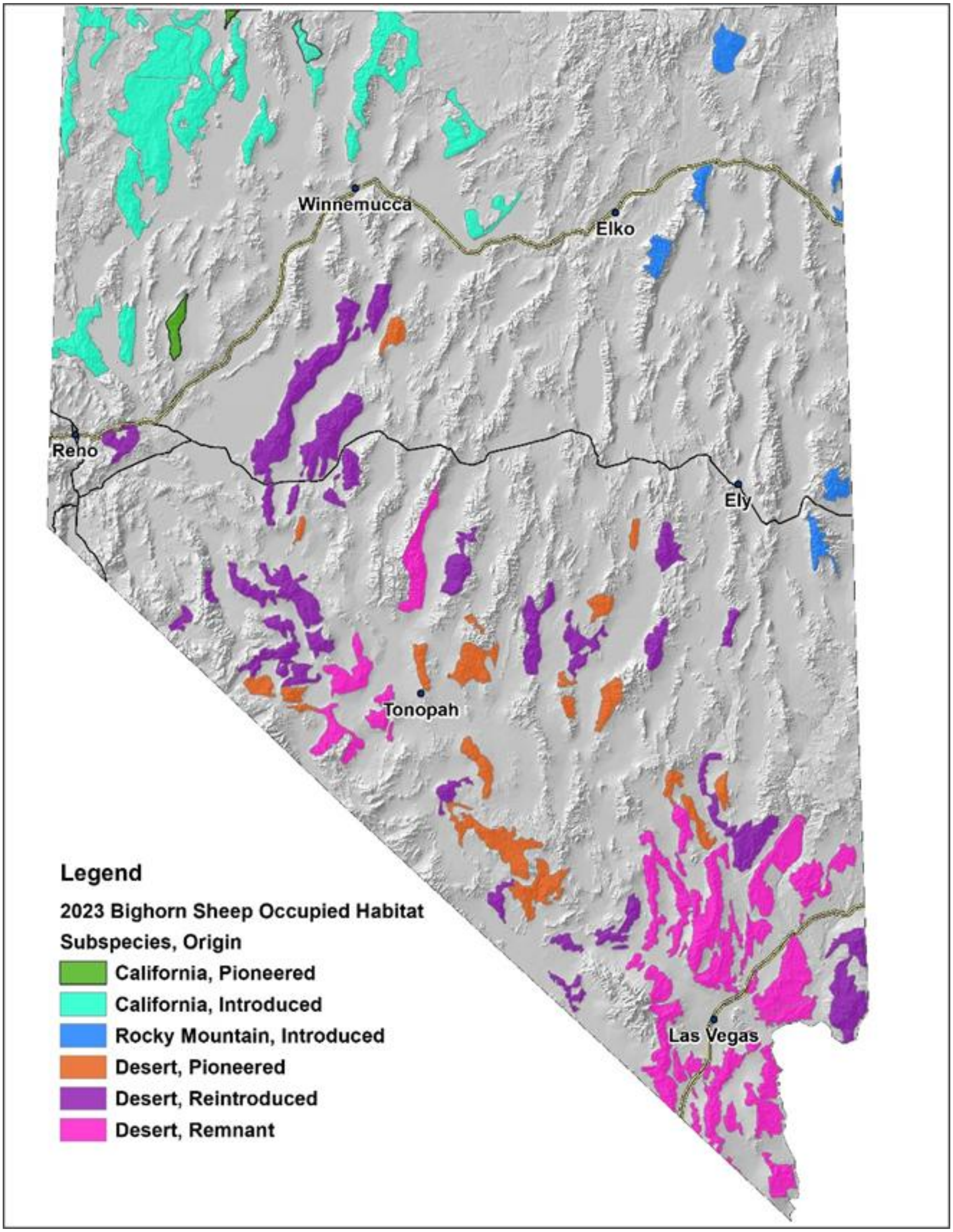


Figure 6. Occupied bighorn sheep habitat in Nevada by subspecies and origin (remnant, reintroduced, or pioneered).

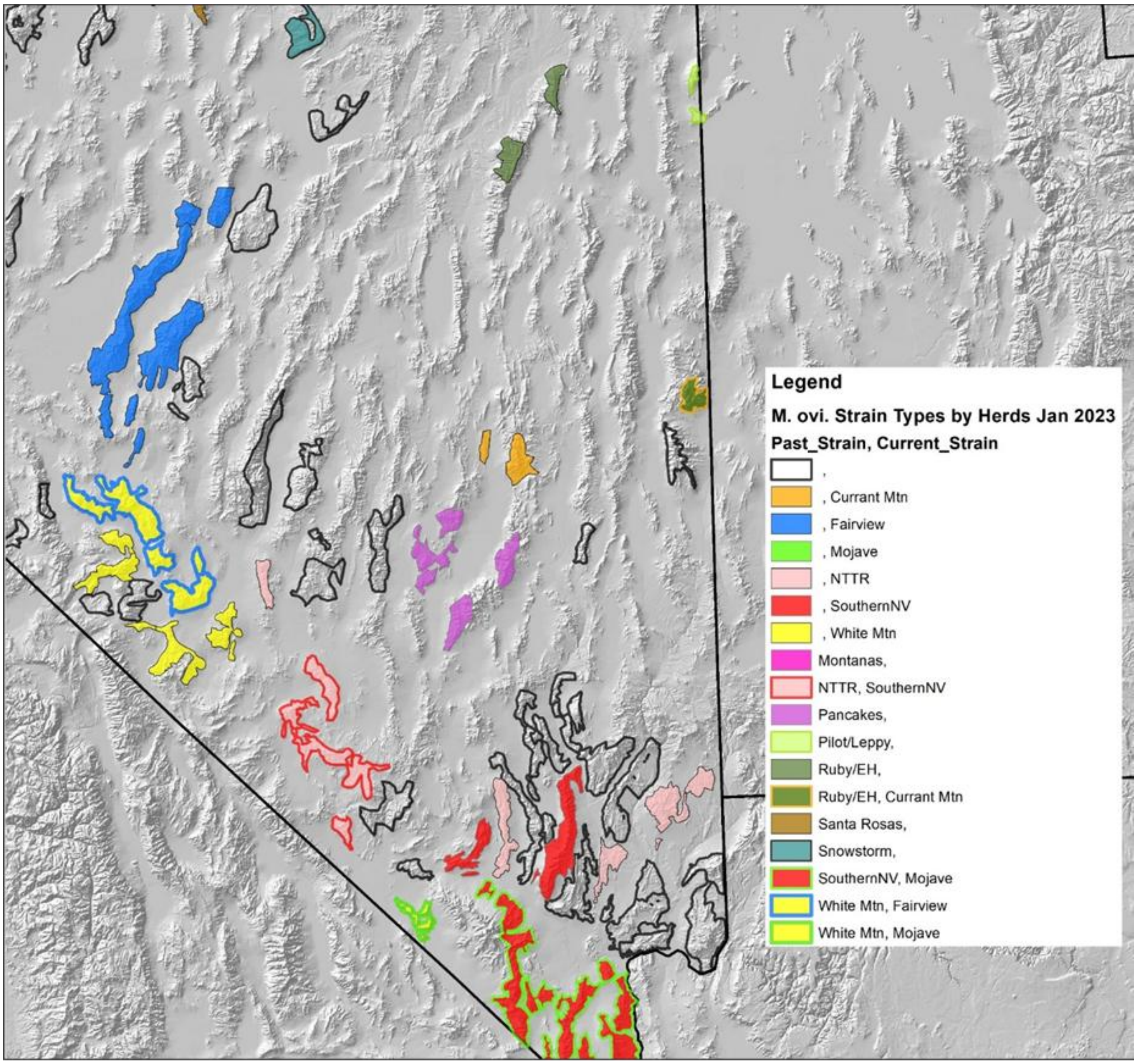


Figure 7. The *M. ovi.* strains (as determined by Washington Animal Disease and Diagnostic Lab via PCR test and DNA Strain typing) detected in many of Nevada's bighorn herds through January 2023. Herds depicted by black outline have been exposed to *M. ovi*. but are yet to be strain-typed.

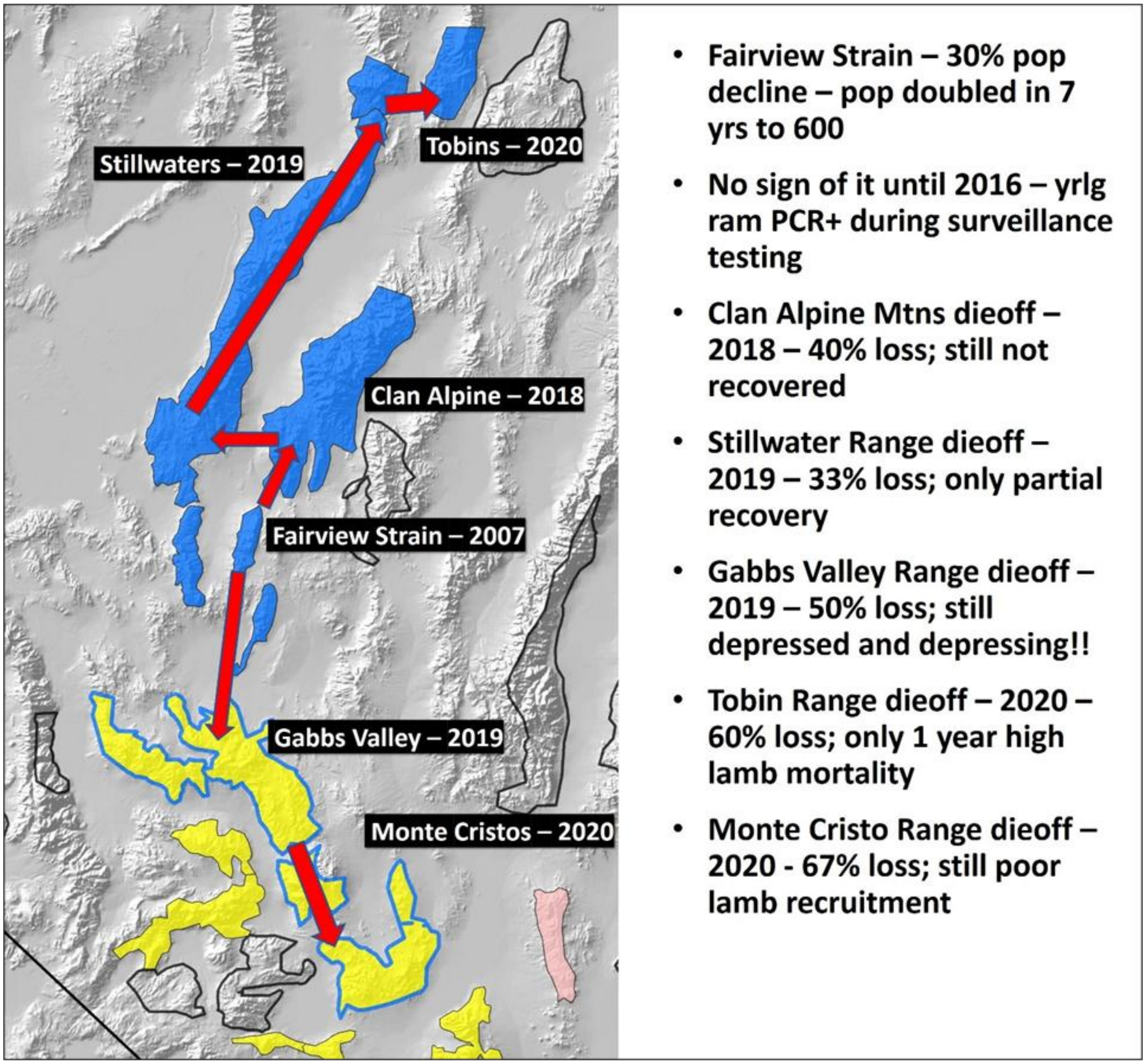


Figure 8. Depicts spread of the Fairview (*M. ovi.*) Strain metapopulation across multiple mountain ranges. The Fairview Strain was kept active within the initial Fairview-Slate-Sand Springs bighorn population for a decade (2007–2017) before it was spread by bighorn sheep to an adjacent herd and thereafter “leap-frogged” to other herds further away. Detection of the Fairview Strain was from a combination of limited hunter harvest samples, and active or passive disease surveillance of larger samples of animals. Demographic responses are based on aerial survey data conducted biennially and population models maintained annually for each bighorn herd.

State Status Report—Texas 2022–2023

Froylán Hernández

Texas Parks and Wildlife Department, Alpine, TX 79830, USA

Desert Bighorn Council Transactions 57:85–89

POPULATION

From 2002 to 2008, the desert bighorn population in Texas was rising, and seemingly leveled off after 2008 where it remained for several years (Figure 1). In late Fall of 2019, however, the first-ever desert bighorn disease die-off associated with *Mycoplasma ovipneumoniae* (*M. ovi*), was detected. Shortly after, in Spring 2020 another *M. ovi* die-off was detected in a distinct population.

The annual aerial desert bighorn surveys were suspended in August 2020 after only 35 hrs of flight time due to a fatal helicopter crash. Afterwards, only a selected few mountain ranges were assessed through ground counts. During the 2022 survey, 785 bighorns were observed with a lamb ratio (lambs per 100 ewes) of 27:100. In 2023, the count resulted in 568 bighorns observed with a lamb ratio of 26:100.

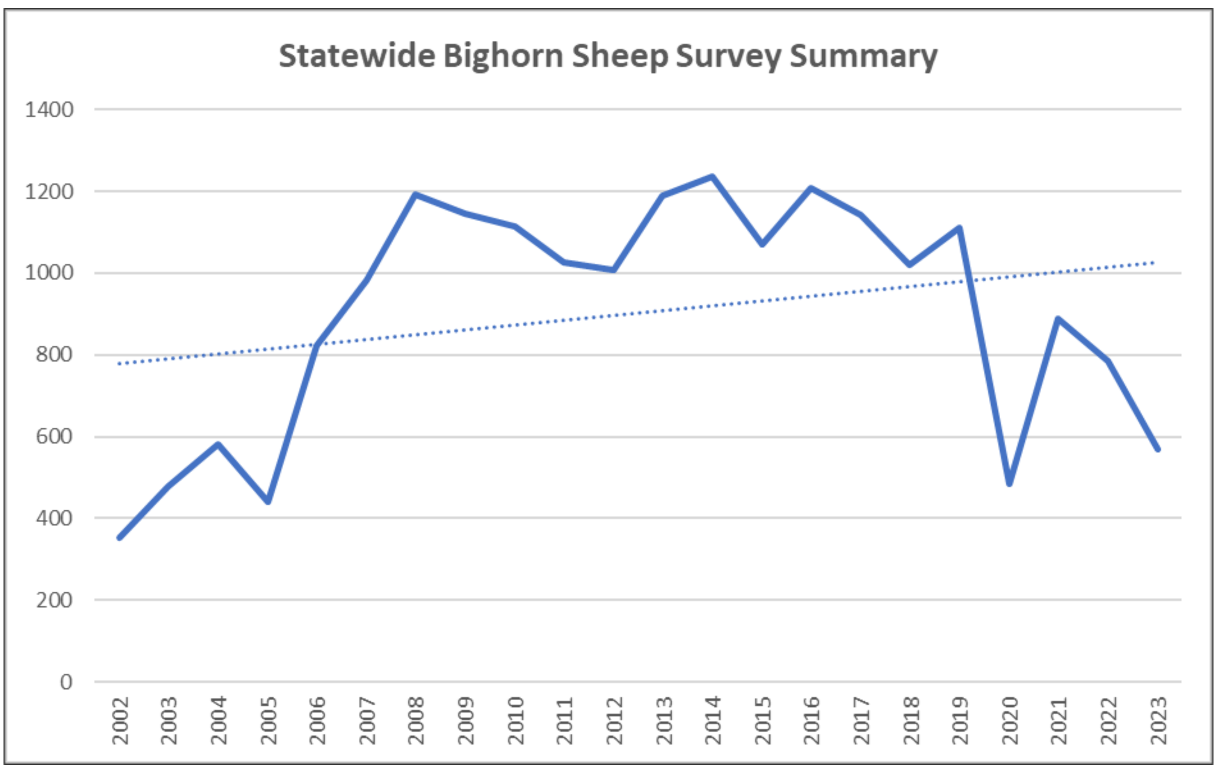


Figure 1. Statewide desert bighorn sheep survey results for Texas, 2002–2023.

HARVEST

There were 22 permits issued for the reporting period (2021-2023; Table 1).

During the 2021-2022 hunting season, 15 permits were issued, which included 2 public, 1 auction, and 12 private landowner permits. Of those 15 hunting permits, one hunt was unsuccessful (failed to harvest after multiple attempts), resulting in a 93% success rate for this season. The new Texas state record was harvested in March 2022 with a net Boone & Crockett score of 187 2/8.

Due to ongoing disease issues, permits were being allocated on a case-by-case basis during the 2022-2023 hunting season. Only 7 permits had been issued at the time of reporting, of which 4 were issued to private landowners and 3 issued to the state (2 public, 1 auction). The final success rate for the 2022-2023 hunting season had not been determined at the time this report was prepared because the season had not ended and there still was 1 outstanding permit, as well as the potential for additional permits not yet issued due to case-by-case allocations. The average age and score for rams harvested through TPWD hosted/guided/outfitted hunts were 10 years and 171 B&C points, respectively.

WATER DEVELOPMENT AND HABITAT IMPROVEMENTS

Five new water catchment guzzlers were constructed in strategic locations and will benefit desert bighorn sheep and other wildlife. These water guzzlers were built on public land or on private property within expansive mountain ranges. These 5 guzzlers added a potential 25,000 total gallons of water across the landscape. In addition to the new guzzlers, repairs were performed on existing water guzzlers that were within bighorn ranges. Further, and in collaboration with the Mule Deer Foundation, several additional guzzlers on the fringes of bighorn habitat were reworked.

Even though supplemental water benefits native wildlife, some wildlife biologists question whether there might be unintended consequences, such as benefiting undesirable species, including aoudad (*Ammotragus lervia*), also known as Barbary sheep. It has been hypothesized that these artificial watering sources could potentially congregate animals and thereby serve as disease transmission points. Additionally, current discussions have pointed out that these water sources could also influence rates of predation.

Table 1. Desert bighorn sheep permits issued and animals harvested in Texas, 2021–2023.

Permit Year	Private	Public	Auction	Total Permits	Permits Used	Success
2021-2022	12	2	1	15	14	93%
2022-2023[1]	4	2	1	7	7	100%
TOTAL	16	4	2	22	21	91%

[1] one permit had not been used at time of report, but all issued permti to this point had been successful

Table 2. Results of PCR and ELISA testing for *Mycoplasma ovipneumoniae* from aoudad collected in Texas, August 2022.

Mtn Range	%PCR Positive	%ELISA Positive
Qutiman	0 (0/22)	64 (14/22)
Eagles/S. Carrizo	11 (2/18)	42 (8/19)
Chinati	15 (4/26)	44 (11/25)
BBRSP	0 (0/23)	14 (3/22)

RESTORATION

In December 2019, a total of 74 bighorn sheep (44 M, 30 F) were captured on Elephant Mountain Wildlife Management Area (WMA) and translocated to Black Gap WMA. Of those 74, 52 (28 M, 24 F) were fitted with telemetry collars to facilitate post-release monitoring and to further ongoing population investigations at Black Gap WMA. Though 2019 translocation efforts initial results were very encouraging, there were at least 21 collared mortalities attributed to infectious pneumonia that appeared to be a result of *Pasteurella*-type pathogens. No capture/transplants for restoration purposes occurred during the 2022-2023 reporting period.

DISEASE MONITORING

TPWD has been actively monitoring aoudad populations for potential disease threats to desert bighorns throughout the West Texas mountains for several years. In late August 2022, a goal was to dispatch 20–30 aoudad from 4 mountain ranges with good quality bighorn habitat. These ranges included the Quitman Mtns, Eagle-Carrizo Mtns, Chinati Mtns, and Bofecillo Mtns of Big Bend Ranch State Park. While the goal was to collect samples from 120 aoudad from an equal proportion of rams and ewes, logistical limitations resulted in a total of 98 aoudad (28 M, 70 F) dispatched and sampled.

The focus of these sampling efforts was to determine the *M. ovi* prevalence within those aoudad populations through PCR and ELISA testing of nasal swabs and serum. The highest percentage of PCR positives occurred in the Chinati Mtns (15%), and the highest ELISA positives were found in the Quitman Mtns (64%) (Table 2). These sampling efforts were conducted in collaboration with Texas Tech University-Natural Resource Management Department (TTU-NRM). TTU-NRM is also interested in aoudad pathogen surveillance, and their research will help TPWD gain a greater understanding of *M. ovi* transmission dynamics within aoudad herds.

RESEARCH

Three MS research projects were initiated in 2023, but no results are yet available. These efforts are described below and are being conducted at Big Bend Ranch State Park and Black Gap WMA, Elephant Mountain WMA, and in the Chinati and Quitman mountains, respectively.

Space Use And Disease Risk Of Desert Bighorn Sheep In The Trans-Pecos Region, Texas

During a recent study in the Trans-Pecos, researchers analyzed niche overlap, temporal resource partitioning, and dietary overlap amongst desert bighorn, aoudad and mule deer. Their findings supported the hypothesis that desert bighorn and aoudad have significant niche overlap in optimal habitat. Niche variation among desert bighorn populations in the Trans-Pecos is lacking, however, as well as how individual space use within each population may shape disease transmission hotspots. The aim of this study is to investigate the connection between space use and disease dynamics to predict pathways of *M. ovi* transmission. The study will address two main objectives: 1) model spatial and temporal desert bighorn co-occurrence on the landscape to predict potential disease transmission hotspots, and 2) assess niche variation among Trans-Pecos desert bighorn populations.

Seasonality Of Competition Potential Between Desert Bighorn And Mule Deer On Elephant Mountain Wildlife Management Area

Elephant Mountain Wildlife Management Area serves as a source population for ongoing desert bighorn restoration efforts. Consequently, the primary management objective is production of surplus animals for use as stock for translocation objectives. However, EMWMA also provides public hunting opportunities, particularly for mule deer. Thus, maintaining a healthy mule deer population is also a key management goal on EMWMA. The area is unique because of apparent spatial overlap between the two species, presumably leading to competition for resources. Moreover, seasonal shifts in space use by each species may exacerbate or curtail competition. The goal of the study is to identify seasonal space use by both species and temporal patterns potentially influencing competition.

Space Use Of Sympatric Aoudad And Mule Deer In The Trans-Pecos

Aoudad ecology, space-use, daily activity cycles, and social dynamics is largely unknown and poorly understood, particularly where the species coexist and potentially interact with the native mule deer in the Trans-Pecos region of Texas. With improved quantitative techniques in movement ecology, aoudad space-use can be readily assessed using the Brownian Bridges Movement Model (BBMM) using collar data. No literature has yet quantified aoudad utilization distributions using the BBMM or examined the influence of aerial gunning relative to changes in movement behavior. The focus of this study is to compare pre- and post-aerial gunning movement to understand spatial and temporal aoudad responses and behavior to aggressive aerial gunning in an effort to develop appropriate big game recovery strategies in the Trans-Pecos.

EMERGING THREATS AND CHALLENGES

In addition to disease issues, Texas continues to face the increasing challenges posed by aoudad. Aoudad hunting has become a substantial financial incentive for many landowners, making it difficult to lethally remove aoudad that occupy desert bighorn range. Additionally, *M. ovi* has been detected in all aoudad populations in 13 distinct mountain ranges. This alone threatens the success of future restoration efforts.

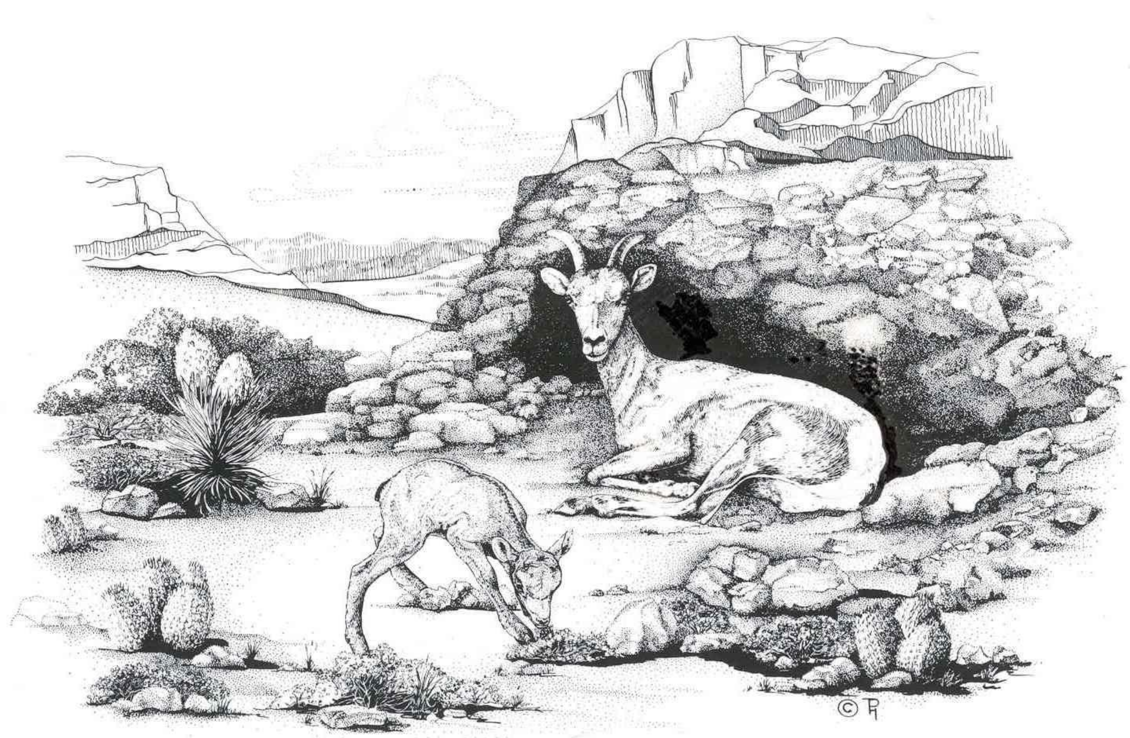
FUTURE RESTORATION PLANS

Aoudad are found in most of Texas' mountains including the mountains considered prime bighorn habitat, and aoudad and have been identified as carriers of *M. ovi*. Because aoudad are found in all mountains surrounding Elephant Mountain, which currently is considered to be the only healthy source of translocation stock for desert bighorn restoration efforts, it is imperative to protect that herd, and thereby the future of desert bighorns in Texas.

The Franklin Mountains were identified as not only prime bighorn habit but are also devoid of aoudad, making them a prime candidate for desert bighorn restoration area. The Franklin Mountains are essentially nestled within the city of El Paso, thereby limiting the potential for aoudad migrating into the area as well as reducing the risk of disease transmission. This, in essence, makes the Franklins a sanctuary for desert bighorns. The goal for the Franklin Mountains is to create another healthy and productive free-ranging source of broodstock, like that at Elephant Mountain, to help ensure an additional healthy desert bighorn population is available to continue future restoration efforts in Texas.

CLOSING

Undoubtedly, disease events have impacted desert bighorn populations in Texas. However, TPWD is committed to expanding the disease monitoring and surveillance program and continuing additional activities and projects that will further restoration efforts. Fortunately, the Texas Parks and Wildlife Department has cemented excellent relationships with hunters and outdoor enthusiasts, dedicated landowners, committed individuals, loyal volunteers, and great conservation organizations, all of which share a passion for wildlife. TPWD will continue to work collaboratively with all interested parties to ensure that the restoration, management, research, and hunting of desert bighorn sheep keep moving forward in Texas.



Status of Bighorn Sheep in Utah—2023

Rusty Robinson

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Desert Bighorn Council Transactions 57:90–92

POPULATION STATUS

Over the last two years, Utah's populations have shown slight increases in both desert bighorn sheep (*Ovis canadensis nelsoni*) and Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*); California bighorns (*Ovis canadensis californiana*) are included with Rocky Mountain bighorn sheep. Current statewide population estimates are approximately 3,000 desert bighorns and 1,450 Rocky Mountain bighorns. This slight increase follows an overall decrease of ~10% in desert bighorns during the previous two years (Figure 1). This was largely due to a decline in the Zion population from approximately 800 to 500 individuals. Utah currently has 15 different huntable populations of desert bighorn sheep not including the Mineral Mountains population in Millard County, which was reintroduced in 2019 and is growing rapidly. There are currently 10 huntable populations of Rocky Mountain bighorn sheep not including the population on Antelope Island, which was reintroduced in 2020 following a die-off event, and the Pilot Mountain population which has a small number of animals. The Pilot Mountain population is shared with Nevada, and the administration of hunting permits alternates between the two states when mature rams are available. The Pilot Mountain population currently is not being hunted by either state.

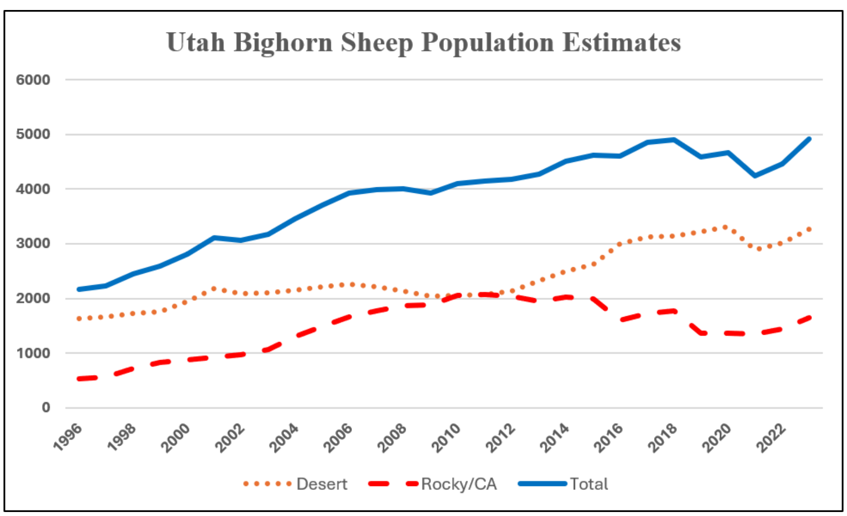

Figure 1. Statewide population estimates of desert bighorn sheep and Rocky Mountain bighorn sheep (includes 'California' bighorn sheep) in Utah, 1996–2023.

HARVEST

The statewide bighorn sheep management plan is a 10-year plan that was written in 2018. The plan dictates that aerial surveys will be conducted every 2 to 3 years. All observed animals are counted and classified as ewes, lambs, and rams, with rams being further classified as Class I (2.5 years old), II (2.5–5.5 years old, III (6.5–7.5 years old), or IV (≥8.5 years old; Geist 1971). Previous studies have shown that sightability on bighorn sheep populations varies between 60 and 70%, depending on the unit and conditions. However, the plan further dictates that hunting permit recommendations are made based on the number of rams actually observed on the most recent survey. Biologists can select from two different sets of sideboards for recommending harvest permits; 12–25% of the total number of rams observed that are of yearling age and older, or 30–60% of class III and class IV rams (6-years-of-age or older) observed. This year, 75 desert bighorn permits are being recommended and is an increase of four permits statewide. Fifty-two Rocky Mountain bighorn permits are being recommended, which is a reduction of 6 permits from last year. Also, for the past few years, there have been ewe hunts in the Newfoundland Mountains for which 5 permits have been allocated each year. Harvest success rates generally are very high, with 2022 success at 94% and 97% for desert bighorn rams and Rocky Mountain bighorn rams, respectively; the success rate for the ewe hunt was 80%. Bighorn sheep are managed as a once-in-a-lifetime huntable species in Utah.

PROJECTS

The Utah Division of Wildlife Resources (UDWR) entered into a cooperative project with a private landowner near Tabiona, Utah to establish a desert bighorn nursery facility. This enclosure is surrounded by an 8-foot high fence and is approximately 1,000 acres in area. In June of 2022, 31 desert bighorn sheep from the Muddy Mountains in Nevada were translocated to the facility. The objective of the project is to grow a nursery population of bighorns that can be protected from *Mycoplasma ovipneumoniae* (*M. ovi*) and used for future translocations. Cougars have been a major problem in the facility, and there have been 12 bighorn mortalities due to cougar predation. The nursery herd likely will be relocated to a new facility with lower predator densities this fall or winter.

Another translocation was conducted in October of 2022. Twenty-eight Rocky Mountain bighorn sheep were moved from near Morenci, Arizona to Antelope Island as part of a collaborative conservation project to augment that population. After a massive die-off and the subsequent removal of all remaining bighorn sheep in 2019, bighorn sheep from Rocky Boys Reservation in Montana were reintroduced to Antelope Island in 2020. The Morenci sheep have given the population a needed boost and added genetic diversity.

This past winter 150 GPS collars were deployed on 57 Rocky Mountain bighorn sheep and 93 desert bighorn sheep as part of Utah's ongoing disease sampling efforts. An additional 175 collars are planned for deployment this coming winter.

INTERAGENCY BIGHORN OUTREACH COORDINATOR

The UDWR entered into an agreement with the Utah Department of Agriculture and Food (UDAF) to create an interagency position to aid in bighorn sheep management. The position is within UDAF and is tasked with creating separation between bighorn sheep and domestic sheep and goats by working directly with livestock producers and private landowners. Duties of this position include identifying and prioritizing areas of potential pathogen spillover and disease risk, educating producers, providing fencing, disease sampling, and assisting in removing wandering bighorn sheep and stray domestic sheep. The position has been a success, and already has helped avoid several potential disease events.

RESEARCH

A study aimed at understanding population performance of bighorns in the Zion unit is wrapping up. Initial findings show that cougar predation is a limiting factor, and spatial use of bighorn sheep plays a role in mortality rates. These results provide insight to managers on those factors that influence population dynamics and potential management actions that may be effective. Another study on Antelope Island focused on predicting lambing dates based on GPS collar movement patterns and utilizing camera traps to estimate bighorn population size is concluding. The investigators were able to use spatial algorithms to predict lambing dates within four days of the actual birth. The use of cameras for estimating population size did not prove to be a promising method.

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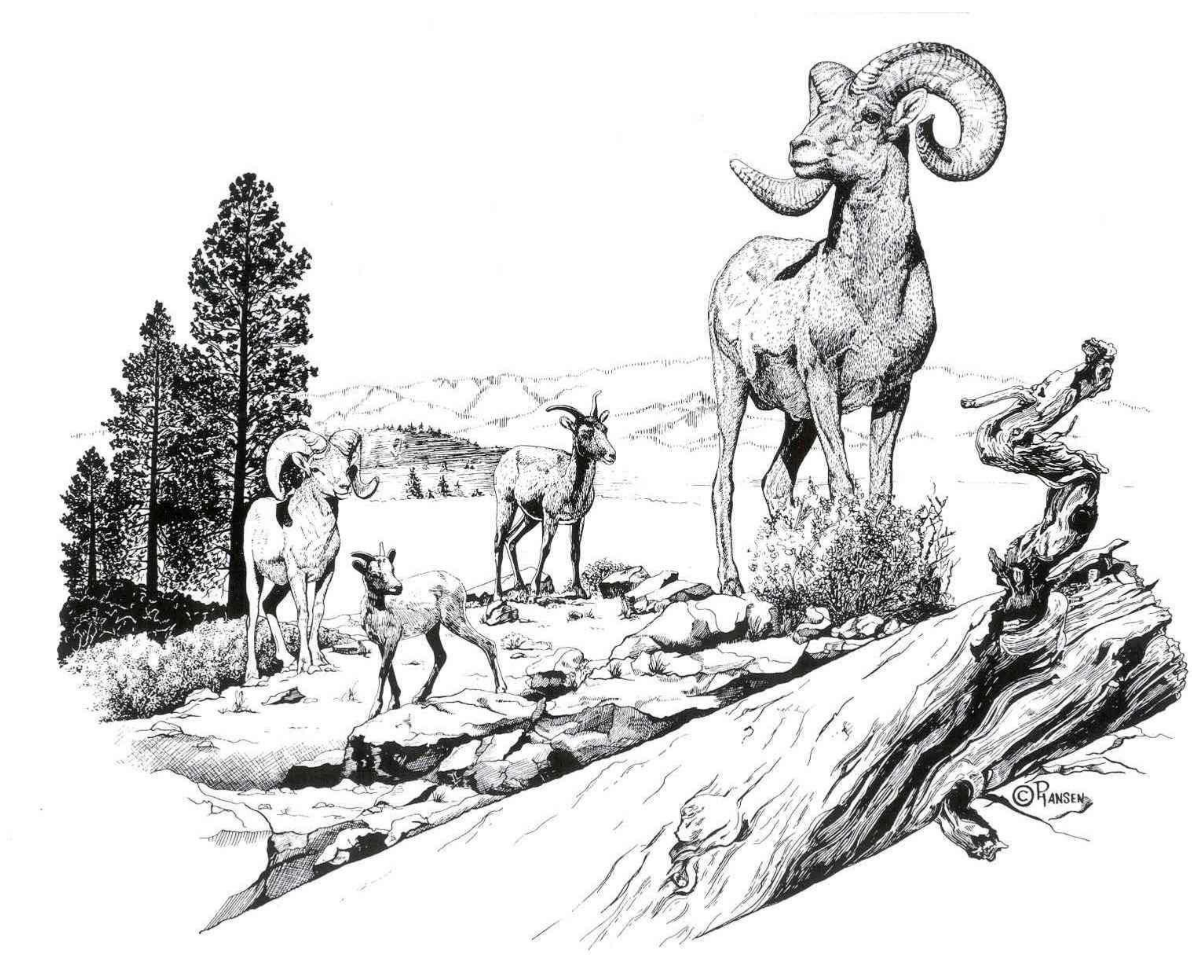
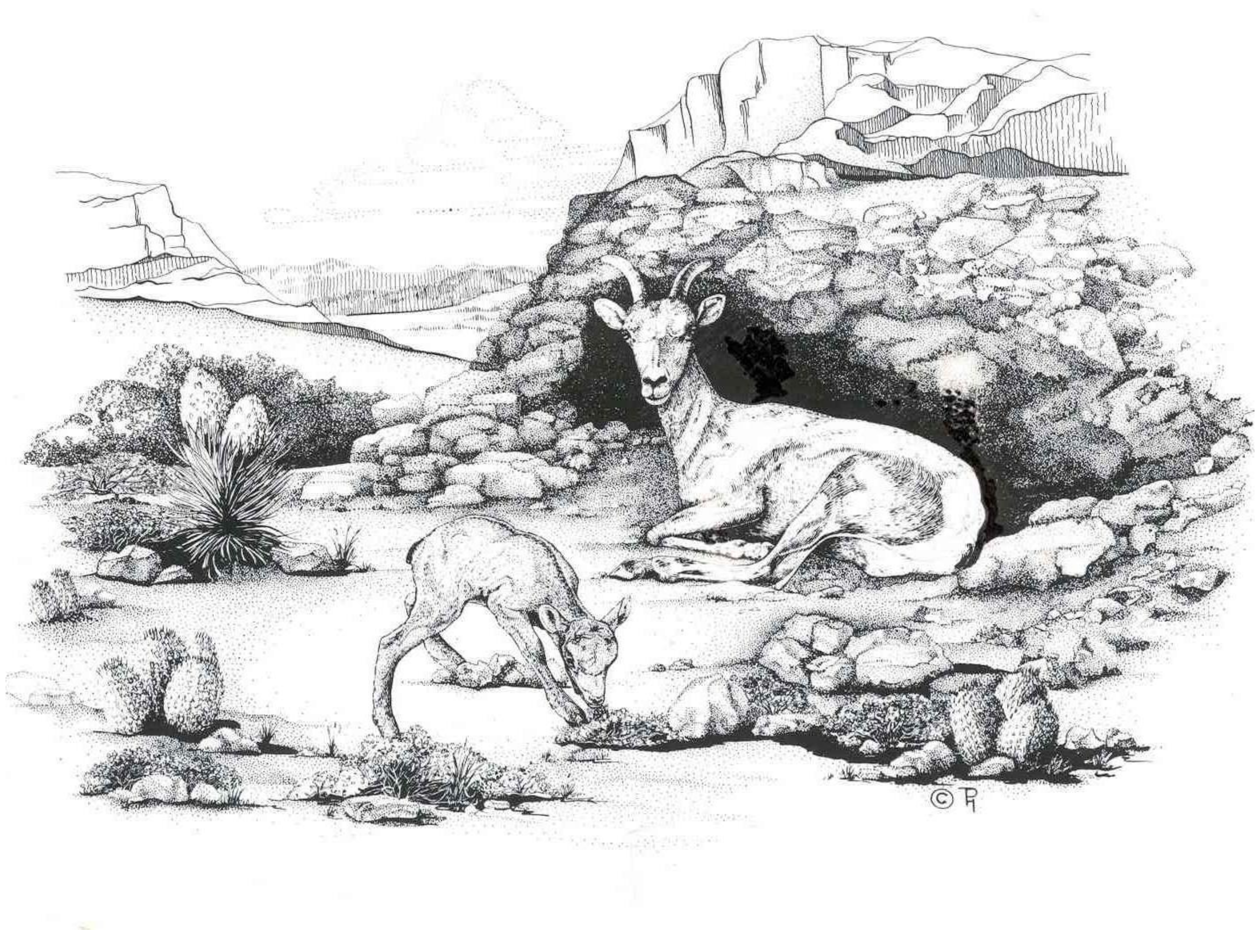


The DBC in History



Pat Hansen: The Evolution of a Gifted Wildlife Artist and Ardent Conservationist

Deborah Clark

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Desert Bighorn Council Transactions 57:94–96

Pat was born in 1928 in San Francisco, California. Her artistic talent was first recognized by her kindergarten teacher when Pat was a small child. She continued developing her talents, learning and experimenting with a wide variety of artistic media throughout high school and college. While in high school she took weaving classes and designed and wove several fine linens. She also took classes in ceramics, copper work, calligraphy, and numerous other artistic media. Pat majored in both art and science in college. She attended Marin Junior College, San Jose State College, Oregon State University (OSU), and later Empire Business College in Santa Rosa. While earning her Bachelor's of Science degree from OSU in the late 1940s she also worked, teaching art and taxidermy and doing freelance scientific illustration.

While still in college, Pat married Charles G. Hansen (known to friends and family as Chuck), who became a wildlife biologist for the US Fish and Wildlife Service and the National Park Service. In 1952, they moved in their station wagon to Steens Mountain, Oregon and lived for a year in their car, sleeping in the back and camping out while Charles did research for his Ph.D. Chuck's dissertation was an ecological survey of the vertebrate animals of Steens Mountain. His research entailed collecting as many animals as possible along different elevational gradients from the base of the mountain to the highest peak. In those days, to prove that you had seen and identified a plant or animal, the investigator had to collect it. This meant they had hundreds of plant specimens to press and preserve, and hundreds of small mammals to preserve as study skins. Pat spent many hours sitting at a card table out in the field, making study skins out of most of the birds and mammals that Chuck collected. Once the fieldwork was completed, the couple moved to Malheur National Wildlife Refuge, Oregon where Chuck was hired as the biologist for the refuge. Pat made several hundred live mounts of the shorebirds and waterfowl found on the Refuge; many of the specimens that Pat prepared remain on display in the Refuge's small museum in 2023.

In 1960 Pat and Chuck moved to the Desert Game Range (currently the Desert National Wildlife Refuge) near Las Vegas, Nevada and then to Death Valley National Monument, California where Chuck's work centered around his research on desert bighorn sheep. Pat (Figure 1) and Chuck became a team comprised of a dynamic writer and a prolific illustrator, focusing their respective talents on these remarkable animals.

Figure 1. Pat Hansen with a female desert bighorn sheep at the Desert Game Range, Clark County, Nevada, 1961.

During their 9-year study of the bighorn sheep at the Corn Creek Field Station for the US Fish and Wildlife Service, Pat began doing pen and ink drawings of bighorn sheep. These drawings provide an intimate window into the world of these majestic animals. Her keen eye for detail allowed her to accurately sketch bighorn sheep, their bodies perfectly adapted to the steep rocky slopes and the stark grandeur of their desert habitat. Pat's extensive experience with nature and her thousands of hours of wildlife observation allowed her to apply her artistic skills to illustrating desert bighorn sheep. Her remarkably accurate illustrations captured the correct morphology and visual essence of these iconic animals. Desert sheep aficionados are known to be very particular—one might even say *fussy*—about the correct visual representation of bighorn and is one reason Pat's art has always stood out.

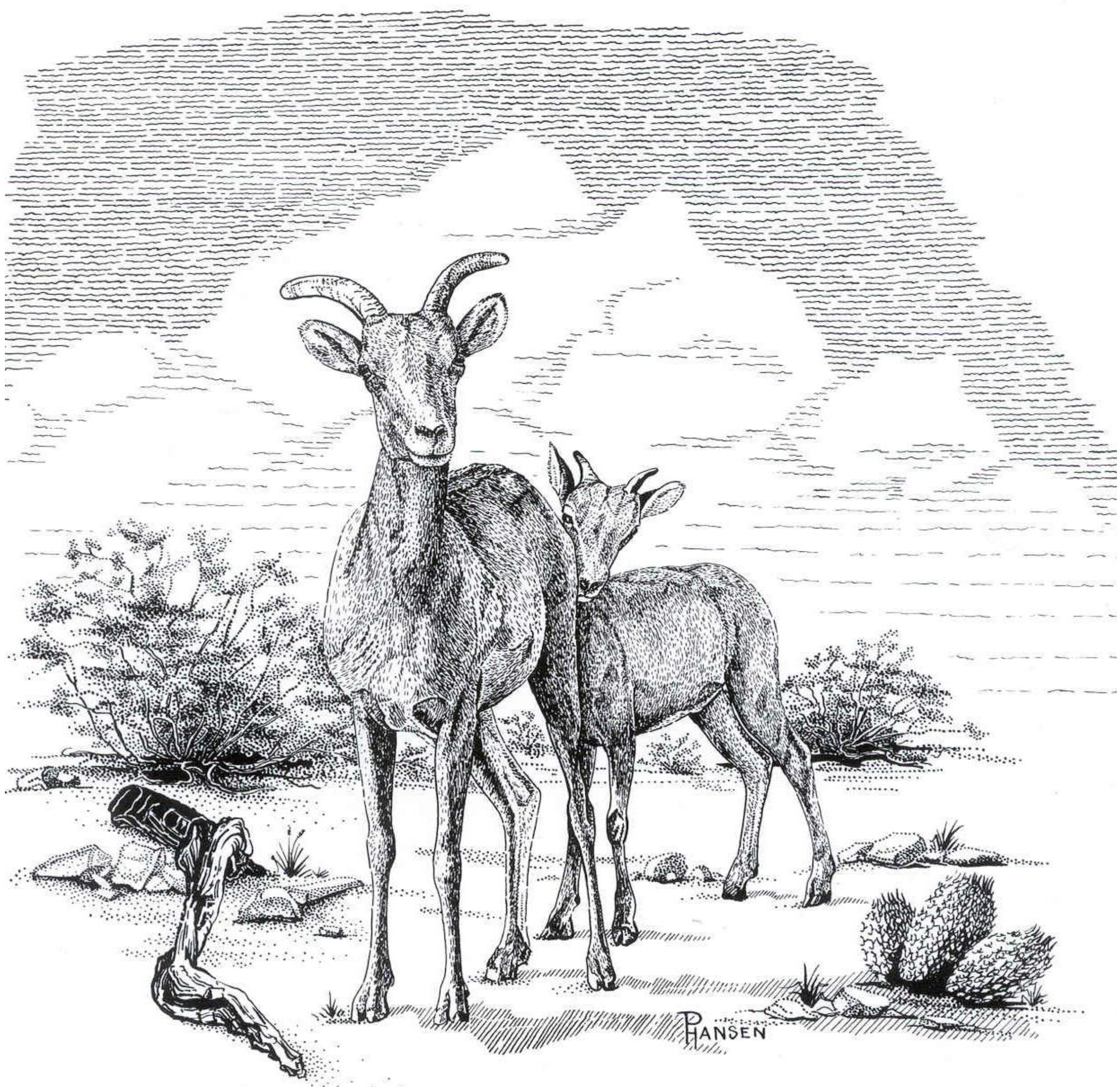
In May 1973 Chuck was killed in an airplane crash while conducting bighorn sheep surveys in Canyonlands National Park, Utah. After the devastating loss of her husband, Pat continued selling her bighorn sheep notecards and prints but she stopped creating new bighorn art. She changed artistic direction to other themes and media, making ceramic pottery and taking several needlepoint classes.

Pat's award-winning illustrations have been published in newspaper articles, as the covers for The Desert Bighorn Transactions for the Desert Bighorn Council, and enhance the book, *The Desert Bighorn*, published by the University of Arizona Press. Pat also illustrated a book on insects, *Legume Insects of Oregon*, published in1955. She received a special award at the Death Valley 49ers Encampment Art Show in 1968, and was the recipient of the Desert Bighorn Council's "Honor Plaque" in 1969.

In the 2000s, her artistic passion turned to an art form called "rosemaling," a Norwegian folk painting style that dates back to the late 1600s and uses intricate, abstract floral patterns, scrollwork, and flowing lines. During this time, she also created numerous botanical illustrations that were included in her daughter Deborah Clark's book, *Capitol Reef Wildflowers*, published in 2009. In 2020, Pat gave the Nevada Humanities Council permission to use several of her bighorn sheep pen and ink illustrations in their 2021 publication, *Sagebrush to Sandstone: A Humanities Guide to Outdoor Nevada*.

Pat is 95 years old and currently lives in an assisted living facility in Santa Rosa, California. There she can reflect on her many happy memories of her family and her life in the field with Chuck as well as her successes at weaving her own artistic career into her rewarding life as a wife and a mother. She was very much ahead of her time in many ways.

Pat's art has been used by the Desert Bighorn Council's publications often enough that it is instantly recognizable. Pat has graciously signed about 50 posters of her prints created from 1960 to 1975, and these will be auctioned off at future Council meetings, with proceeds to be donated to the Council's scholarship fund. Pat has generously granted permission for the Desert Bighorn Council to use her art in the Transactions and for scholarship fundraising in perpetuity.



Where Have We Been and Where Are We Going?[1]

Ralph E. Welles

National Park Service, Joshua Tree National Monument, California

Desert Bighorn Council Transactions 57:97–100

The questions, "Where have we been and where are we going?" are not as easily answered as they might seem. In the first place the questions must be translated to mean, "What have we achieved to date, and what can we achieve in the future?" There is still a third translation which is probably the most realistic, "What have we been trying to do up to now?" and "What are we going to try to do from now on?"

I don't believe anyone could complete a discussion of this subject in twenty minutes or even twenty hours, because there will be inevitable differences of opinions as to the degree of success we have had in the past, and as to the course we should set for the future. I have arrived at a partial inventory after having read every word of all the papers we have published, the recorded bull sessions we have had, and the minutes of our business meetings. I read them all and re-read some of them several times. I made notes as I read and began to put the notes into two columns, one black and one red—one positive on the success side; one negative, on the failure side. I would earnestly urge this task on all who are seriously concerned with the activities of this Council.

I found much on the positive side, and eventually I began to see where we have been and what we have been doing. For the past nine years we have been at school learning the trade, the profession, which many of us may have thought we had already mastered—the job of protection and management of the desert bighorn and his habitat. This has taken some doing. In 1959 the Transactions asked this question, "Where are we now?" Then answered it in this way: "Our attitude toward our lack of knowledge of the bighorn sometimes reminds us of the general attitude toward money during the Great Depression of the '30s, 'nobody has any, so why worry?" The relaxed, "we're all in the same boat" attitude prevailed for several years and many people remember it as one of the most comfortable periods of their lives. Through no fault of their own they were relieved of the responsibility of being successful. It was easy-going and comfortable for us here as long as we all keep saying, "We don't how anything about bighorn—no one does." It seems to us, however, that the Bighorn Council is about to jar us into maturity. Sooner or later we will be forced into admitting that we *do* know *something* about sheep and if this Council continues to function it will force us into *accepting our responsibility* of learning about them.

Read the Transactions and you will see that this has happened—up to a point. Then comes the negative column. It could be argued that the Council has not matured as it should have. It still suffers from certain taboos, some issues are not faced. For instance, is there any. actual need of predator control in the Bighorn

[1]Originally published as Welles, R. E. 1966. Where have we been and where are we going? Desert Bighorn Council Transactions 10:5–8. Footnotes of historical and solicited papers are consecutive throughout these sections—EDITOR.

Management program? Is it possible that predator control may even be a threat to bighorn welfare? Are we squarely facing the issue of exotic introductions into bighorn habitat? Have we had our say about human encroachment in the form of highways into the Desert Game Range? Flooding bighorn habitat by damming the Grand Canyon? The spending of millions on building roads and trails into ancestral bighorn strongholds throughout the desert for every hundred that is spent on its protection? And, have we come as far as we should until we establish some criteria for our publications? Is there anything to be gained by the publishing in 1964 of a rehash of Dr. Buechner's [1960] rehash of Seton's [1929] rehash of everything he [Seton] could get hold of prior to 1929?

In 1965, the Transactions published in one paper this astonishing array of misleading statements about the bighorn and burros of Death Valley. (1) The average male desert bighorn will weigh from 250 to 300 lbs. (2) The Death Valley bighorn tends to migrate according to the season. There is a definite downward migration during spring from the higher elevations, a summer residence at low levels and then a distinct fall migration back to high country. (3) Copulation takes place during the months of September and October. (4) The most important single problem occurring in Death Valley National Monument today is the wild burro competition for the bighorn forage. (5) The burro causes heavy pollution of the water by defecation. (6) In the Panamint Range the bighorn were present in the 1930s, but left in 1935.

Ample proof of the fallacy of all the above statements has already been published in the Transactions and elsewhere. Should we keep saying that once a ram reaches 7 years of age he is no longer useful to the herd? And that killing the best specimens over seven [years-of-age], the “trophy rams”, will not harm the population? Should we ignore the many observations of these “trophy rams” being deferred to during the rut by not only the younger rams, but [also by] the smaller rams of the same age?

A thirteen year old ram sired a lamb in the San Diego Zoo. That left him six more years of productivity than we have been allowing him. Does it not follow that as the Trophy Rams of seven years and up are harvested the ratio of breeding opportunities for the inferior rams is increased? Thus, it would seem that there is a great deal of the positive and some of the negative in where we have been and what we have been doing. This is all down in black and white and clearly discernible to all who will read it.

Where we are going is not so easy to see. Certainly, we should continue to stay in school, so to speak, to continue to learn. And it may be that if this Council continues to function, our first step into the future would be to accept, fully, our responsibility for doing something about what we have learned—by stepping out boldly on the path we know we should follow. This is not easy.

We may know what the path is, where it is, and how to take it. But we find the footing insecure and obscured by the clouds of dust raised by the road and trail building into and through the areas we are supposed to be protecting. And the air grows murky with smog as the traffic roars through [all the while] spewing beer cans and Kleenex over the countryside. Sometimes we find the way completely blocked by the blizzard from Olympus leaving insurmountable drifts of memoranda behind. And, as we shovel these drifts aside, we find ourselves up to our necks in a quagmire of red tape from which very few of us ever completely extricate ourselves.

Let me once more recommend the Transactions to you, particularly the paper by Dr. William Graf (1964). He said, “Reduced to its essence the situation is that while a number of dedicated people, largely this group, are much concerned over the welfare of the desert sheep and have gathered together much information about them and have made many worthwhile suggestions that would improve sheep management, nothing has been or is being done, to implement these suggestions. What is the reason for this?" Then Dr. Graf gives the following answers. (1) The lack of an administrative decision-making policy for the solution of sheep problems; (2) the lack of delegated authority to qualified field men; and, (3) the lack of an organized and coordinated study and research program. Graf [1964] then wonders whether we really want to do something for the bighorn or [if we are] going to stand by with a holding action while the sheep become extinct, or "are at best reduced to museum pieces in the field." I am not rehashing now; I am quoting [him] because what he said needs repeating and cannot be over-emphasized. "In view of the lack of action, I wonder whether the various Federal agencies, or many of the state agencies involved, really want more sheep—or any sheep for that matter. I have good reason to believe that at least some of the administrators of some of these agencies would be much happier if we have no sheep at all—then we would have no troublesome Bighorn Council to listen to, not to mention even more troublesome academic points of view." If asked about this, these administrators would vehemently deny this, but their actions would bear it out. Let's look at a typical instance and let me assure you that this is the rule and not the exception.

As most of you know, Mrs. Welles and I, in 1960, completed a ten-year project of bighorn, burro, and water source research in Death Valley (Welles and Welles 1961). As set forth in our contract, we left behind us a record of all the wildlife water sources in the Monument with recommendations for their maintenance and protection. In 1965, we visited the Monument and inquired about these water sources to see how our renovation work had stood up and how our recommendations had worked out. There was no one there that we could find who even knew the names of these springs, let alone where they were or what condition they might be in.

Why does this happen? In another area I asked an administrative assistant how much, about what percentage, of the mountain of mail on his desk had to do with the all-pervasive people-service orientation, the philosophy which dictates that all energies must be bent toward aiding the exploding population of this planet in its enjoyment, its use, and its abuse of our natural resources, and what percentage of it dealt with the conservation, the preservation of these resources for the future. He said, "About 99% of it reflects the people-service orientation, but that is what we are, a people-service organization." [I responded, "Yes, ...but] isn't the preservation of these areas the *first* service we are supposed to perform for the people?" In response he said, "[Oh, yes, but I guess] that is just taken for granted!" And therein lies the gravest danger to the bighorn and to all wildlife on this planet. It is taken for granted, not only by the government agencies charged with the responsibility for preservation—but by almost everyone else mistakenly believing that simply because these areas are once set aside for the present and all future generations to enjoy, they are therefore safe, that the supply is inexhaustible, and that there should be no limitation set on *how* it is to be enjoyed, or how much or how fast it is used up. Let me say again that we cannot effectively deal with the bighorn problem without placing man at the top of the list. Our job is not so much one of knowing how to manage bighorn as it is how to manage ourselves. Unless we make a positive approach to this proposition we may not be going anywhere.

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How Wide is the Scope of the Desert Bighorn Council?[2]

William Graf

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Desert Bighorn Council Transactions 57:101–103

ABSTRACT It is within the scope of the Council not only to publish research findings but also to interpret the studies and research and take action based on the interrelations. The Council cannot leave the action to others. To do so would constitute dereliction to .its own objectives and purposes.

The scope of the Desert Bighorn Council must be determined by two things: (1) the objectives of the Council, and (2) by the nature of the organization which seeks to implement these objectives. The first of these factors is quite simply stated by the Council, "to promote the advancement of knowledge concerning the Desert Bighorn Sheep and the long-range welfare of these animals." The second, the nature of the organization, is also not difficult to define. It is composed in the majority of professional biologists who devote their efforts to the study of biology, and especially that of wildlife biology, if not entirely the biology of the desert sheep.

The greatest proportion is concerned with the study and management of wildlife, including that of the desert sheep. A few, like myself, are primarily concerned with research and the teaching of wildlife management in public institutions. A few are non-professional people who, nevertheless, are vitally interested in all phases of the stated objectives, and particularly the welfare of these animals.

All members regardless of their training and background have a special interest in wild desert sheep—otherwise they would not be here. It is important to keep this in mind for it has a most important bearing on what determines the scope of the Desert Bighorn Council, particularly as it relates to the second part of the objectives of the Council.

The purpose of the Council can be divided into two separate objectives, which while not unrelated are nevertheless quite distinct in the way in which they can be implemented and fulfilled. The first can be implemented simply through diligent study and research and the publication of the results of these efforts. The Council is doing this to the fullest extent of its resources. It is gathering the information and publishing it in its Transactions and making it available to all who are interested in it. The scope of the first objective is not difficult to define—anything and everything that relates either directly or indirectly to the sheep. It runs the endless gamut of subjects from the ancient to the modern history of the sheep and its past and present range, to the biology and all its complex ramifications related to the sheep internally or externally, individually or

[2]This paper originally was published as Graf, W. 1966. How wide is the scope of the Desert Bighorn Council? Desert Bighorn Transactions 10:9–12.

collectively and in its relationship to other animals.

The second part of the purpose of the Council, "the promotion of the welfare of the animals" defines the scope of the Desert Bighorn Council in terms of the nature of the people who make up the Council, and their intent to achieve a goal which is not of purely academic interest, but may be actively and specifically subjective. In this second part of the purpose of the Council we deal not with the gathering of information and its dissemination, but in the translation of this information into decisions and actions that will have a definite effect on the welfare of the animals. This part of the purpose calls for action and the achievement of definitely stated results.

This part of the purpose of the Council is related to the first through the management of the animals. The Council's study will reveal what the management was in the past and what it is today. The professional makeup of the people who gather the information will make it possible for them to decide what management is needed now and in the future. The members of the Council must be able to, and should, examine critically their own management and administrative practices and policies and then make the necessary corrections without regard for politics or personal feelings.

Too often in the past, as well as the present, policies have been based on political expediency rather than the actual needs of the. animal under consideration. Just one example, with which all of us are well acquainted, may be cited here. Consider the widely accepted "multiple use" practice policy which has been so widely heralded and accepted by government agencies and conservationists. It has been my experience and observation that in most instances this is only a politically expedient term for what is really a "multiple-abuse and misuse practice policy." The Council must be able to carefully examine and review all such practices and policies and must be prepared to make recommendations for changes when and where needed. In fact it, the Council, is obligated to do this if it is to maintain and fulfill its objectives.

Although it is not difficult to define the objective and purpose of the Council, it must be kept in mind that the implementation of the objectives can be achieved only through those who are properly trained and fitted for this type of work, namely, professional biologists such as those who devote their entire energies to this end. Long-range welfare through management can best be determined by those having intimate knowledge of the needs of the animals as they exist and as they should exist. Most important, the interpretation of this information and the implementation of the decisions can also best be made by those having the greatest knowledge and understanding of the needs of the sheep. The Council, through its members is best qualified to meet these requirements and standards.

What the needs of the animals are or will be can be determined only as the knowledge gathered becomes available to the Council. When such knowledge does become available to it, the Council will have to make a decision regarding the welfare needs and will have to act upon this decision. It will be the objective and critical analysis by these people, passed on to the interested public officials, that will make possible the support of intelligent programs proposed by the professional biologist as well as the rejection of programs not based on sound biological knowledge by the uninformed or misinformed.

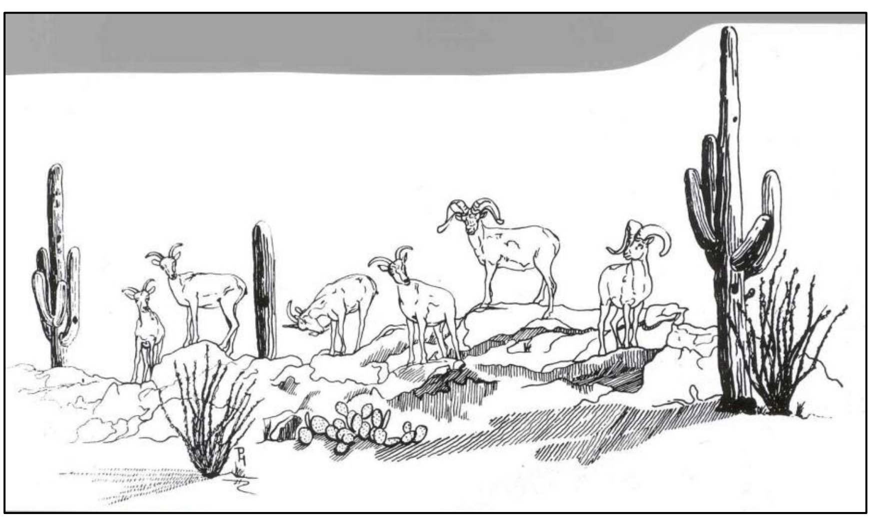
Just what is the scope of action that the Council can and must take to fulfill its professional objectives in its resolve to promote the long-range welfare of the desert sheep? To develop long-range action, short-range action must also be taken. The Council cannot expect the future to take care of itself if it does not take care of the present. *The present is the future of the past, and it is also the past of the future*. What happens to the sheep today will determine whether the sheep have any future at all!

The Council should ask itself, "Can we influence the future by merely gathering and publishing information?" [and] "Can this influence the critical and immediate present?" The [answers are], "It MAY influence the present, and it MAY influence the future." However, that it MAY do so is not enough. It is the Council's responsibility to see to it that it DOES influence both the present and the future.

To be effective, the knowledge must be translated into decisive action, and this must be done when and where it is needed by those best qualified. The Council should, and must, see to it that this knowledge and its interpretation is carried out as quickly as possible, and must take whatever steps may be necessary to carry out their decisions.

Recently it has been suggested that the efforts of the Council be limited merely to the gathering and presentation of information and knowledge—nothing more—[and] that the Council should at most make suggestions. This would, for all practical purposes, result merely in making suggestions to itself and would leave the decisions to others. Since the suggestions are those of the professional biologists, and since the implementation of these suggestions is to be left to "others", it must be assumed that the ”others" are non-professional persons or groups involved in management.

The Council would be derelict to its own professional background and qualifications if it fails to act on its own decisions and if it fails to back its own convictions. To talk to oneself may be comforting, but it gets no work done! The purpose of the Desert Bighorn Council can and must include action. If it does it will be just another group that is long on talk and short on action—waste of time and money. [The previous sentence is as it appeared in Graf’s original article. I suspect, however, that it may have been edited for political correctness, and may have originally read, “if it does *not*, it will be just another group that is long on talk and short on action—waste of time and money.” I suggest readers consider this possibility given the overall tone of Graf’s comments—EDITOR]. It is within the scope of the Council to take positive action to achieve its objectives. Only in this way can it achieve its objectives and only in this way can it justify its existence.



Goals of the Council[3]

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Desert Bighorn Council Transactions 57:104–106

When the Desert Bighorn Council was first thought of by a few interested men and then brought into reality in 1957, its objectives were to allow field men an opportunity to exchange ideas, compare findings, discuss problems, and seek solutions to management of desert bighorn sheep. The first meeting was made up of personnel from our Southwest; representatives from state and federal agencies and colleges. Mostly, these individuals were directly concerned with management of desert bighorn sheep.

As a result of this first gathering, a purpose for the organization was created, which simply stated, "Established to promote the advancement of knowledge concerning Desert Bighorn Sheep and the long-range welfare of these animals." This is so stated on the brochure that is sent to inquiring individuals interested in the functions of our organization. The statement quoted is also part of our letterhead.

Shortly after our first meeting the Council adopted a Constitution and Bylaws, and in this governing document we find four objectives. Briefly, these are to (1) provide for the exchange of information...through meetings and published transactions; (2) stimulate and coordinate studies in all phases related to desert bighorn; (3) provide a clearing house of information among all agencies, organizations and individuals through the appointment of work committees; and (4) function in a professional advisory capacity, where appropriate, on local, national and international questions involving the management and protections of the desert bighorn, and adopt such measures as shall tend to promote the advancement of knowledge concerning bighorn and the long-range welfare of these animals.

Those of you who are familiar with the [Council's] Constitution realize I have quoted the last objective in its entirety. I did so because it is probably the most important and possibly the cradle to the whole organization and its makeup. The last half of the fourth objectives also provided us with the wording of the purpose found in our letterhead. Although these are objectives, they are to be thought of as goals of the Council and should be given important consideration because they have implications that are being questioned today, not only by our own members, but [also] by the administrations of cooperating agencies.

In an organization of this type we are exposed to varied personal philosophies and ideologies, but often our ideas are guided and influenced by our own organizational policies. In our contacts here we are entertained by many thoughts and ideas with which we may not necessarily agree. For every idea expressed, I am sure someone, someplace, can provide a counter-idea, or an argument. At this point you may wonder how this is related to the goals of the Council. It may simply be stated that we must accept our goal in its basic concept without looking for complicated definitions or hidden meanings to gain a

[3]This paper originally was published as Russo, J. P. 1966. Goals of the Council. Desert Bighorn Council Transactions 10:1–4.

means to an end, [with] the end in this case being personal satisfaction. I should like to elaborate on this.

Our four objectives speak for themselves and require little interpretation or explanation. We fulfill our first objective by exchanging information freely in our meetings and in the form of [the DBC] Transactions. Pick up a copy of our publication and this is proof enough. From the demand shown for our Transactions it may well be considered a success.

Our second goal, or objective has been partially fulfilled. We have certainly stimulated studies of desert biqhorn in the past nine years.

Our third goal appears to be the most difficult [of the four] and requires considerable effort on our part. Lack of time and restricted space limits the effectiveness of committees to make material progress in functioning as a clearing house. The Technical Committee and individual contributions have helped to meet this objective. The Council will continue to profit by fulfilling this goal through the endeavors of interested and cooperating members.

The last Council objective requires some close scrutiny in view of recent events. I did not realize this until I received copies of correspondence stating that one agency [would withdraw from] the Council because of a resolution that was written several years ago.

We do not want the Desert Bighorn Council to be treated by state and federal agencies with studied contempt, nor do we want agencies looking upon us as another spur-of-the-moment, fly-by-night, bandwagon-type organization that comes from a small interested group with the idea of sitting around entertaining ourselves by exchanging [yarns] and waxing sentiment. I am sure that we have all seen such councils, task groups, task forces, committees, workshops, and what-not, come and go with the seasons, the moods and the whims of a few, and soon dissipate.

To say we must refrain from mentioning anything that might be controversial is to limit us to a parrot-like conversation of each agency policy without recourse for debate through scientific thinking. An organization is emasculated when it cannot express itself to the good of the organization, or what it represents, without a furtive, benevolent nod from the parent agency. I should think that the administrative bodies would have more faith in their representatives. I am sure they do. [The final sentence of this paragraph appears as it was published. As originally written, however, it may well have read, "I am *not* sure they do" but was modified to be 'politically correct' by the original editor. That possibility should not be ignored—Editor.]

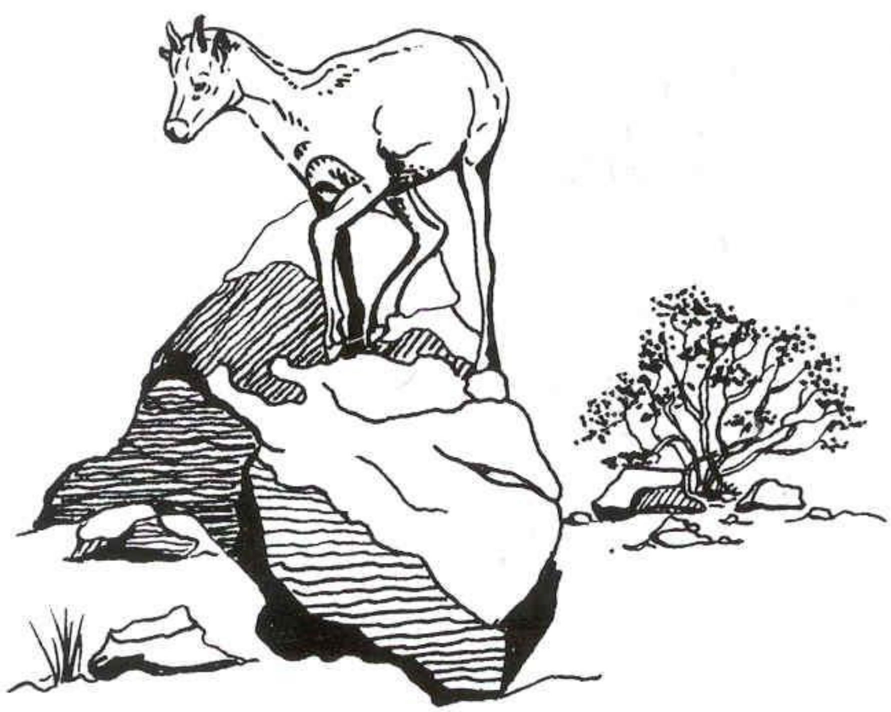
The Desert Bighorn Council has made several resolutions directed to the welfare of desert bighorn; it has provided a mutual meeting ground where the problems and findings, dealing with desert bighorn, could be discussed; it has generated interest not only among men working with bighorn, but among sportsmen, guides, taxidermists, and conservationists; it has provided an outlet for all these findings, knowledge and data; and most of all, the Council has become recognized through its own beneficial contributions, [whether] materially, financially, physically [or] intellectually. These are all goals.

I feel that the Desert Bighorn Council cannot idly stand by and watch mismanagement of bighorn or bighorn habitat, or the circumvention of authority by those who do not understand the needs of the desert bighorn. Some would have us continue in a line of progressive reasoning, [and] pursuing space-age ideas with an 'overhead pull-chain' philosophy. We are confronted now with a problem of dragging our feet and paying little attention to anything except discussing bighorn sheep, or we can take into consideration the welfare of this animal in all related fields. If we understand the latter, then we must express ourselves as a unit.

I have heard members say that the Council is ‘falling apart’. We may reflect upon this for a moment to try to analyze why [there is] dissension among the ranks—so to speak. Throughout the existence of this organization there have been sounds of discontent brought about by disagreement, dissatisfaction and, in some cases, petty jealousy. On several occasions, members have purposely taken to the floor to ‘tactfully criticize policy of an agency’ or take a ‘sophisticated oratory poke’ at someone who said something that was not exactly agreed with. Corrective criticism is always welcomed, I am sure, but to excoriate under the guise of corrective criticism should not be allowed in the Council. This is not the place. for a harangue of this type. When this happens we are no longer objectively working in behalf of the organization; rather, we are subjectively tearing it down. Do not let personal sentiment interfere with good judgment.

[I ask again,] “What is the goal of this organization?” I think it is a combination of purpose, as we outline in our brochure, and [the objectives as mentioned] in our constitution. Without these, we have no other reason or means to conform to any type of an organization. We have no reason for getting together.

[I feel, however] there is something else we must strive for—a goal that cannot be expressed like a formula. This goal should be the success of the organization through fulfillment of its purpose and its objectives. We would be selfish to sacrifice the Desert Bighorn Council for want of personal satisfaction. We would be derelict in our duties to the conservation of the desert bighorn and its habitat not to take a stand on issues. But, above all this and foremost in our intentions, our goal is the success of the Desert Bighorn Council.



The Desert Bighorn Council—the First 25 Years[4]

Warren E. Kelly

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Desert Bighorn Council Transactions 57:107–110

ABSTRACT The Desert Bighorn Council has been in existence for 25 years. The first meeting of the Council was held in Las Vegas. Three years later, we had developed a Constitution and Bylaws. In our 25 years we have published 25 transactions containing about 500 technical papers. The Council has presented several awards for outstanding accomplishments, and it has memorialized its members who have died. The Council has prepared a book about the life history of the desert bighorn and contributed to a book about the wild sheep in North America, published by the Wildlife Management Institute. Two attempts have been made to force the Council to merge with the Western Association of Game and Fish Commissioners. Other proposals have been made to merge the Council with other bighorn groups. So far, the Council has maintained its own autonomy.

The Desert Bighorn Council (DBC) had its beginning in Las Vegas in the spring of 1957 when biologists from the U.S. Fish and Wildlife Service, National Park Service and the Nevada Fish and Game Commission met to discuss the existing knowledge of the desert bighorn sheep. Clair Aldous, Gordon Fredine, Wally Wallace, Al Ray Jonez, and Warren Kelly attended this meeting. The review of existing literature didn't take long. About the only publication of a scientific nature on desert bighorn in existence at that time was the results of John Russo's work in southwestern Arizona during the early 1950s.

Gordon Fredine made the comment that most of the information on desert bighorn was still unpublished and stored in the minds and diaries of the people that were working on sheep at that time. He suggested we have a meeting of all persons currently working with the desert bighorn. The states of Texas, New Mexico, Arizona, Nevada, and to a lesser extent California, were active in bighorn programs. Also, personnel at the San Andres, Kofa, Cabeza Prieta and Desert game ranges, and at Death Valley National Monument were conducting bighorn investigations.

The first meeting of biologists doing research and gathering management data on desert bighorn was held in September 1957. Twenty-seven people attended that meeting. The meeting was given the name of the Desert Bighorn Sheep Council. The agenda consisted of status reports from each state, refuge, park, or monument. Unstructured discussions were conducted on such topics as water requirements, breeding and lambing periods, lamb survival, herd composition, seasonal food requirements, 'territory' of individuals and bands, burro-bighorn competition, hunting, census techniques, and sign reading. Each discussion was recorded, and the tape was transcribed and printed in the Transactions. After papers and discussions, we had our first business meeting. Two questions

[4]This paper originally was published as Kelley, W. E. 1982. The Desert Bighorn Council—the first 25 years. Desert Bighorn Council Transactions 26:100–101.

were asked [to] the group: was the meeting a success, and shall the meetings become an annual affair? The answers were a unanimous "yes!"

The second meeting was held in Yuma during the first week in April. Again, that year we had a small group and nearly everyone at the meeting presented a paper. The program chairman had requested papers on specific subjects such as water developments, trapping and tagging, lungworm infections, water requirements, and daily movements. Our field trip was an overnight affair to the Kofa Game Range.

In 1959 we met in California's Death Valley National Monument. This is where the Desert Bighorn Council actually came into being. At our business meeting we formally adopted the name Desert Bighorn Council as our official title. At this meeting a committee was appointed to prepare a Constitution and Bylaws for approval at the next meeting of the Council. The Constitution and Bylaws were approved at the 1960 meeting in Las Cruces, New Mexico. In this governing document there are four objectives, which are to (1) provide for the exchange of information ... through meetings and published transactions; (2) stimulate and coordinate studies in all phases related to desert bighorn; (3) provide a clearing house of information among all agencies, organizations and individuals ... through the appointment of work committees; and (4) function in a professional advisory capacity where appropriate, on local, national, and international questions involving the management and protections of the desert bighorn—and to adopt such measures as shall tend to promote the advancement of knowledge concerning bighorn and the long-range welfare of these animals. In the last objective you may have recognized the origin of the words on our letterhead, which reads "Established to promote the advancement of knowledge concerning bighorn and long-range welfare of these animals."

During these first 25 years, have we satisfied any of these objectives? Let's take a look. At our first meeting we decided that we would hold our meetings in different places each year. We would then have an opportunity to visit other bighorn areas, visit with other biologists and observe their problems firsthand, observe existing and proposed trapping and trans[location] sites, and generally make the Desert Bighorn Council Meeting a well-rounded annual training session. Since 1957 we have met in 22 different places and have had outstanding field trips. Our membership has been between 100-150 people since our first 3 or 4 meetings. We have published 25 transactions of our meetings and there has been an average of 20 papers in [each volume] of the transactions. The Council has prepared 2 management guidelines, one on trapping and translocating, and the other on habitat requirements of desert bighorn. The Council has prepared several resolutions relative to the introduction of exotic ungulates, the San Gorgonio Wilderness, the regulation and control of public use on public land, feral burros, and [one] to permanently mark legally taken bighorn trophy heads.

In 1960 the Council presented its first Trophy Award to Ralph and Buddy Welles for their work at Death Valley National Monument. Since then, Trophy Awards have been presented to Oscar Demming, John Russo, Charles Hansen, Steve James, Clair Aldous, the Arizona Desert Bighorn Sheep Society, the Mexico Forestry and Wildlife Department, and to Bob McQuivey. Honor plaques have been presented to the Nevada Operations Office of the Atomic Energy Commission, Pat Hansen, the Inyo National Forest, Lydia Berry, Jim Blaisdell, and the Society for the Conservation of Bighorn Sheep. In 1975 the Council presented an Award of Excellence to Gale Monson and Lowell Sumner, editors of The Desert Bighorn. In 1964 the Mexican Forest and

Wildlife Department presented the Silver Ram to the Council at the 8th Annual Meeting in Mexicali-San Felipe, Baja California, Mexico. The Mexicans intended this trophy to be given as an award. Since there was no way we could duplicate the Silver Ram for all future awards recipients, the Council voted to keep the Silver Ram as a symbol of the Council. It would be passed from chairman to chairman and would be on the podium at each meeting.

In 1962, Winn Banko, using the same argument that Gordon Fredine used in 1957, proposed that the Council members compile a book on the life history, ecology, and management of the desert bighorn. This idea was approved, and the Technical Staff was appointed and charged with the task of overseeing the completion of the book. Gale Monson and Lowell Sumner took on the task as editors. The editors worked with the sixteen authors to prepare 22 chapters and the book *The Desert Bighorn* was finally published in 1980.

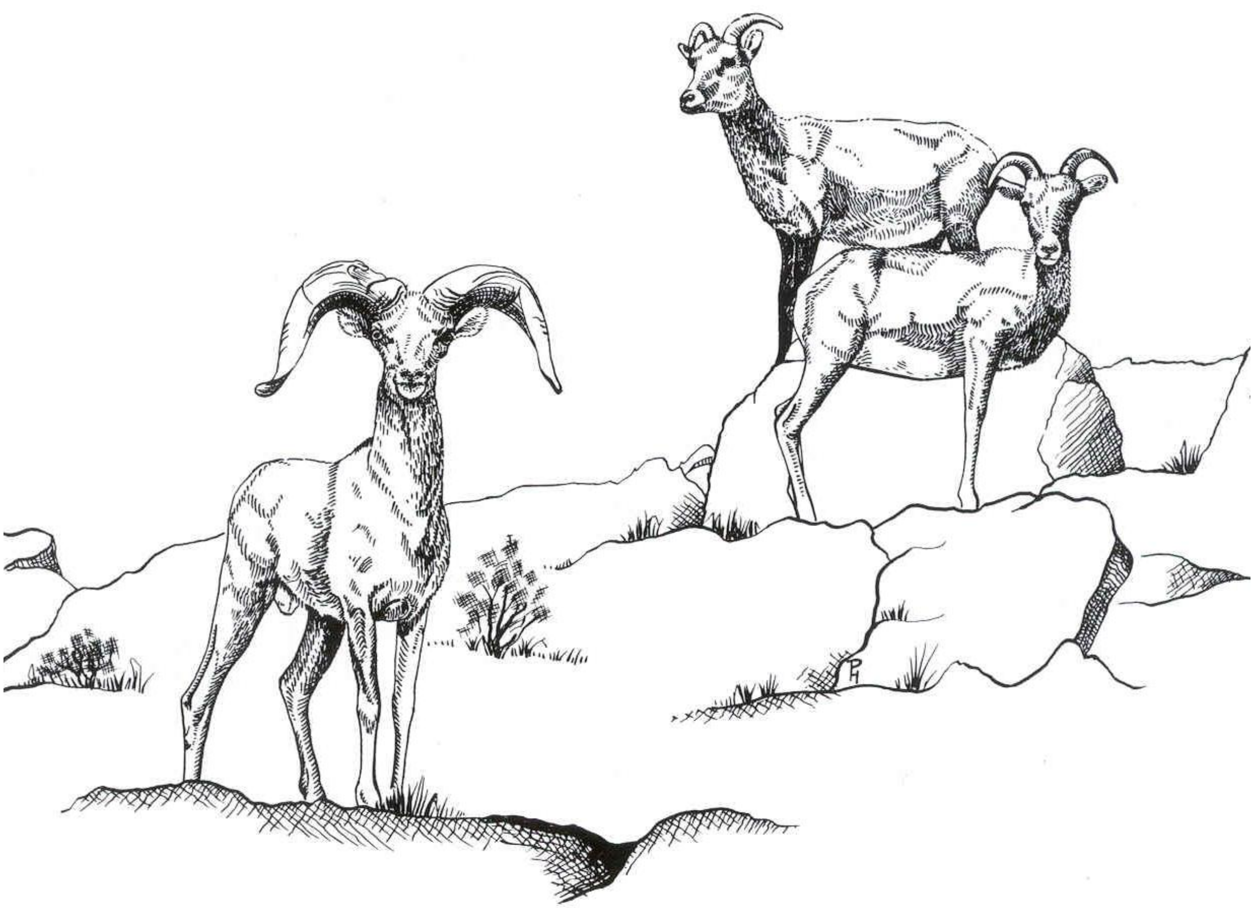
In June of 1974, 17 Desert Bighorn Council members met with 61 other biologists and administrations at a workshop about North American Wild Sheep in Missoula, Montana. The workshop was sponsored by the Wildlife Management Institute. The proceedings were published in a book titled The Wild Sheep in Modern North America. Approximately one-half of the book relates to reports and management recommendations for the desert bighorn.

In 1964 the Desert Bighorn Council began a practice of dedicating [the] Transactions to members who had died. The first was Sr. Luis Macias, Director of the Mexican Forestry and Wildlife Department. Others were John Reed, Cecil Kennedy, Bun Morgan, Jake Metherell, [and] Bill Graf; and Bill Cooper, John Ebersole, and Dick Smith who died in an airplane accident with Chuck Hansen. Chuck, Bill, John and Dick were doing an aerial bighorn survey when [the] accident happened. All of these people were dedicated to their profession and to the protection and preservation of the desert bighorn. [Since publication of this paper, an additional 27 individuals dedicated to the management and conservation of desert bighorn sheep have been recognized in the DBC Transactions—Editor].

On 2 occasions efforts were made to force the Desert Bighorn Council to become integrated into the Western Association of State Game and Fish Commissioners (currently the Western Association of Fish and Wildlife Agencies). On each occasion the Council resisted these efforts. The reasons for opposing this proposal were (1) only administrators and a favored few would attend the meetings; (2) biologists actually working on bighorn would lose the opportunity to visit other bighorn areas; (3) possibly the greatest loss would be to the local [Fish and Game Biologist, Conservation Officer, or Game Warden] in such places as Bishop [CA], Monticello [UT], Kingman [AZ], Las Cruces [NM], or Kerrville [TX]; these communities aren't on the Western Association's meeting list; (4) we would have to gain permission from the parent organization prior to taking any action. I believe the Council exhibited its maturity in dealing with pressures brought on by a relatively few members of the Western Association.

We [also] have had proposals to merge with other bighorn groups—either permanently or on a one-year-in-five basis. On each occasion the Council has voted to maintain its own integrity. During the first 5 years of the Council we heard comments such as (1) we will soon exhaust the amount of data for papers; or (2) due to lack of data we will have to meet every two years or so; or, (3) we should merge with other bighorn groups so we won't run out of data for papers; or, (4) no new studies of desert bighorn will be initiated. So far none of these dire predictions have occurred. The number of papers has remained consistent with past years, and the quality and diversity of the subject matter has gotten better. The Council has encouraged research, and the Technical Staff has reviewed study plans, [of which] the most recent was Jim DeForge's project. Sometime soon the Council may be financially able to sponsor research through the Charles Hansen Memorial Fund [currently the Desert Bighorn Council Charles Hansen-Ralph Welles-Robert Campbell-Dick Weaver Memorial Scholarship].

The Desert Bighorn Council has been a leader, pusher, counselor, and even occasionally an activist to meet and exceed the objectives as set forth in the Constitution and Bylaws. You all know that Las Vegas [the location of this Council] is a gambling town. Five people took a chance back in 1957, and the desert bighorn came out as the winner. I hope they can be winners during the next 25 years.



The Desert Bighorn Council—Have We Made a Difference?[5]

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Desert Bighorn Council Transactions 57:111–115

Ray Lee asked me to prepare a brief history of the Council for presentation here. How many of you in the audience were born after 1957? [show of hands—about half)]. That is the year the Council was formed—so about half of you are younger than the Council!

- Organizational History. The Council was formed in 1957 by interested biologists from several fish and game agencies. A constitution was developed by 1959. In 1962, a Technical Staff [hereafter, Tech Staff] was formed to start work on a comprehensive, up-to-date book on desert bighorns. The Tech Staff currently functions by providing input to land use and management agency proposed actions, legislative proposals, and hot issues such as embryo transfers [and] preparation of the Guidelines For Management of Domestic Sheep in Desert Bighorn Habitat. It is made up of biologists from land management and game and fish agencies, and the private sector. The Council was incorporated in Nevada in 1980, with help from Wayne Capurro, a Reno lawyer who was also a hunter and conservationist. The Tech Staff became the Council's Board of Directors. With help from the father of then-Secretary-Treasurer Bill Dunn, the Council was granted [tax-exempt status] by the Internal Revenue Service under section 501(c)(3), in 1988. In 1993, [Rick] Brigham prepared an Operations Manual, which outlines the duties of each officer and committee in the Council except the Awards Committee. This was done to provide for a smooth transition between officers and committee chairs since they change frequently, and this is an all-volunteer organization. At the urging of Kevin Hurley of the Northern Wild Sheep and Goat Council, this Council applied for and was granted membership in the Western Association of Fish and Wildlife Agencies (WAFWA) in 1999. By having WAFWA sanction, [Desert Bighorn Council] members who work for game and fish agencies should be able to get travel funds and authorization more easily. The annual meeting of the [Desert Bighorn] Council rotates between Arizona, Nevada, California, Utah, Texas, New Mexico, Colorado, and occasionally old Mexico, to give local biologists an opportunity to attend and participate in the meetings.
- Getting the Word Out. This is done in two ways: the first was publication of the book, The Desert Bighorn-Its Life History, Ecology, and Management, which was published by the University of Arizona Press at Tucson [Monson and Sumner 1980]. The second way is that the Council prepares and distributes annual Transactions. A Transactions Editor was established in the

[5]This paper originally was published as Brigham, W. R. 2000. The Desert Bighorn Council: have we made a difference? Desert Bighorn Council Transactions 44:1–5. It has been edited slightly for clarity, with most such edits appearing in [bracketed phrases]—EDITOR.

1960s and is a volunteer position. There are three types of papers [published] in the Transactions: individual state reports, which follow a standard format; opinion pieces or discussions of new, untried methodologies; and peer reviewed and refereed technical papers. Indices have been prepared twice for the Transactions: a stand-alone version for the years 1957–1971; and [another] covering the years 1957–1986 [Kovach 1989] , which was published in the Transactions.

- Awards. There are three types: the Ram Award; the Honor Plaque; and the Award of Excellence. There are also Certificates of Appreciation, which are presented occasionally. Dick .Weaver will have more to say about these later in this meeting.
- Brochures. [These] were prepared, updated, and disseminated in the 1960s, in 1983 by Warren Kelly and Rick Brigham, and [again] in 1998 by Darren Divine, the current Secretary-Treasurer.
- Hansen-Welles Memorial Fund. Dr. Charles G. Hansen was an early stalwart in the Council, [and was a] US Fish and Wildlife Service biologist in charge of the Desert National Wildlife Range. He met an untimely demise in an aircraft accident while looking for desert bighorns in Utah. In 1984, the Council established the Hansen Fund, which is comprised of federally insured certificates of deposit CDs]. The original funds used to purchase the CDs were from individual donations, royalties from the sale of the Council's book, contributions from the Desert Bighorn Council Ewes (a group of biologists' wives, headed by Doris Weaver). The Ewes have sold T-shirts, mugs, prints by Pat Hansen, carvings by Warren Kelly, [and other items] for decades. Accrued interest from the CDs is used for stipends for students and researchers working with desert bighorns and their habitats. An application form is found in one of the latest Transactions [and now is available on the Council's website], and the Tech Staff makes the actual grant.

HAS THE COUNCIL MADE A DIFFERENCE?

[Listed below] are many of the Council's accomplishments.

- Rendezvous. The annual meeting provides a formal and informal venue where members share ideas, concepts, new methodologies, etc., including the benefit of 'cross-fertilization' of ideas.
- Annual Meetings. Rotation has allowed many biologists and managers to attend, who would not be able to do so otherwise.
- Guidelines for the capture of desert bighorns [Wilson et al. 1973] were published in the 1973 Transactions and updated [Wilson et al. 1982] in the 1982 Transactions.
- Preparation of the chapter on desert bighorn sheep by individual Council members that appeared in [The Wild Sheep in Modern North America (Trefethen 1975)], and was published by the Boone & Crockett Club.
- Guidelines on habitat requirements [of desert bighorn sheep (Wilson et al. 1980) were] published in the 1980 Transactions.
- Guidelines for the management of domestic sheep in bighorn habitat [Desert Bighorn Council Technical Staff 1990] were published in the 1990 Transactions These guidelines were prepared at the request of the Interior Department's Bureau of Land Management (BLM). They were adopted as guidelines following a 1992 meeting attended by representatives of the Council, the BLM, the US Forest Service, several wildlife veterinarians, and the American Sheep Council, and issued as an information bulletin. In 1998, following a second similar meeting, the guidelines were issued as BLM policv for all BLM-managed public lands, under a formal Instruction Memo.
- Comments on BLM Interim

Management Guidelines for Wilderness Studv Areas [were prepared] and the Council sent several letters to the BLM acting Director in 1993 and 1994 identifying major disparities in interpretation of the BLM guidelines between BLM wilderness specialists and wildlife biologists, among BLM wilderness specialists at various levels within the BLM, BLM managers on adjacent management units, and BLM management between states. The Council's comments and constructive criticisms caused the BLM Wilderness Management Staff to revamp the [Interim] Guidelines, making them much more restrictive for on-the-ground management than prior versions. The BLM Wilderness Management staff deleted entirely the U.S. Department of the Interior policy on management of resident wildlife by state game and fish agencies. No BLM biologists were consulted during preparation of the 1995 [BLM wilderness] guidelines. Following a chorus of protest from state agencies, WAFWA, and BLM non-wilderness personnel, the guidelines were revised [and that resulted] in a more pro-management document ([when compared to the earlier and more preservation-oriented document]).

- Listing of California Bighorns [was proposed] by the U.S. Fish and Wildlife Service [USFWS] as a categorv 2 candidate species, [but the] Council was stonewalled by USFWS after 3 Freedom of Information Act requests in 1994 and 1995 to find out why the California bighorns were even considered as a candidate species. The Council offered to share its knowledge, but was never contacted by USFWS.
- A Position Statement on embryo transfers [Brigham 1996] was published in the 1996 Transactions. This proposal was developed by Texas A& M University researchers. Under the proposal, fertilized desert bighorn eggs would be carried to term in domestic ewes. The Council noted among other things that bighorn behavior could be modified to remove wariness to hunters, and that "designer sheep" (big horns=big trophies) would be a probable result.
- The 1999 North American Wild Sheep Conference was held at Reno, [and] it was a joint venture between the [Desert Bighorn] Council and the Northern Wild Sheep and Goat Council. The transactions of this meeting [Thomas and Thomas 1999] should be printed and distributed in 2000. Kevin Hurley of the Northern Wild Sheep and Goat Council deserves much credit for the idea, and [for] being a prime motivator [for the meeting].
- Resolutions [passed by the] Council are numerous and have addressed the following in (1) 1963, the opposition to the introduction of exotic ungulates with a thorough environmental analysis, several years before the passage of the National Environmental Policy Act (NEPA); (2) 1964, a request to the U.S. Secretary of the Interior to delegate management authority to regulate and control public use [to] the land managing agencies; (3) 1967, endorsement of retention of desert bighorn habitat in public domain (=public lands)—under the Classification & Multiple-Use Act; (4) 1967, a request to the land managing agencies to control feral burros; (5) 1967, an endorsement of development of water for desert bighorns in a bighorn habitat management proposal; (6) 1972, urging that permanent identification of legally taken bighorn heads and horns to aid wildlife law enforcement; (7) 1980, support for the state of New Mexico listing of desert bighorns as endangered, but [we] did not support federal listing; (8) 1981, encouraged the state of Texas to re-initiate the Texas desert bighorn reestablishment program; (9) 1982, a recommendation to California that the California Department of Fish and Game develop a goal-oriented management program for desert bighorns; (10) 1982, a recommendation to [the state of] California

that desert bighorn management be transferred from the California State Legislature (!) to the Department of Fish and Game; and (11) 1982, support for the reclassification of 11 roadless areas within Anza Borrego [Desert] State Park to California State Wilderness status.

Has the Council made a difference? YES! Through the annual rotating meeting; the Tech Staff comments, position statements and guidelines; the book—best of its kind when it was published; the North American Wild Sheep Conference; the Desert Bighorn Council Transactions getting the word out; help to Mexico in the form of expertise on surveys and financial assistance; and YES to motivating people. Participants come away from these annual meetings charged up and [are] revitalized to fight battles for bighorns for another year.

I have talked with you about the Council's history, what it has done that it has made a difference in the grand scheme of wild sheep management. Here are several things I would like to see for the future. (1) Consider a Council website or tier off some other wildlife or wild sheep organization, keeping in mind that this Council is an all-volunteer organization and it takes time to maintain web sites once they are established; (2) E-mail is a neat tool! We are starting to use it for distributing the Council's Newsletter, Bleats and Blats. I used it extensively when working with several other folks to prepare for the North American Wild Sheep Conference. It can mean faster responses to hot issues, and it is cheaper than the telephone and fax; (3) the Tech Staff should continue to provide input to land use plans [and] planning documents, as needed, such as the Northern and Eastern Colorado Desert plans, actively provide input to federal wilderness legislation that that may be upcoming for Nevada, and should continue to provide input to wilderness management plans as these are developed by land management agencies following wilderness designation, especially in the southern California desert; (4) legislative proposals for Nevada's Black Rock Desert are also in the works, and should be commented upon; (5) the Council should revisit the 1967 research needs paper (Hansen 1967), compare it with information developed since then, including that presented during the North American Wild Sheep Conference, and see where we are and what is left to do; (6) more active participation in the Council by the US Fish and Wildlife Service would be appreciated, since USFWS has the lead in preparing recovery plans for the peninsular bighorn sheep, and [because] USFWS stonewalled the Council in the mid-1990s, for reasons as yet unexplained; (7) revise the 1980 Habitat Management Guidelines [Wilson et al. 1980] and publish in an upcoming Transactions; (8) publish Ramev and Wehausen's mountain sheep (re)classifications in the Desert Bighorn Council Transactions, so members will have easy access to them, and to get the word out to all Council members [this appeared as Wehausen and Ramey (2000)]; and, (9) continue to make more financial grants through the Hansen-Welles Fund.

Last, I leave you with these thoughts. Always keep in mind the following question posed many times by Dick Weaver (a founding member of the Council), "What is best for the sheep?", and a statement from the late Bill Graf (an early Council member), "We know enough to manage sheep [but] we must have the will."

We, the Desert Bighorn Council members individually and collectively—YOU AND I—ARE THE WILL!! Never forget that! Thank you.

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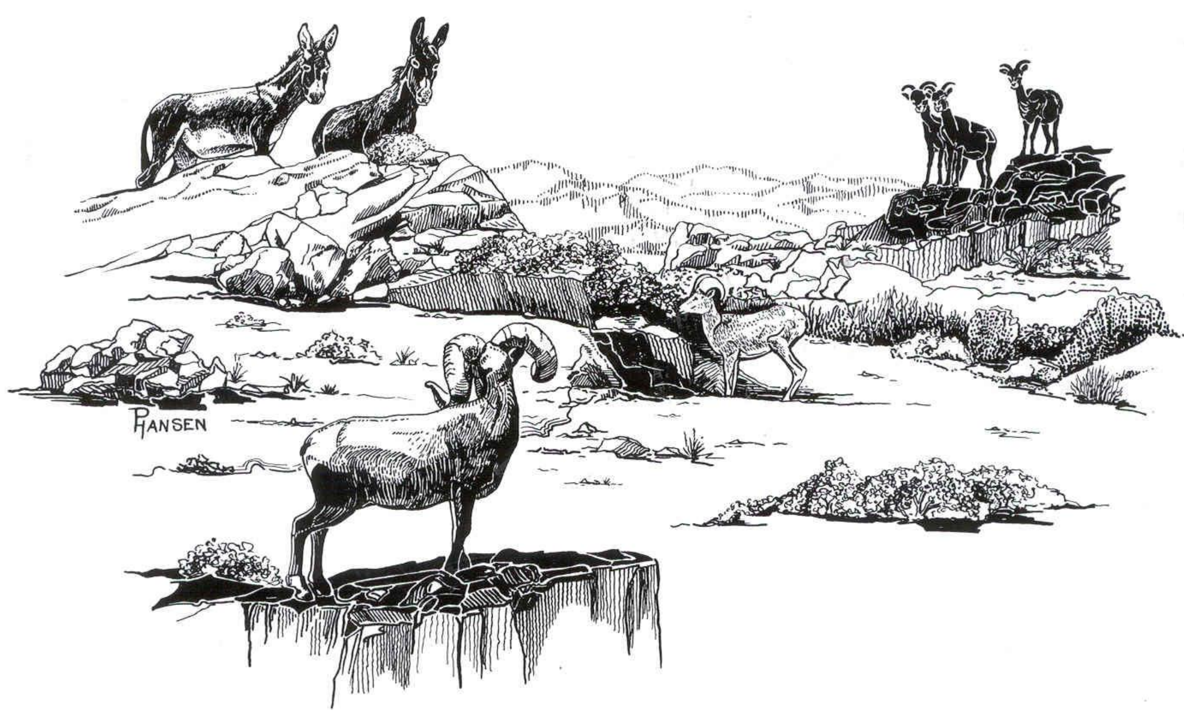

The Use Of Desert Bighorn Council Transactions[6]

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Desert Bighorn Council Transactions 57:116–118

Recently, members of the Desert Bighorn Council have discussed various aspects of publishing the Desert Bighorn Council Transactions (Transactions); i.e., length of volumes, value of status reports, and the peer-review process. The length of volumes and number of technical papers depends upon the number and quality of those submitted. The Transactions have been peer reviewed since the late 1970s. Douglas (1979) indicated that "Peer review has been used for a number of years . . .". Douglas' (1979) note acknowledged the importance of peer-review and he revised the Transactions so reviewed articles were presented first followed by status reports (that are not peer-reviewed). This practice was continued when the Transactions were divided into sections: technical papers, status reports, case histories, and comments in the late1980s.

The issue of peer review has been addressed by Douglas (1979), Smith (1988), Guthery (1988), Capen (1988), and Bissonette (1988). The general agreement is that peer review is not perfect, but it is the best system to present scientific material; it is a critical part of the scientific process. I predict that peer review will continue to be a source of discussion; peer review is critical for the Transactions to continue to develop and be considered an important source of literature. In reviewing the Literature Cited sections of the Transactions it was obvious that authors used the Transactions as a source of information. However, I was curious as to how biologists used papers presented in the Transactions.

To answer this question, I examined 4 other sources of literature that publish articles about mountain sheep (*Ovis canadensis*): Transaction of the North American Wild Sheep Conference (1971, 1976), Northern Wild Sheep and Goat Council (1980, 1982,1984, 1986, 1988, 1990), and articles in the Journal of Mammalogy and Journal of Wildlife Management since 1957 that were related to mountain sheep.

Authors used over 170 sources when writing about mountain sheep. Peer-reviewed journals (e.g., Journal of Wildlife Management*,* Desert Bighorn Council Transactions, Journal of Mammalogy) were the most commonly cited sources (Table 1). Other sources (e.g., M.S. theses, Ph.D. dissertations, state and provincial reports) also were used commonly (Table 1). I answered my question by compiling this list and finding that, overall, the Transactions were the sixth of over 170 cited sources of literature and the second most commonly cited source among peer-reviewed journals. Either way, this compilation indicates that the Transactions are used and are an important source of literature.

[6]This paper originally was published as Krausman, P. R. 1992. The use of Desert Bighorn Council Transactions. Desert Bighorn Council Transactions 36:48.

The Transactions are the most important part of the Desert Bighorn Council, and they provide a service to the scientific community. The management of all species, including mountain sheep, will require information based upon research. The Transactions can continue to play a role in that process.

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Table 1. The most commonly cited literature used by authors writing about mountain sheep in the Transactions of the North American Wild Sheep Conference (1971, 1976), the Northern Wild Sheep and Goat Council (1980–90), and Journal of Mammalogy and Journal of Wildlife Management since 1957.

Sources Searched	DBC Citations (N)
Journal of Wildlife Management[a]	591
72 peer-reviewed journals (<25 citations/journal)[a]	556
M.S. theses	386
North Wild Sheep and Goat Council Proceedings	352
28 state and 11 provincial reports	327
Desert Bighorn Council Transactions[a]	144
Ph.D. dissertations or theses	139
International Mountain Goat Symposium Proceedings	129
Journal of Mammalogy[a]	127
Journal of Wildlife Diseases[a]	105
Journal of Range Management[a]	95
Mountain sheep: a study in behavior and evolution[b]	90
Canadian Journal of Zoology[a]	85
Wildlife Monographs[a]	77
Canadian Field Naturalist[a]	46
Ecology[a]	46
Journal of the American Veterinary Medical Association[a]	45
First North American Wild Sheep Conference	40
National Park Service Fauna Series[a]	39
Northern Wild Sheep Council Proceedings	39
8 popular magazines	38
Wildlife Society Bulletin[a]	36
3 published books (<25 citations/book)	33
N. American Wildlife and Natural Resources Conference[a]	30
American Midland Naturalist[a]	27
Big Game of North America[c]	27
American Journal of Veterinary Research[a]	25
Journal of Animal Science[a]	25
4 USDA Forest Service reports	22
2 Canadian Wildlife Service reports	19
11 miscellaneous conference proceedings	18
4 Canadian Forest Service reports	6
2 U.S. Fish and Wildlife Service reports	4
1 USDI Bureau of Land Management report	1

[a]Peer reviewed publication; [b]Geist (1970); [c]Schmidt and Gilbert (1978)

Desert Bighorn Council's 50th Anniversary[7]

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Desert Bighorn Council Transactions 57:119

In 1957, the first meeting of the Desert Bighorn Council was held in Las Vegas, Nevada. To commemorate the 50 years of research and management, the Desert Bighorn Council again met in Las Vegas in 2007. These Desert Bighorn Council Transactions are the official record of that meeting.

I did not attend the 1957 inaugural meeting of the Desert Bighorn Council. The first meeting I attended was held in Page, Arizona in 1986. I attended regularly during my graduate years while studying bighorn sheep, but after the 1989 meeting in Grand Junction, Colorado, I was unable to attend other meetings as I was preoccupied studying the other charismatic megafauna: wild turkeys. In fact, I did not return to another meeting until 2003 in St. George, Utah when I agreed to serve as the editor of the Transactions.

On returning to the Desert Bighorn Council Meetings, I was at first surprised at the number of familiar faces that had been returning for the entire length of time I had been away. Many of those faces had been quite intimidating to me as a graduate student when I was presenting results of research in which I had been involved; Dick Weaver, John Wehausen, Rick Brigham, and Vern Bleich are only a few of the names that had been involved in landmark management and research activities, and they were well respected. I was certain that my underfunded research, which could have benefited from better planning, would get me laughed off the speaker's platform. Quite the opposite; constructive criticism and encouragement is what I received.

With every passing year, and each subsequent volume of the Transactions, we learn more about bighorn sheep conservation. I am impressed with the advances wildlife science has made, yet substantial basic knowledge is still lacking in some arenas. Studies continue to fill in the knowledge gaps. And we continue to discover things we need to learn more about.

After 50 years, there is much the same as in the early days. We are still encouraging each other to get the most from the data we collect. We continue to break new ground and learn more about relationships we once believed were well understood. We are also learning to deal with new challenges to bighorn sheep management that have not been considered before. The Desert Bighorn Council was vital to sharing knowledge and identifying needs 50 years ago. I believe that it will still play that same role in another 50 years. As you read the papers in this volume, I encourage you to reflect on the past while looking toward the future.

[7]This paper originally was published as Wakeling, B. 2007. Desert Bighorn Council's 50th Anniversary. Desert Bighorn Council Transactions 49:i.

Post Hoc Ergo Propter Hoc[8]

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Desert Bighorn Council Transactions 57:120–121

> "Twenty-seven lawyers in the room, anybody know *'post hoc, ergo propter hoc'*?"… "After it, therefore because of it. It means one thing follows the other, therefore it was caused by the other, but it's not always true. In fact, it's hardly ever true."—President Josiah Bartlet, played by Martin Sheen in The West Wing, second episode, which first aired on 6 October 1999.

Cause and effect. In research, we apply experimental treatments to determine the effects on some response variable that result from the treatment of some action, perhaps a management activity. We employ controls and sophisticated analyses to isolate effects and infer rationales or explanations for what we observe. Yet logical and plausible relationships are often inferred from correlative ones. This approach has been successful and we have advanced wildlife science beyond what was once only an art by using it. Hippocrates (460 BC–370 BC) is the first person known to have examined relationships between human disease and environmental relationships, and he is sometimes described as the father of epidemiology. Epidemiological studies are retrospective, relying on data compiled from a variety of sources, on which correlative relationships are examined to determine if causative relationships are plausible. Much of modern medical knowledge has been based, at least in part, on epidemiological studies. Similarly, wildlife research often uses comparisons among unrelated data sets to help us identify plausible causative relationships. When wildlife scientists look at retrospective data sets, we often call these "fishing expeditions" or "data dredging." We should be cautious, and for good reason. In 2005, John P. A. Ioannidis from the University of Ioannina School of Medicine in Ioannina, Greece published a paper entitled "Why most published research findings are false" in the PLoS medical online journal. His critique is not only of retrospective, but also of designed studies. This paper has been cited over 660 times in the 5 years since its initial publication, and he points out several failings, which he terms corollaries.

1. The smaller the studies conducted in a scientific field, the less likely the research findings are to be true.
2. The smaller the effect sizes in a scientific field, the less likely research findings are to be true
3. The greater the number and the lesser the selection of tested relationships in a scientific field, the less likely the research findings are to be true
4. The greater the flexibility in designs, definitions, outcomes, and

[8]This paper originally was published as Wakeling, B. F. 2009. *Post Hoc Ergo Propter Hoc*. Desert Bighorn Council Transactions 50:i.

analytical modes in a scientific field, the less likely the research findings are to be true,

5. The greater the financial and other interests and prejudices in a scientific field, the less likely the research findings are to be true, and

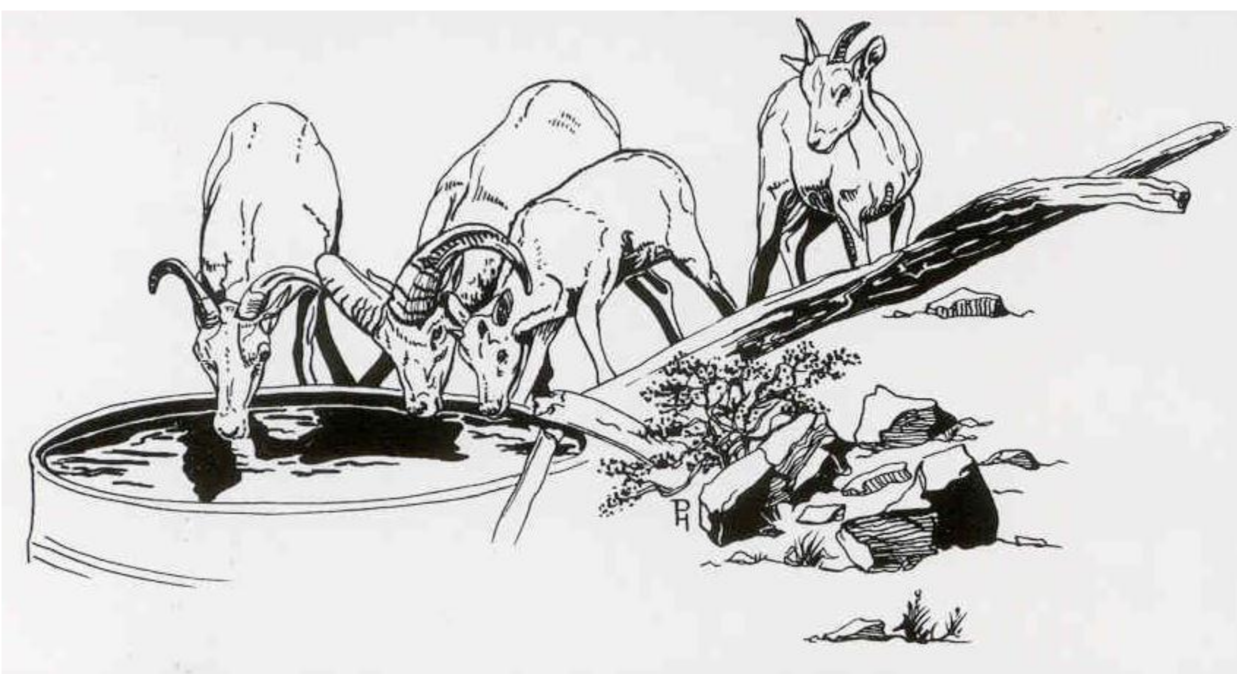
6. The hotter a scientific field (with more scientific teams involved), the less likely the research findings are to be true.

Should we therefore shun those papers that dredge our historical data sets? I believe not. Many important relationships have first been noted through these retrospective evaluations. But we should not accept these relationships as absolute fact until time and additional studies affirm them. The trick then is to learn from what we observe and design well developed studies with the appropriate power to detect real effects. Retrospective research should pose testable hypotheses for future research that should hold if the relationships observed are indeed true.

I recall a conversation I had with Harley Shaw, my first supervisor with the Arizona Game and Fish Department and respected mountain lion, bighorn sheep, and turkey biologist. He noted that a particular paleobiological explanation for wildlife distribution was dangerous because it was a popular notion that gained notoriety, but was virtually untestable. Its popularity outweighed its applicability. As a young biologist, that gave me something to think about.

The first paper in this volume is an example of the type of retrospective analysis that generates more questions than it answers. The authors (which include me) examine our historical bighorn sheep management activities and try to determine those that are good, those that are bad, and those that may be ugly. This is an important dialogue in which to engage for both scientists and administrators. Our management, while influenced by social desires, must be based on solid science.

Yet that is what the Desert Bighorn Council Transactions have been fostering for over 50 years.



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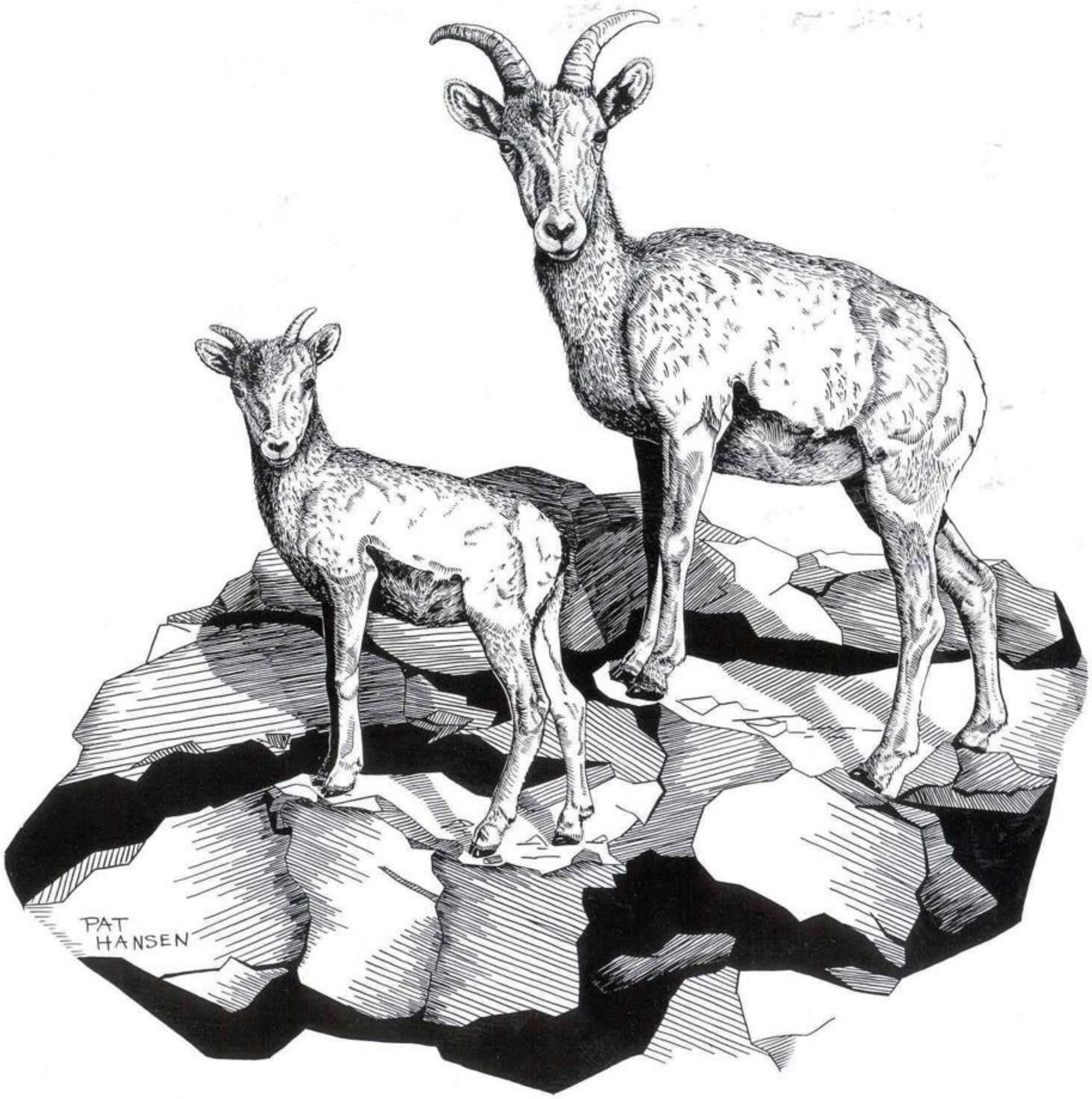

Important Considerations When Using Models[9]

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Desert Bighorn Council Transactions 57:123–127

A Ph.D. student entered my office at the University of Arizona and asked me to review a habitat model for a desert ungulate that was part of their dissertation. I gladly did so, and when the student returned for my comments, I gave my opinion and asked how they thought the habitat characteristics afield aligned with those in the model. The study area was only a few hours southwest of the university. The response puzzled me when the student stated "Oh, I did not realize they were that close and no, I have not ever seen the species and have never been to the area." The entire model developed by the student was based on remote sensing and information of others that had not been verified, much of which was speculation.

In essence this is a problem with some models used in manuscripts submitted to the Journal of Wildlife Management. Many submitted models rely too much on unverified work of others, make no attempt to obtain information from the animals or their habitat, do not sample randomly, and do not attempt any form of ground truthing, verification, or validation to ensure that data are accurate and results are appropriate for the inferences made, and to justify that a model's intended use meets specified performance requirements (Rykiel 1996, Hastie et al. 2001, Roberts et al. 2017, Brice et al. 2020).

Models, each with different considerations, include statistical models, analytical models, and simulation models. Statistical models are more commonly used to test scientific theories when the data (e.g., observations, processes, boundary conditions) are subject to stochasticity (Hartig et al. 2011). Analytical models use mathematical equations to predict simple linear components of ecosystems and simulation models are somewhere between experimental methods and purely theoretical models. Simulation models are used to solve analytic equations computationally to capture and mimic real-world systems that unlike real-world systems can then be experimented upon (Winsberg 2003). All types of model have their place and are important tools to advance the science and practice of wildlife management. Models have been used in an array of arenas including those designed to better understand foraging, reproduction, predator avoidance, and other components of behavioral ecology (Mangel and Clark 1988); population modeling and translocation (Converse et al. 2013); determination of species occurrence (MacKenzie et al. 2009); wildlife habitat and habitat selection (McLane et al. 2011); crop damage (Retanosa et al. 2008); anthropogenic

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disturbances (Braunisch et al. 2011); estimation of probability of use, occurrence, and selection of habitats in time (Wisdom et al. 2020); harvest management (Boyce et al. 2012); and just about every other aspect of wildlife ecology and management. Özesmi and Özesmi (2003) even use fuzzy cognitive mapping models to include abstract and aggregate variables, model relationships that are not known with certainty, include complex relationships, and use different knowledge sources (e.g., people's knowledge in place of data). Model accuracy continues to improve as more data and types of data (e.g., citizen science) become available, but none are perfect and controversy will continue related to model selection, multimodel selection, and the inferences made (Fieberg and Johnson 2015, Hooten and Hobbs 2015). Yet fundamental to the reliability of any model is the sampling design that went into guiding model development in the first place (Thompson 1992, Reich 2020). There are dozens of examples of highly sophisticated models built with data collected by an underlying biased sampling design (Brice et al. 2020). Too often models are designed to be applied to a single population at a specific time and are not generally applicable (i.e., generality) to broaden knowledge across species or areas (Levins 1966, Wisdom et al. 2020). When using models, it is important to ensure that they are being used appropriately. Are they being used for prediction, a specific population, or generality so they can be applied elsewhere?

Second, modelers must decide on the appropriate spatiotemporal scale (e.g., from molecules, macromolecules, cells, organs, organisms, populations, communities, and ecosystems) and from short to long periods (Getz et al. 2017,Wisdom et al. 2020). The selected resolution and extent of scale should be appropriate for the measured covariates and objectives, and be clearly identified in the methods.

Third, data used must be adequate (i.e., sufficient sample sizes and an appropriate sampling design) to estimate model parameters (Getz et al. 2017). Too often, researchers breeze through the data sources as if they are adequate without any reference to limitations or indication that they have been vetted to meet modeling assumptions and objectives. It is not merely sufficient to have large enough datasets to obtain precise estimates. Any modeling exercise should consider the underlying sampling design of the data collection. Large samples of biased data will lead to precise but biased model results. Many modern online data repositories (e.g., eBird, citizen science) are the result of convenience sampling designs with significant sampling biases that must be addressed in model development (Kramer-Schadt et al. 2013). This is especially true when researchers use large datasets from different data sources that have been collected by others or use datasets obtained from web access to generic, open-source formats. Biased data from even a single source can minimize the use and rigor of the model. On the other hand, the advent of big data and metareplication approaches allow us to develop and evaluate models with multiple study areas and datasets (Griffin et al. 2011), which in turn expands inference space and can lead to more robust regional models with broader application than one-off case studies. The model should be able to address the objectives and hypotheses formulated and should be based on adequate data related to sample size and sampling design (Wisdom et al. 2020). Also, there should be enough data available for model validation and evaluating model success (e.g., cross-validation; Boyce et al. 2002, Hooten and Hobbs 2015, Getz et al. 2017). The most powerful types of validation will be true out-of-sample validation (Mladenoff et al. 1995, 1999). In some cases, only sparse data are available because of access limitations, small populations, or data that are difficult and expensive to collect. Even then, the limitations must be addressed in the discussion. Unfortunately, if the assumptions demanded by the model are not met, simply discussing them will not enhance the quality of the model. Inadequate data can result in models and inferences that are biased and inaccurate and often results are presented without estimates of accuracy or are too precise given the data. There is no excuse for using data that are not adequate (Lozier et al. 2009).

Fourth, models should include the state variables needed (e.g., nutrients, movement, environmental representation) and important biological elements (e.g., species, occupancy, population estimates) to represent the biological processes of interest without overfitting. Further, depending on the objectives of a study, age, sex, population relationships, population performance, and other variables should be included for assessing models and determining their adequacy, again without overfitting (McLane et al. 2011). The appropriate level of detail should be included for clarity and to ensure that the results of the model are not sensitive to perturbations in the parameters used (Getz et al. 2017, Wisdom 2020). In many studies, researchers use too many variables, given the effective sample size, and many of them will often be biased or spurious (Freedman 1983). Trying to fit numerous variables (e.g., 30) to limited observations (e.g., 100) is a recipe for overfitting, spurious results, and the opposite of parsimony (Freedman 1983). Often the simplest model is the best, most general, and easiest to test its assumptions (e.g., Ockhams' razor). For example, Hurley et al. (2017) examined overwinter survival of juvenile ungulates and used approximately 4,000 mule deer years. The top model (selected by sample cross-validation) had only 3 parameters. The simpler model was more general and could be applied and better predicted across the entire state of Idaho, USA. The best model selected by Akaike's Information Criterion (AIC; Akaike 1974) had more than twice as many parameters. Some model selection methods (e.g., AIC) can often lead to over parameterization and are guilty of fitting data too well and failing to address generality (Levins 1966). It is important to understand the generality of a model (Levins 1966) so it can be applied to other systems with rigor. The model structure needs to be consistent with the available data (Boyce et al. 2012).

Fifth, models should ideally include experimental controls in their sampling design and consider ecologically plausible sets of competing models in their development and selection (Burnham and Anderson 2002, Getz et al. 2017, Wisdom et al. 2020). The controls might be necessary to evaluate how well a model can characterize an ecological process in question. Some sort of model selection approach should be used to compare potential models (Chamberlain 1890), but remember that approaches such as AIC were designed to approximate the performance of a model under true out-of-sample validation (Burnham and Anderson 2002). Thus, researchers should be on their guard that AIC can and often does select a model with spurious results as the top choice (Lukacs et al. 2009), and always aim to assess model performance using some sort of cross-validation (Hastie et al. 2001). And finally, all models used to advance wildlife science should have reliable interpretations for ecological understanding and use in management. Too often, manuscripts are presented with complex models and detailed statistical analysis but fail to clearly address sampling design, biological objectives, hypotheses being tested, or limits of inference.

Sometimes models are developed by researchers who know little about the biology of the species being studied, the quality of the data used, or how managers or ecologists might apply or interpret results. Successfully running a model in a software package can sometimes become the default objective.

Deficiencies in results are obvious, reflecting an approach of simply assimilating available data in a model without ecological thought or consideration. Use models with a purpose, quality data, and structured biological framework, and use them to advance the science of wildlife management.

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Managing Artificial Intelligence[10]

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Desert Bighorn Council Transactions 57:128–131

By the time you finish reading this editorial about artificial intelligence (AI), it will be outdated; the AI field is growing beyond the imagination of many. One cannot even look at the news without finding something about AI: duplication of voices (even John Lennon's years after his death), use of AI in art and music creation, facial recognition, and others. This new field is readily used in the management of big data in many arenas but is filled with risks and uncertainty (Botes 2023). If the world population declines in number (scientificamerican.com/article/ population-decline-will-change-the-world-for-the-better/, accessed 19 Jun 2023), there will be even more demand for AI to replace needed skills once provided by humans. The last part of the sentence is important because AI focuses on things typically done by humans. Artificial intelligence is a real game changer and needs to be managed wherever it is used, including the scientific process. The purpose of this editorial is to briefly indicate how The Journal of Wildlife Management (JWM) will incorporate AI in publishing.

Artificial intelligence has been defined as an umbrella term for an array of algorithmic-based technologies, albeit with their own glitches, that solve complex tasks, which previously involved human thought, to whatever has not been done yet (DeWaard 2023). Artificial intelligence is living up to the promise of delivering value, influenced by advances in the availability of relevant data, computation, and algorithms from agriculture (Smith 2018) to zoology (Santangeli et al. 2020, Tuia et al. 2022) and everything in between. Artificial intelligence is also advancing wildlife management and conservation such as the use of drones in combination with AI to locate bird nests (Santangeli et al. 2020) and an array of other uses in wildlife and animal ecology as reviewed by Tuia et al. (2022).

Artificial intelligence can also be used for nefarious activities such as Deepfake AI, a type of AI used to create convincing images, audio, and video hoaxes. To combat these uses, countries in The European Union are proposing laws (e.g., the AI Act) to put guardrails on the rapidly growing AI uses for policymakers and others. The United States is doing the same and other countries will not be far behind.

Concerns over the use of AI is also growing elsewhere and universities are developing programs to train a new cadre of professionals to deal with the rapid changes and development in AI in all arenas. The rapid emergence and scope of AI generative tools, like chat generative pre-trained transformer (ChatGPT), Scite (an AI tool that provides quantitative and qualitative insight into how scientific publications cite each other), and DALL-E (an AI system named after S. Dali and Pixar's WALL-E movie) that can produce realistic images from text prompts, are at the

[10]This paper originally was published as Krausman, P. R. 2023. Managing artificial intelligence. Journal of Wildlife Management 87:e22492. It is reprinted here with permission.

forefront of many higher education conversations across the nation (e.g., University of Arizona) that are surveying faculty to identify salient topics surrounding emergent AI tools. And, there are a bunch of them.

Scientists are surrounded with digital tools and platforms. As the professional academic social networks continue to grow, there have been changes in the publishing world almost as fast as the emergence of AI. For example, many journals are online with open access or are moving in that direction, social media is used to promote research, and with the advent of Covid, societies moved from in-person conferences to virtual conferences. All of these changes and others were assumed to operate with scientific integrity, which should continue with the emergence ofAI. In publishing, as in other arenas, AI relates to the ability for machines to learn patterns to do things that have typically been done by humans.

Artificial intelligence is the next major frontier in the process and dissemination of scientific knowledge and has arrived without much fanfare, but it is here to stay (Bachanan 2023). Artificial intelligence has been used for analysis and writing, among other parts of the scientific method by drawing on current knowledge and content available online with various combinations of accuracy, biases, and errors (Bachanan 2023). Like Bachanan (2023), I know that AI is here to stay but will have to wait to see how successful it is and how its uses will influence publishing. With the rapid growth of AI, we will not have to wait long. Artificial intelligence is touching all aspects of the publication world including the writing of articles (e.g., PaperPal, Writefull), article submission (e.g., Wiley's ReX, which automatically extracts data from manuscripts), tools to screen manuscripts on submission (e.g., Penelope, RipetaReview), support of peer review (e.g., SciScore) for method checking, and checking scientific images (Proofig, ImageTwin). Need more examples of the emerging role of AI in publishing? Check out Scite.ai to see how citations support arguments in manuscripts and the use of AI in marketing, creating proofs, copyediting, summarization (i.e., Scholarcy), using published material as data, reading (e.g., SemanticScholar summarizes manuscripts in 1–2 sentences), checking on similarities between submissions (e.g., TurnItIn, STM), determining if the scientific process is properly followed, finding referees, and detecting plagiarism (e.g., Content Authenticity Initiative; DeWaard 2023). These are just some of the uses of AI in publishing.

There are also pitfalls that need to be addressed including scientific fraud and the potential legal risks for policies and decisions made with AI. One of the greatest challenges in using AI tools in the scientific process is to ensure the truth and validity of results from experiments. If truth is not grounded in scientific evidence or presented with sufficient qualifications, the scientific method would be violated. Artificial intelligence tools are built on probabilistic models that do not have rigorous closed-form mathematical solutions and therefore cannot be independently validated. Further, the algorithms are typically designed and trained to optimize a problem (i.e., to get the highest score possible on a certain task). As such, Generative AI models (e.g., ChatGPT) could fabricate scientific references in generating scientific papers to support a conclusion. The obvious danger is that if these references get past reviewers and accepted into the body of scientific literature, they could be referenced by scores of future authors to support a similar conclusion. Yet, at the core, the reference and its corresponding confusion may have never existed in the real world. Imagine how this could negatively influence the scientific process and its effects on the world and humanity. Similar errors could also creep into conclusions when AI is used to detect the number of animals in satellite imagery. Artificial intelligence could be also used to generate purely synthetic imagery of events that never occurred to promote some cause by actors who want to influence the scientific process. For example, what if an endangered species that never existed in an area was shown to exist in the middle of a development project in a peer-reviewed scientific study?

Also, how does one address a machine or hold a program responsible for faulty information? And, by combining data from various places and individuals into a single data set, how is diversity of thought maintained? Authors are responsible for the ethical treatment of animals and their data, and must be aware of all aspects of how their data are collected and used. These and other issues must be addressed as AI is incorporated in publishing activities.

Thus, the Editor-in-Chief and staff of JWM must embrace the responsibility of managing AI in our publications to maintain research integrity and ensure that AI does not replace the expertise and critical thinking of humans. To foster this idea, JWM staff follows Wiley's guidelines in dealing with AI: "Artificial Intelligence Generated Content (AIGC) tools—such as ChatGPT and others based on large language models (LLMs)—cannot be considered capable of initiating an original piece of research without direction by human authors. They also cannot be accountable for a published work or for research design, which is a generally held requirement of authorship …, nor do they have legal standing or the ability to hold or assign copyright. Therefore—in accordance with COPE's position statement on AI tools—these tools cannot fulfill the role of, nor be listed as, an author of an article. If an author has used this kind of tool to develop any portion of a manuscript, its use must be described, transparently and in detail, in the Methods or Acknowledgements section. The author is fully responsible for the accuracy of any information provided by the tool and for correctly referencing any supporting work on which that information depends. Tools that are used to improve spelling, grammar, and general editing are not included in the scope of these guidelines. The final decision about whether use of an AIGC tool is appropriate or permissible in the circumstances of a submitted manuscript or a published article lies with the journal's editor or other party responsible for the publication's editorial policy." (https://authorservices.wiley.com/ethics-guidelines/index.html#5, accessed 14 Jun 2023).

I will be incorporating similar language in updated publication guidelines to explain how AI-generated material should be treated in JWM. The bottom line is that AI cannot be an author, any use of AI must be acknowledged (except for tools used to improve spelling, grammar, and general editing), and author(s) are responsible for all information in their manuscripts including data generated by AI.

As AI develops and is used more in the scientific method and publication process, the policies we follow will also evolve to maintain the foundation of human thought, ethics, and the scientific method in published work. The Wildlife Society Code of Ethics states that members should understand "…human society's proper relationship with natural resources, and in particular for determining the role in wildlife in satisfying human needs and addressing the management of wildlife-related impacts" (https://wildlife.org/wp-content/uploads/2017/07/Code-of-Ethics-May 2017.pdf, accessed 28 Jun 2023). We should all keep abreast of technological advances, including AI, and understand the roles they play in managing our wildlife resources. Keep on publishing but keep AI off the author list.

ACKNOWLEDGMENTS

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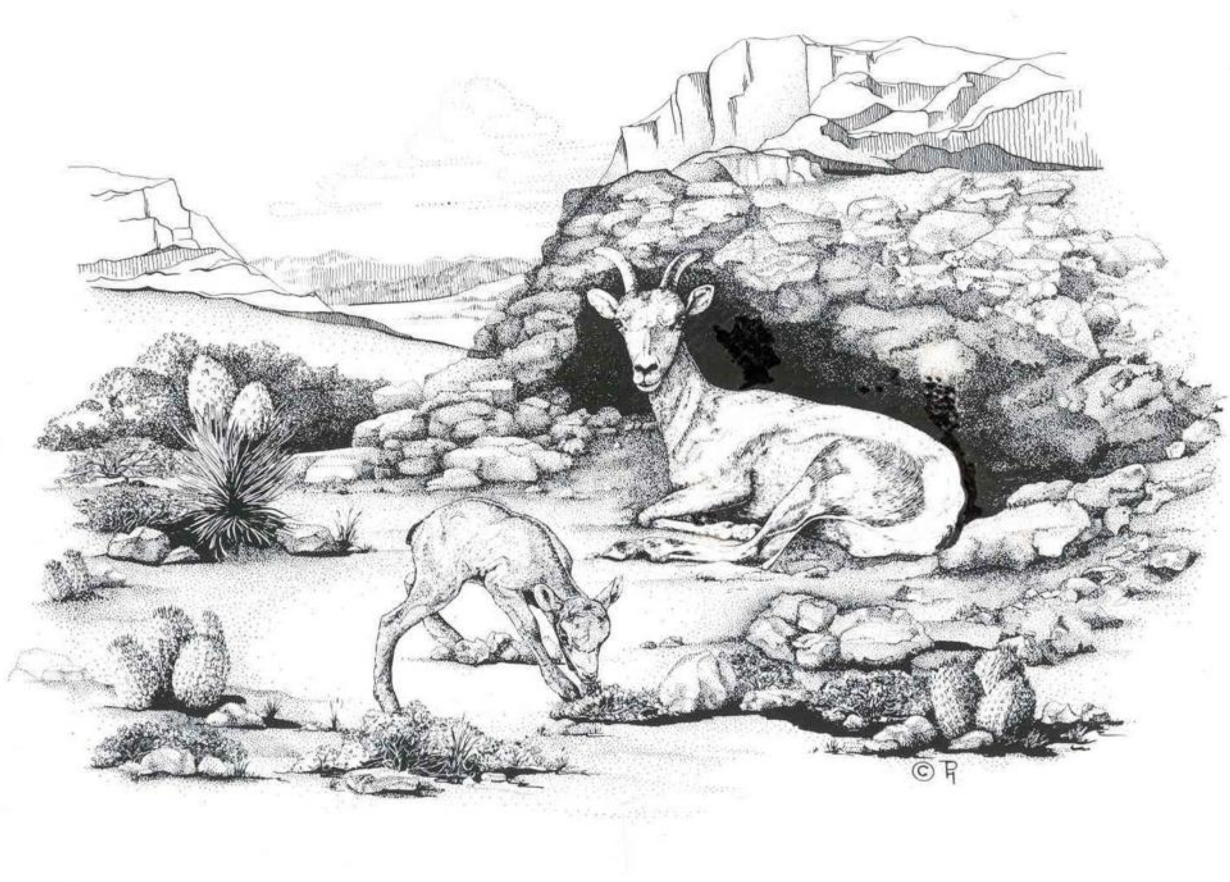

The Western Association of Fish and Wildlife Agencies, the Wild Sheep Initiative, and the Desert Bighorn Council

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Desert Bighorn Council Transactions 57:132–134

The Western Association of Fish and Wildlife Agencies (WAFWA) represents 23 states and Canadian provinces, an area covering nearly 3.7 million square miles of some of North America's most wild and scenic country and is inhabited by over 1,500 premier wildlife species. In the 1920s, game commissions throughout the West began to assume responsibilities for the management of game and fish resources. In 1922, these visionary managers formed the precursor of today's WAFWA to advocate for state fish and game management authority and to foster regional cooperation focused on a variety of conservation topics. As member agencies became "departments" rather than "commissions", the Western Association evolved to its current name, the Western Association of Fish and Wildlife Agencies. The Western Association's leadership has held strong for over 100 years and has maintained the goal to support sound resource management and build partnerships at all levels to conserve fish and wildlife for the use and benefit of all citizens, now and in the future. The Western Association's mission is to *"advance collaborative, proactive, science-based fish and wildlife conservation and management across the west"* through leadership, integrity, teamwork, excellence, support, respect, and accountability.

THE WILD SHEEP INITIATIVE

Background and Mission

The Western Association's Wild Sheep Initiative (WSI) began as the Wild Sheep Working Group (WSWG) in 2007 when agency directors saw the need, value, and urgency to convene wild sheep managers, researchers, veterinarians, and others to address the myriad of challenges they faced while managing both bighorn and thinhorn sheep in North America. The Wild Sheep Initiative is comprised of a representative from each WAFWA state, province, and territory (N=20) with wild sheep, as well as representatives from the U.S. Forest Service, Bureau of Land Management, National Park Service, Tribal entities, and the Wild Sheep Foundation.

The WSI is committed to the restoration and conservation of North American wild sheep for the benefit of future generations, and its mission is, *To identify priority topics and management challenges to wild sheep in* *western North America; collaboratively develop solutions to those challenges; and foster strong relationships between state, provincial, and territorial jurisdictions, federal land management agencies, indigenous groups, and wild sheep advocates; and engage with domestic livestock owners and users that share the same landscapes inhabited by wild sheep.*

The WSI formally meets twice a year, once at the summer WAFWA meetings and in the winter at the Wild Sheep Foundation's Sheep Show. Beginning in 2007, the WSWG was chaired by Kevin Hurley (Wyoming; 2007–2011), Clay Brewer (Texas; 2011–2016), and Mike Cox (Nevada; 2016–2023). The WSWG's name was changed to the Wild Sheep Initiative in 2023 concomitant with changes in WAFWA leadership and construct. Currently, Daryl Lutz (Wyoming) serves as the Initiative's chair and Brent Lonner (Montana) is the vice-chair. In the past, these positions were funded jointly by the employing agency and WAFWA; currently, however, neither the chair nor vice-chair are paid by WAFWA. The chair's and vice-chair's employing agency each have agreed to provide full salaries, but to adjust workloads as needed and allow time to fulfill the WSI's commitments. As a result, assessments of member agencies now provide direct support for the WSI's many ventures, products, and outcomes (see below)

There have been differing opinions offered regarding the benefits of the Desert Bighorn Council (DBC) affiliating with WAFWA (Kelly 1982, Brigham 2000), but the DBC now is sanctioned by WAFWA. Both WAFWA and the WSI recognize the value of, support , and sanction the workshops and symposia sponsored by a number of organizations, including those of the Desert Bighorn Council. WAFWA views these symposia as important forums for wildlife professionals to interact with each other and discuss new research results, management, enforcement, and administrative practices. Further, WAFWA encourages the subsequent use of this information to promote better management of wild sheep. Moreover, WAFWA views "sanctioning" as an ongoing means to keep abreast of important management issues and as such, these workshops and symposia receive the highest consideration for attendance by agency personnel. The relationships with the DBC and participation in the biennial symposia are invaluable and contribute immeasurably to the mission of the WSI.

Wild Sheep Initiative's Work

The WSI has focused on identifying and addressing a variety of topics surrounding wild sheep conservation in North America, many of which are among the most difficult and formidable challenges faced by the professionals responsible for managing this important resource. Among these challenges are those related to wild sheep habitat, disease, predation, population management, organizational hurdles, and climate change. The WSI has published a number of works to highlight these challenges and to recommend strategies for achieving results that will enhance the viability of wild sheep throughout their range. All of the work of WSI can be found on the WAFWA Wild Sheep Initiative web page (https://wafwa.org/initiatives/wsi/). Among the recent products or outcomes are

- Recommendations for Domestic Sheep and Goats in Wild Sheep Habitat (WAFWA 2025a).
- Observed Changes in Populations of Thinhorn Sheep in Western Canada and Alaska (WAFWA 2025b)
- Range-wide status of Bighorn and Thinhorn Sheep in North America (WAFWA 2023, 2024, and 2025c)
- Wild Sheep Capture and Handling Guidelines (Bleich and Lutz 2024)

- Test and Remove Workshop presentations from 2021, 2023 and 2025
- Pneumonia and Bighorn Sheep: Test and Remove fact sheet
- Thinhorn Sheep: Conservation Challenges and Management Strategies for the 21st Century (Jex et al. 2016)
- Updated maps of historical and current wild sheep distributions

SUMMARY

Wild sheep face an uncertain future due to a host of issues and challenges, and management of all wildlife in North America is complex ecologically, politically, and socially as evidenced in 1943 by Aldo Leopold's statement, "Wildlife management is comparatively easy; human management is difficult" (Flader 1974:188). The Western Association of Fish and Wildlife Agencies and the Wild Sheep Initiative have committed to address these challenges by (1) supporting and using the best science available; (2) providing a platform for collaboration among managers, researchers, veterinarians, disease ecologists, and others; (3) providing funding; and (4) publishing information and recommendations to best guide management and conservation of these iconic ungulates well into the future. They deserve no less than our best efforts!

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WAFWA. 2025a. Recommendations for domestic sheep and goat management in wild sheep habitat. Western Association of Fish and Wildlife Agencies Wild Sheep Initiative, Boise, Idaho, USA.

WAFWA. 2025b. White paper: observed changes in populations of thinhorn sheep in western Canada and Alaska. Western Association of Fish and Wildlife Agencies Wild Sheep Initiative, Boise, Idaho, USA.

WAFWA. 2025c. Range-wide status of bighorn and thinhorn sheep in North America. Western Association of Fish and Wildlife Agencies Wild Sheep Initiative, Boise, Idaho, USA.

2023 DBC Awardees

During the 57th Meeting of the Desert Bighorn Council in Alpine, Texas, two long-standing members were recognized for their contributions to the Council and the conservation of Desert Bighorn Sheep. Jimmy Cain received the Honor Plaque in appreciation of his outstanding service as Editor-in-Chief of the DBC Transactions Volumes 53–56, and Kathleen Longshore received the Desert Bighorn Ram Award in recognition of her career-long contributions to research, the management and conservation of desert bighorn sheep, and her many years of dedicated service to the Desert Bighorn Council. The text of each award follows.

The Desert Bighorn Council Honor Plaque
Is Presented To
JAMES W. CAIN III
in recognition of your role as Editor-in-Chief of
The Desert Bighorn Council Transactions
Volumes 53 – 56
and your continuous support of scientific inquiry and
its relevance to the conservation and management of
Desert Bighorn Sheep.
Presented at the 57th Meeting of
The Desert Bighorn Council
April 2023

THE DESERT BIGHORN COUNCIL
RAM AWARD
Is Presented To
KATHLEEN M. LONGSHORE
in recognition of
your many investigations centered on habitat selection
and its implications for conservation;
the effects of disturbance on behavioral responses;
understanding the consequences of predation; the
value of water development projects; and,
your numerous collaborations with personnel
representing state or federal agencies, non-governmental
organizations, and academic institutions. These efforts,
and your many years of service to the Council,
have yielded substantial benefits toward the
conservation of Desert Bighorn Sheep.
Presented at the 57th meeting of
the Desert Bighorn Council
APRIL 2023

Recipients of the Desert Bighorn Council's Awards, 1960–2023

Ram (Bighorn Trophy) Award

2023— Kathleen M. Longshore, U.S.G.S
2021— Pat Cummings, Nevada Department of Wildlife
2019—Ben J. Gonzales, California Department of Fish and Game
2019— Ross Haley, National Park Service
2017—Walter M. Boyce, University of California Davis
2017—Clinton W. Epps, Oregon State University
2015—Don Armentrout, Bureau of Land Management
2013—Elise Goldstein, New Mexico Department of Game and Fish
2013—Eric M. Rominger, New Mexico Department of Game and Fish
2011—Jack Kilpatric, Texas Parks and Wildlife Department
2011—Texas Parks & Wildlife Department
2011—Texas Bighorn Society
2011—Society for the Conservation of Bighorn Sheep
2009—Mark C. Jorgensen, California Department of Parks and Recreation
2009—Esther S. Rubin, Conservation Biology Institute
2007—Joe Cresto, Bureau of Land Management
2007—Raymond Lee, Foundation for North American Wild Sheep
2007—Nevada Bighorns Unlimited—Reno Chapter
2007—Fraternity of the Desert Bighorn
2007—California Department of Fish and Game-Wildlife Investigations Lab
2002—Rick W. Brigham, Bureau of Land Management
2002—Vernon C. Bleich, California Department of Fish and Game
2000—Paul R. Krausman, University of Arizona
1999—John D. Wehausen, White Mountain Research Station
1997—Rob Roy Ramey, University of Colorado
1986—Richard A. Weaver, California Department of Fish and Game
1984—George Welsh, Arizona Game and Fish Department
1983—Charles L. Douglas, National Park Service
1983—David M. Leslie, Jr., Oregon State University
1979—Robert P. McQuivey, Nevada Department of Fish and Game
1978—Fauna-Silvestre, Mexico
1974—Arizona Desert Bighorn Sheep Society, Inc.
1969—M. Clair Aldous, U.S. Bureau of Sport Fisheries and Wildlife
1968—Steve James, Jr., Fraternity of the Desert Bighorn
1966—Charles G. Hansen, U.S. Bureau of Sport Fisheries and Wildlife
1965—John P. Russo, Arizona Game and Fish Department
1963—Oscar V. Deming, U.S. Bureau of Sport Fisheries and Wildlife
1960—Ralph and Florence Welles, National Park Service

Honor Plaque

2023—Jimmy Cain, New Mexico Cooperative Fish and Wildlife Research Unit
2021—Clay E. Brewer, Wild Sheep Foundation
2021—Desert National Wildlife Refuge
2017—Marine Corps Air Ground Combat Center Twentynine Palms
2017—Raul Valdez, New Mexico State University
2015—Brian Wakeling, Nevada Division of Wildlife
2015—Leon and LaVelle Lesicka, Desert Wildlife Unlimited
2015—Steven R. deJesus, Landells Aviation
2013—Bill Montoya, New Mexico Game and Fish Commission
2013—Mara Weisenberger, U.S. Fish and Wildlife Service
2013—New Mexico Game and Fish Commission
2013—New Mexico Department of Game and Fish
2011—Clay Brewer, Texas Parks and Wildlife Department
2011—Mike Pittman, Texas Parks and Wildlife Department
2011—Mike Hobson, Texas Parks & Wildlife Department
2009—CEMEX
2007—William E. Clark, California Department of Fish and Game
2007—Sierra Nevada Bighorn Sheep Recovery Program
1997—Kathy Rollins, Bureau of Land Management
1994—Jerry Wolfe, Colorado Division of Wildlife
1993—Raymond Lee, Arizona Game and Fish Department
1991—California Department of Fish and Game Wildlife Investigations Lab
1988—Andrew Sandoval, New Mexico Department of Game and Fish
1986—Warren Kelly, U.S. Forest Service
1985—United States Naval Weapons Center China Lake
1982—Maurice “Bud” Getty, California Department of Parks and Recreation
1982—Desert Bighorn Council Ewes
1981—Thomas D. Bunch, Utah State University
1981—Grant Kinzer, New Mexico State University
1981—New Mexico Department of Game and Fish
1980—The Society for the Conservation of Bighorn Sheep
1979—Jim Blaisdell, National Park Service
1973—Lydia Berry, Desert National Wildlife Refuge
1972—Inyo National Forest
1969—Pat Hansen, Independent Bighorn Illustrator
1968—Nevada Operations Office, Atomic Energy Commission
1962—Ralph and Florence Welles, National Park Service

Award of Excellence

1986—Charles L. Douglas, National Park Service
1975—Gale Monson, Arizona-Sonora Desert Museum
1975—Lowell Sumner, National Park Service

DESERT BIGHORN COUNCIL MEETINGS, 1957–2023

Year	Location	Chairperson	Secretary	Treasurer	Transactions Edito
1957	Las Vegas, NV	M. Clair Aldous			
1958	Yuma, AZ	G. Monson, W. Kelly			
1959	Death Valley, CA	M. Clair Albous	Fred Jones	Fred Jones	
1960	Las Cruces, NM	Warren Kelly	Fred Jones	Fred Jones	
1961	Hermosillo, MX	John B. Van den Akker	Ralph Welles	Ralph Welles	
1962	Grand Canyon, AZ	James Blaisdell	Charles. Hansen	Charles Hansen	C. Hansen, E. Fount
1963	Las Vegas, NV	Al Jonez	Charles Hansen	Charles Hansen	Jim Yoakum
1964	Mexicali, MX	Rudulfo Corzo	Charles Hansen	Charles Hansen	C. Hansen, D. Smitl
1965	Redlands, CA	John Goodman	John Russo	John Russo	Jim Yoakum
1966	Silver City, NM	Cecil Kennedy	John Russo	John Russo	Jim Yoakum
1967	Kingman, AZ	Claude Lard	John Russo	John Russo	Jim Yoakum
1968	Las Vegas, NV	Ray Brechbill	John Russo	John Russo	Jim Yoakum
1969	Monticello, UT	Ralph and Buddy Welles	W. G. Bradley	W. G. Bradley	Jim Yoakum
1970	Bishop, CA	William Graf	W. G. Bradley	W. G. Bradley	Jim Yoakum
1971	Santa Fe, NM	Richard Weaver	Tillie Barling	Tillie Barling	Jim Yoakum
1972	Tucson, AZ	George Welsh	Doris Weaver	Doris Weaver	Charles Hansen
1973	Hawthorne, NV	Warren Kelly	Doris Weaver	Doris Weaver	Juan Spillet
1974	Moab, UT	Carl Mahon	Lanny Wilson	Lanny Wilson	Juan Spillet
1975	Indio, CA	Bonnar Blong	Lanny Wilson	Lanny Wilson	Charles Hansen
1976	Bahia Kino, MX	Mario Luis Cossio	Peter Sanchez	Peter Sanchez	Charles Hansen
1977	Las Cruces, NM	Jerry Gates	Peter Sanchez	Peter Sanchez	Charles Hansen
1978	Kingman, AZ	Kelly Neal	Peter Sanchez	Peter Sanchez	Charles Hansen
1979	Boulder City, NV	Bob McQuivey	Peter Sanchez	Peter Sanchez	Charles Hansen
1980	St. George, UT	Carl Mahon	Peter Sanchez	Peter Sanchez	Charles Hansen
1981	Kerrville, TX	Jack Kilpatric	Peter Sanchez	Peter Sanchez	Charles Hansen
1982	Borrego Sprs., CA	Mark Jorgensen	Rick Brigham	Rick Brigham	Charles Hansen
1983	Silver City, NM	Andrew Sandoval	Rick Brigham	Rick Brigham	Charles Hansen
1984	Bullhead City, AZ	Jim deVos, Jr.	Rick Brigham	Rick Brigham	Charles Hansen
1985	Las Vegas, NV	David R. Pulliam, Jr.	Rick Brigham	Rick Brigham	Charles Hansen
1986	Page, AZ	Jim Guymon	Bill Dunn	Bill Dunn	Paul Krausman
1987	Van Horn, TX	Jack Kilpatric	Bill Dunn	Bill Dunn	Paul Krausman
1988	Needles, CA	Vernon C. Bleich	Don Armentrout	Don Armentrout	Paul Krausman
1989	Grand Jct., CO	Jerry Wolfe	Don Armentrout	Don Armentrout	Paul Krausman
1990	Hermosillo, MX	Raul Valdez	Don Armentrout	Don Armentrout	Paul Krausman
1991	Las Cruces, NM	Bill Montoya	Don Armentrout	Don Armentrout	Paul Krausman
1992	Bullhead City, AZ	Jim deVos, Jr.	Stan Cunningham	S. Cunningham	Paul Krausman
1993	Mesquite, NV	Kathy Longshore	Charles Douglas	Charles Douglas	Walter Boyce
1994	Moab, UT	Jim Guymon	Charles Douglas	Charles Douglas	Walter Boyce
1995	Alpine, TX	Doug Humphries	Charles Douglas	Charles Douglas	Ray Boyd
1996	Holtville, CA	Andy Pauli	Charles Douglas	Charles Douglas	Ray Boyd
1997	Grand Jct., CO	D. Reed, V. Graham	Steve Torres	Charles Douglas	Raymond Lee
1998	Las Cruces, NM	E. Rominger, D. Holdermann	Darren Divine	Charles Douglas	Raymond Lee
1999	Reno, NV	R. Brigham, K. Hurley	Darren Divine	Charles Douglas	A. and H. Thomas
2000	Bullhead City, AZ	Ray Lee, Jim deVos, Jr.	Darren Divine	Charles Douglas	Jon Hanna
2001	Hermosillo, MX	Carlos Castillo, Jim deVos, Jr.	Darren Divine	Charles Douglas	Jon Hanna
2002	Palm Springs, CA	Mark Jorgenson	Darren Divine	Charles Douglas	Jon Hanna
2003	St. George, UT	Jim Karpowitz	Darren Divine	Darren Divine	Brian Wakeling
2005	Alpine, TX	Clay Brewer	Esther Rubin	S. Ostermann	Brian Wakeling
2007	Las Vegas, NV	Ross Haley	Esther Rubin	S. Ostermann	Brian Wakeling
2009	Grand Jct., CO	Scott Wait	Esther Rubin	K. Longshore	Brian Wakeling
2011	Laughlin, NV	Brian Wakeling	Esther Rubin	K. Longshore	Brian Wakeling
2013	Las Cruces, NM	E. Rominger, P. Morrow	Esther Rubin	K. Longshore	Brian Wakeling
2015	Borrego Spr, CA	Ben Gonzales, R. Abella	Amber Munig	K. Longshore	James W. Cain
2017	St. George, UT	R. Robinson, J. Shannon	Amber Munig	K. Longshore	James W. Cain
2019	Mesquite, NV	Steven Kimble, Mike Cox	Erin Butler	K. Longshore	James W. Cain
2021	Alpine, TX (Virtual)	F. Hernandez, C. Brewer	Erin Butler	K. Longshore	James W. Cain
2023	Alpine, TX	F. Hernandez	Erin Butler	K. Longshore	Vernon C. Bleich

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Abstracts of Presented Papers

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Desert Bighorn Council Transactions 57:141–150

BLUM, M. E.[1], K. M. STEWART[2], J. A. GREENBERG[2], T. E. DILTS[2], M. COX[3], B. F. WAKELING[4], AND V. C. BLEICH[2]. Selection of birth sites and bed sites by neonatal bighorn sheep: a room with a view.

An understanding of how females select birthing areas is important for managing wildlife, because it can be used to conserve habitat or aid in selection of sites for translocation. Unmanned aerial vehicles (UAVs) have been used increasingly in wildlife research and, when coupled with remote-sensing technologies, have been effective in mapping wildlife habitat. We used a combination of publicly available remote sensing products and UAVs to map detailed characteristics of habitat, and to estimate characteristics of habitat selected at birth sites and bed sites of adult female, and neonatal, desert bighorn sheep (Ovis canadensis nelsoni) and, thereby, to understand how females select birth sites and how female-offspring pairs select bedding areas. We used UAVs to map the area surrounding birth and bed sites, and random locations within 150 m of those sites. We compared broad-scale (50 m2) and fine-scale (1 m2) selection for birth sites, and fine-scale habitat selection for bed sites across 2 study areas in west-central Nevada. Additionally, we estimated fine-scale selection based on survival status of neonates to 4 days post parturition. Neonates had lower absolute survival at birth sites with higher downslope and lower upslope visibility than those neonates that were born in sites with lower downslope and higher upslope visibility. Females that selected areas with greater upslope visibility experienced higher survival of young, suggesting an increased probability of detecting predators approaching from upslope of birthing or bedding sites. Our results demonstrate the utility of UAVs for mapping viewsheds, and their application to wildlife habitat analyses.

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BLUM, M. E.[1], K. M. STEWART[2], M. COX[3], K. T. SHOEMAKER[2], B. F. WAKELING[4], J. R. BENNETT[3], T. E. DILTS[2], B. W. SULLIVAN[2], AND V. C. BLEICH[2]. Reproductive ecology and resource selection of desert bighorn sheep (*Ovis canadensis nelsoni*).

Reproductive fitness is linked to selection of resources, which likely varies relative to an individual's reproductive state. Females of some species, especially mountain ungulates, may sacrifice quality of forage in favor of safety of offspring immediately following parturition. We investigated this tradeoff in desert bighorn sheep (*Ovis canadensis nelsoni*) by comparing habitat selection during the last trimester of gestation, following parturition while females were provisioning dependent young, and females whose offspring had died. We analyzed diet quality and forage selection by bighorn sheep before and following parturition to determine how nutritional demands associated with rearing offspring influenced forage acquisition. We captured female bighorn sheep at Lone Mountain, Nevada, during 2016–2018. We used vaginal implant transmitters in pregnant females to identify parturition events, and captured and radio-collar neonates to monitor survival of young. We collected fecal samples during the breeding season and the remainder of the year to compare diet quality and composition during those periods. We used Bayesian inference approaches to estimate whether bighorn sheep traded resources via habitat selection and vegetation composition and diet quality according to the periods described above, and used neonate survival status to inform a series of regressions. We found evidence of this tradeoff between habitat selection and nutrient availability. Our results provide further insight into tradeoffs in bighorn sheep by linking nutrition and habitat selection to demonstrate how these processes occur within populations of montane ungulates.

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BREWSTER, P. C.[1], M. LOVARA[2], A. HURT[3], A. OTT[3], P. G. SMITH[3], P. COPPOLILLO[3], W. SEVERUD[2], AND S. T. WALK[1]. Integrated microbiome-host health comparison of the Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*).

Rocky Mountain bighorn sheep are susceptible to over-hunting, habitat loss, and zoonotic diseases. Increased surveillance has been implemented across North America to generate information for more precise conservation and "best-practices" for the re-establishment of herds across historic ranges. The microbiome of bighorns has received little atention, but there is strong rationale for its evaluation and incorporation into conservation efforts. For example, the microbiome composition of mammals depends on dispersal between cohabiting individuals, thereby providing a potentially useful proxy for host population interaction and gene flow. This project tests specific hypotheses regarding whether and to what extent the bighorn sheep microbiome can be used to predict overall host health. During a recent (March 2023) field capture, nasal, oral and stool samples were collected from 98 Rocky Mountain bighorn sheep in Nebraska (n=39) and South Dakota, (n=59), USA. Metadata (sex, age, weight, health status) were collected on all individuals while trapping locations (GPS coordinates) only were obtained in Nebraska. Diagnostic testing was performed on nasal swabs and blood (Washington Animal Diagnostic Laboratory) for the highly virulent respiratory pathogen *Mycoplasma ovipneumoniae*, and in-house PCR assays will be performed to detect the presence of other common bighorn sheep pathogens (*Mannheimia haemolytica*, *Pasteurella multocida*, or *Bibersteinia trehalosi*). The microbiome of all samples are being evaluated by sequencing (Illumina,16S rRNA encoding gene sequencing, variable region 4). Bioinformatics and statistics will be used to test for associations between host health and microbiome diversity present in nasal, oral, and gut (stool) samples. This is the first study we are aware of to quantify bighorn microbiome diversity and test for associations with host health and disease state.

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KARISH, T.[1], G. W. ROEMER[1], D. K. DELANEY[2], AND J. W. CAIN[3]. Multi-scale habitat selection and water dependency of feral burros in the Mojave Desert.

Expansion of feral burro (*Equus asinus*) populations across the Southwest are causing rangeland degradation, competition with native species, and human-wildlife conflicts. On Fort Irwin

National Training Center (NTC), California, feral burros interfere with military training and are involved in vehicle collisions and other conflicts. Limited data on burros poses a challenge for the development of management plans. We estimated home range area, water use frequency, and 2nd and 3rd order seasonal habitat selection by adult female feral burros from 2015 to 2017. Mean home range sizes did not differ among seasons or between burros that resided close to or far from urban areas. Burros visited water sources more often during the hot-dry season (every 22 hours) compared to the cool-wet seasons (every 39.7 - 45.9 hours). Water use was consistent with habitat selection; burros selected areas near water in all seasons and at both spatial scales, but selection was stronger in the dry season and the landscape scale. When available, burros strongly selected for areas near urban areas. Burros consistently selected for areas with green forage and at lower elevations, but selection for other topographical features was variable. Our results suggest that urban areas, and resources therein, and water sources have the strongest influence on burro resource selection, and management plans could focus mitigation efforts on these areas.

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EPPS, C. W.[1], C. AIELLO[1], R. CROWHURST[1], AND N. L. GALLOWAY[2]. Tracking metapopulation dynamics with a 23-year genetic database.

Tracking population dynamics and connections among populations can provide useful insights about metapopulation function, gene flow, potential disease spread, and effects of management actions. We compiled a database of 1289 genetic samples for desert bighorn sheep in the Mojave Desert, collected from 2000 to present. We genotyped fecal, blood, and tissue samples collected in more than 35 populations at up to 16 microsatellite loci. Although originally collected for a variety of purposes, these data were aligned, extended, and georeferenced. We used individual-based assignment tests and estimates of genetic structure to evaluate changes in genetic structure from 2000-2012 to 2013-2022, deduce new or ephemeral connections among populations, and characterize origins for newly surveyed populations. We also evaluated changes in connectivity for two populations with apparent recent increases in population size, following reduction or elimination of cattle grazing. Since 2013, previously unobserved connections among populations have appeared in many locations. The two mountain ranges with large population increases showed increased connectivity with surrounding ranges and previously unobserved links, suggesting that population increases provide increased stimulus for such movements. A mountain range newly colonized in the late 1990s is now better integrated into the metapopulation, as connections with surrounding populations have formed. Shifts in genetic structure suggest that previously unrecognized changes in population size or makeup have occurred in some locations. In combination with insights from GPS collars, these data will continue to inform management decisions around connectivity and habitat management.

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EVANS, A. D.[1], B. BANULIS[2], N. PERRY[3], C. R. ANDERSON, JR.[4], AND J. W. CAIN[5]. The effects of wildland recreation on desert bighorn sheep in western Colorado.

In recent decades, outdoor recreation in the United States has increased dramatically, with continued increases in the number of user days projected in the coming years as well as the expansion of recreation infrastructure including trails and other facilities. Recreational disturbance has been shown to impact ungulate populations by altering activity budgets, increasing physiological stress, reducing habitat quality, 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 on desert bighorn in the Dominguez-Escalante National Conservation Area. We are quantifying recreation activity using game cameras and extrapolating human use across the linear network of the trail system. We are currently conducting desert bighorn behavioral observations to estimate activity budgets and assess foraging efficiency to identify trade-offs in foraging and vigilance behaviors. We are collecting fecal samples to quantify physiological stress from fecal glucocorticoid metabolites, and calculating habitat selection, movement rates, and space use at varying spatial and temporal scales using the locations of GPS-collared adult females. The results of this study can be applied throughout the American Southwest to inform management decisions regarding the type, intensity, and seasonality of recreation in desert bighorn habitat to help avoid or mitigate negative effects on this species.

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GOODSON, N. J.[1], D. R. STEVENS[1], J. COLE[2], AND J. FORT[2]. Test and remove in desert bighorn sheep on the Navajo Nation: an extreme case.

The Lower San Juan River Canyon bighorn sheep population originated with a transplant in 2003. The herd increased steadily and reached an estimate of over 170 bighorn sheep by 2013. Lamb production and survival were consistently high from 2004 through 2013. In 2014 few lambs were observed in our May and June surveys and no lambs were observed in October. In February 2015 five bighorn sheep were captured on the Lower San Juan Canyon bighorn range and nasal swabs and blood samples were collected for testing. All five bighorn tested positive for *Mycoplasma ovipneumoniae* (Movi) by both ELISA and PCR. From 2015 through 2021 lambs were produced but fall surveys indicated only one survived its first year. The estimated number of ewes fell from 70 in 2013 to 15 in 2021. In 2018 and in 2020 a majority of bighorn sheep captured and tested in the Lower Canyon were positive for Movi using PCR. Winter 2020-2021 we proposed a Test and Remove operation for the Lower San Juan River Canyon herd. In three helicopter capture operations during November 2021 – March 2022 we captured, radio collared and tested the surviving ewes in the Lower Canyon. Over half of ewes tested positive for Movi using PCR. Ewes testing Detected (positive) for Movi were removed. Surveys in spring and fall of 2022 demonstrated significant lamb survival for the first time since 2013.

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LOVARA, M. C.[1], P. C. BREWSTER[2], A. HURT[3], P. SMITH[3], A. OTT[3], P. COPPOLILLO[3], K. P. HUYVAERT[4], S. T. WALK[2], AND W. J. SEVERUD[1]. Prospective use of detection dogs as a screening tool for *Mycoplasma ovipneumoniae* infection in bighorn sheep.

Mycoplasma ovipneumoniae (*M. ovipneumoniae*) is a bacterium that can spill over from domestic to wild sheep, with effects ranging from low/no lamb recruitment to whole-herd all-age die offs. Many bighorn sheep (*Ovis canadensis*) populations have also failed to recover following repeated die-offs and associated *M. ovipneumoniae* infections. Fast and reliable disease detection is needed to remove infected sheep most effectively from the population, and/or avoid spreading infections during capture and translocation events. The current reference testing methods can take a week or more for results, in which time wild sheep can continue to transmit the pathogen unless quarantined in captivity. Other, in-field testing methods are also expensive and still undergoing validation. Here, we evaluate whether specially trained detection dogs can offer another complementary tool for *M. ovipneumoniae*-affected animal screening along with logistical considerations for integrating canine diagnostics in captures and in non-invasive field settings. We will present preliminary results of canine performance on *M. ovipneumoniae*-affected animal detection in nasal swabs and fecal samples from bighorn sheep collected in Nebraska and South Dakota, USA, and the dog's ability to be integrated into on-site testing. If successful, canine *M. ovipneumoniae* detection would represent the fastest and most cost-effective method of disease determination available.

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MONTGOMERY, I.[1], AND K. MANLOVE[2]. Disentangling factors contributing to Zion bighorn population performance.

Survey-based estimates for the Zion bighorn sheep herd indicate that the population has declined from an estimated 807 individuals in 2018 to 462 in 2021. Identifying vital rates (i.e. fecundity, recruitment, and age-specific survival) that have the greatest influence on population growth is necessary for developing effective management actions to address concerns in overall population trends. The degree to which population trajectories are influenced by a particular vital rate depends on both how much the vital rate contributes to population growth, as well as the vital rate variability. We conducted a life-stage analysis (LSA) to estimate the impact of each vital rate on the Zion herd's total population growth rate (λ) in order to find the vital rates having the greatest impact on Zion bighorn performance. We empirically estimated vital rates using data from a combination of population-level ground and aerial surveys, as well as individual-level survival and reproduction information derived from GPS collars deployed throughout the Zion bighorn herd. In addition, mortality investigations of GPS-collared individuals indicated a high level of mountain lion predation. In order to assess the influence of predation on bighorn sheep population dynamics, we first calculated cause-specific mortality rates for each subunit within the population using nonparametric cumulative incidence functions and then assessed whether predation had additive effects on adult bighorn sheep survival. The LSA and the particular examination of predation impacts are initial steps toward projecting the Zion bighorn herd's population dynamics in response to changing bottom-up and top-down conditions, with the goal of informing management that can address the population's decline.

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OCHOA-ESPINOZA, J.[1], J. CARRERA-TREVINO[2], A. ESPINOSA-TREVINO[3], F. HERNANDEZ[4], T. ATHENS[5], AND M. MENDOZA-PEREZ[6]. Restoration of a transboundary habitat throughout binational cooperation against a common enemy: borrego berberisco.

Exotic species are one of the main causes of biodiversity lost in the world. In the Chihuahuan Desert ecoregion a huge variety of topics has been shared between Mexico and United States. Inside the transboundary conservation corridor composed by Big Bend National Park, Big Bend Ranch State Park, Adams Ranch, and Black Gap Wildlife Management Area in Texas, and the protected areas of Cañón de Santa Elena in Chihuahua, and Maderas del Carmen, and Ocampo as well as El Carmen Natural Reserve in Coahuila, are one of the biggest conservation complex in North America. At least for the last three decades, the aoudad (*Ammotragus lervia*) populations have increased, impacting the populations of native ungulates such as mule, and white tail deer, and ultimately bighorn sheep, becoming a frustrated situation where any effort seems to be not enough as long as aoudad persist. However, many actions have been implemented at both sides of the border, such as reintroduction of bighorn sheep to its original habitat, educational and informative campaigns about the effects of exotic species, involvement of local communities in monitoring, development of informative materials for a variety of target public. Nevertheless, these efforts might be integrated to get better outcomes. It is a reality that aoudad eradication is a huge challenge, however, to establish a control rate for aoudad on both sides of the border, and across the region would be key to the successful recovery of the native wildlife and its habitats.

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PARIKH, G. L.[1], J. L. ETCHART[2], R. O. SHAUGHNESSY[3], L. A. HARVESON[4], C. E. GONZALES[4], F. HERNANDEZ[5], AND J. W. CAIN[6]. Multiscale habitat selection of desert bighorn sheep (*Ovis canadensis mexicana*) and sympatric non-native aoudad (*Ammotragus lervia*) in a west Texas mountain range.

In many systems, species with similar ecological requirements and life histories have co-evolved mechanisms that facilitate niche partitioning and minimize competition. However, intentional introduction of an exotic species leads to the development of a novel ecological interactions, including exploitative, interference, or apparent competition. In the Trans-Pecos region of west Texas, introduced populations of aoudad (*Ammotragus lervia*) have become invasive and may pose a substantial threat to native desert bighorn sheep (*Ovis canadensis nelsoni*). Both species are adapted to high elevation desert mountain ranges with arid climates, steep slopes, rugged terrain and low primary productivity. We assessed habitat selection in sympatric populations of aoudad and bighorn sheep in the Sierra Vieja Mountains in west Texas. We collared 36 adult bighorn sheep and 12 adult aoudad and used remote sensing data to assess landscape characteristics at both the within-home range and landscape scales. Using resource selection functions, we assessed a suite of predictors of habitat use. Habitat selection for both species was based on similar environmental characteristics, such as elevation, ruggedness, and distance to water, suggesting potential for competitive interactions. Aoudad are very well adapted to an arid climate and are more generalized in their habitat and dietary strategies, which could provide a competitive edge over bighorn sheep in areas of sympatry. Understanding the axes of niche overlap provides important insights into the potential for interspecific competition between these sympatric ungulates.

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ROMINGER, E. M.[1] A plausible consequence of the recently discovered hominid occupancy 37,000+ ybp on a current predator-prey disequilibrium in North America.

The recently discovered mammoth kill in New Mexico, dated 37,000-39,000 Years Before Present (YBP), pushes back the known human occupancy of North America by >20,000 years. This substantially changes the paradigm of the hypothesized impact of early-humans on North American fauna. A plausible consequence is a hypothesized anthropogenically created niche, following the Pleistocene mega-predator extinctions, which allowed the entry of mountain lions (*Puma concolor*) into North America. Mountain lions likely arrived in North America thousands of years after man.

The impact of 37,000+ years of human presence on North American wildlife is largely speculation; however, with human population size hypothesized to have peaked ~5,000 YBP the pressures on all natural resources are likely to have been substantial. Human exploitation of predators, following the Columbian-landfall, resulted in the extirpation of two superior predators, wolves (*Canis lupus*) and grizzly bears (*Ursus arctos*), in the majority of habitats occupied by mountain lions. These extirpations have resulted in mountain lions becoming the primary predator of adult ungulates in the western United States. A predator-prey disequilibrium, observed in many ecosystems, is hypothesized to be a result of the arrival, and subsequent release, of this novel predator. The late-20th century release of mountain lions from intensive predator control has resulted in an evolutionary trap for some species, e.g., bighorn sheep (*Ovis canadensis*). This effect is especially profound in ecosystems where mountain lion populations are relatively unexploited by human harvest or subsidized by free-ranging livestock.

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RUHL, C.[1], J. W. CAIN[2], F. ABADI[3], J. HENNIG[4], AND E. M. ROMINGER[1]. Improving population estimates for desert bighorn sheep in New Mexico through double observer sightability modeling and the estimation of residual heterogeneity.

Hybrid double-observer sightability (DOS) models that include the estimation of residual bias have demonstrated value in producing robust population estimates. Development relies on covariate data, double-observer detection histories, and an initial sample of radio-collared animals. We conducted helicopter surveys of a desert bighorn sheep (*Ovis canadensis* ssp.) population in the Fra Cristobal Mountains (FCM) and collected data for 168 desert bighorn groups. Group detection probabilities and abundance estimates under four modeling methods were compared: a standard sightability model, a standard DOS model, a DOS model incorporating a recapture type heterogeneity parameter, and a DOS model incorporating a mark-type heterogeneity parameter. In estimating group detection probabilities, models including group behavior were the most supported based on AIC. Log-transformed group size, drainage terrain, and cover were also present in competitive models. The average group detection probability under the recapture heterogeneity model was 0.735 [range, 0.189−0.894]. Coefficients of variation were below 0.20 for all methods and DOS models with residual heterogeneity had average CVs ≤ 0.10. Estimates resulting from DOS models with residual heterogeneity had improved precision over standard sightability modeling and accounted for more bias than a standard DOS model. Abundance estimates and concomitant proportions of estimated bighorn sheep observed from 2016 to 2017 were 301 (95% CI = 271−392, 80.7%), 292 (95% CI = 273−352, 90.1%), and 337 (95% CI = 276-480, 65.3 %) using the DOS recapture heterogeneity model. This comprehensive survey-specific approach to estimating bias yields statistical and social confidence and managers desiring robust estimates should consider utilizing this method.

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THOMAS, L.[1], AND W. COOK[1]. Evaluating aoudad (*Ammotragus lervia*) as a pneumonia risk to Texas bighorn sheep (*Ovis canadensis nelsoni*).

Conserving bighorn sheep (*Ovis canadensis*) in their native range is challenged by pneumonia epizootics. *Mycoplasma ovipneumoniae* and Pasteurellaceae family bacteria are strongly implicated in these epizootics. Domestic sheep (*Ovis a*ries) and domestic goats (*Capra aegagrus*) frequently carry these agents, and frequently cause bighorn sheep epizootics. However, the southwestern United States and northern Mexico host feral populations of aoudad (*Ammotragus lervia*). Aoudad are native to the Barbary coast of northern Africa and were introduced to the United States in the 1950s to provide hunting opportunities. Their habitat and diet requirements are apparently like those of bighorn sheep. Further, aoudad are within the subfamily Caprinae, within which most species are competent carriers of respiratory pathogens. Wildlife managers suspect that aoudad may negatively impact bighorn sheep populations through competition and potential disease transmission. To address these concerns, we investigated the host competency of aoudad, their ability to transmit important respiratory pathogens to bighorn sheep, and the clinical pathological effects of these agents in aoudad. These questions were answered through a two-phase study.

In phase 1, we experimentally inoculated aoudad with leukotoxigenic Pasteurellaceae and/or *M. ovipneumoniae*. Aoudad were competent hosts of these pathogens for at least 53 days after exposure when sampled longitudinally. Additionally, aoudad develop antibody titers detectable by a widely used assay for bighorn sheep and domestic sheep disease management. Aoudad were still capable of transmitting respiratory pathogens after developing antibodies to *M. ovipneumoniae*. Experimentally inoculated aoudad in this study transmitted *M. ovipneumoniae* to uninoculated (sentinel) individuals through fenceline contact. While it was unclear at what point in the study sentinel individuals were exposed, lesions found upon study termination appeared to be chronic, suggesting that transmission occurred relatively quickly. Aoudad did develop clinical and pathological signs consistent with pneumonia, but captivity stress was a significant contributor. Aoudad exposed to both respiratory pathogens exhibited more severe disease, but some individuals from both inoculated groups had chronic, mild lesions consistent with healing of the respiratory tract. This, in combination with a lack of observed pneumonia outbreaks in aoudad across their feral North American range, suggests free-ranging aoudad are relatively resistant to pneumonic pathogens fatal to bighorn sheep. Taken together, phase 1 provided evidence that aoudad are conceptually a respiratory pathogen transmission risk to bighorn sheep without being themselves highly susceptible to pneumonia epizootics.

The phase 2 study involved exposing bighorn sheep to indirect and direct contacts with aoudad experimentally infected with leukotoxigenic Pasteurellaceae and/or *M. ovipneumoniae*. We were particularly interested in whether sharing a common water source was an important indirect contact type for interspecific transmission. Aoudad transmitted respiratory pathogens intra and interspecifically indirectly (shared water) and directly. Bighorn sheep contacting infected aoudad had moderate to rapid pathogenesis and mortalities. Aoudad experienced no fatal pneumonia and had mild disease without gross respiratory lesions. Importantly, this study demonstrated that some aoudad carry *M. ovipneumoniae* for longer periods of time than others. While some aoudad cleared the infection by 155 days after exposure, others carried the agent 211 days after exposure when the study was terminated. If given more time, these individuals may have continued shedding *Mycoplasma ovipneumoniae*. This demonstrates that not all aoudad are of equal transmission risk to bighorn sheep and that transmission among aoudad may be complicated by individual heterogeneity.

Overall, aoudad pose a conceptual disease threat to bighorn sheep and this requires future research on: 1) the virulence, transmissibility, and sources of different *M. ovipneumoniae* strains in aoudad, 2) how shared water sources may serve as a transmission risk and impact herd-level diagnostics, 3) how aoudad may directly and indirectly affect bighorn sheep social contact networks, 4) the efficacy of various diagnostic assays in free-ranging aoudad, and 5) the environmental and demographic drivers of pathogen exposure in aoudad populations.

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TORRES, S. G.[1]. Desert bighorn sheep management—evolving and adapting to future challenges.

Desert bighorn sheep management history will be presented as chronicled through the DBC Transactions. Reviewing past and present management practices are discussed to consider past successes and additional needs to assist long-term population persistence.

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WRIGHT, E. A.[1], R. D. BRADLEY[1], AND J. D. MANTHEY[1]. Translocations, rising populations, and phylogeographic consequences: genomic implications for conservation of introduced aoudad (*Ammotragus lervia*) in the southwestern US.

Over the last century, Texas has been inundated with exotic ungulates, with as many as 67 species represented by captive and free-ranging populations. One of the most successful species to have established free-ranging populations are aoudad (*Ammotragus lervia*). Herein, we expand on previous genetic studies in aoudad by including new genomic profiles based on double digest restriction site-associated DNA sequencing methods with the intent of better understanding the effects of > 70 years of human-mediated translocations, population expansion, and gene flow among populations. Using thousands of single nucleotide polymorphisms obtained from 73 individuals, we measured genetic patterns of diversity and connectivity between source populations from California and New Mexico and resultant aoudad populations in Texas. Principal components analyses identified phylogeographically structured populations across Texas. Further, we identified a signature of isolation by distance among Texas populations. To assess geographic regions that facilitated or blocked gene flow between populations, we used Estimation of Effective Migration Surfaces, which indicated three barriers to movement between populations as well as connectivity among populations in close proximity. Although *A. l. blainei* appeared to be genetically unique from other subspecies, comparison of mtDNA haplogroups and nuclear genotypes were discordant indicating that the current subspecific taxonomic classification needs refinement. Given the vulnerable status of aoudad in their native range of northern Africa and the exponential population growth and competition with native ungulates in Texas, management and conservation efforts of aoudad need to maintain and preserve unique genetic units while minimizing competition and other detriments to native species.

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WRIGHT, E. A.[1], J. D. MANTHEY[1], M. R. BUCHALSKI[2], E. K. ROBERTS[1], R. C. WIEDMEIER[3], B. P. MCKINNEY[4], F. HERNANDEZ[5], W. C. CONWAY[6], C. D. PHILLIPS[1], AND R. D. BRADLEY[1]. From extirpation to restoration: the genomic status of Texas desert bighorn sheep.

In Texas, desert bighorn sheep (DBS) historically occupied 16 mountain ranges in the Trans-Pecos Region. Described as *O. c. texiana*, this subspecies of DBS was presumably extinct in the 1960s due to overharvesting, competition, and diseases. Historical restocking efforts have relied on translocating *O. c. mexicana* and *O. c. nelsoni* from Arizona, Nevada, Utah, and Mexico. These efforts allowed populations to increase from <14 to >1,500 individuals across 11 mountain ranges by 2018. Restriction site-associated DNA sequencing was used to determine the population structure, genetic variation, and relatedness in contemporary populations. Inbreeding and other deleterious mechanisms were not detected in Texas DBS based on the genetic diversity and F-statistic datasets. Three analyses (PCA, maximum likelihood phylogenies, and admixture) demonstrated that DBS west of 104° longitude (Sierra Diablo, Beach, Baylor, and Van Horn mountains) possessed similar nuclear genomes to populations in Arizona whereas DBS east of 104° longitude (Elephant, Black Gap, Dove, and Bassey mountains) genomically were similar to populations in Nevada. In addition, kinship analyses were indicative of movement between mountain ranges of sheep and possible traces of inbreeding, reproductively successful males, and prolific females. This is the first study to genomically compare several subspecies and the distinction between Rocky Mountain bighorn sheep and desert subspecies of bighorn sheep was evident in all analyses. Distinctions between northwestern and southern populations in Nevada were also detected with an individual from Colorado possessing similar genomic signatures, suggesting a possible corridor from southern Nevada to the four corners region.

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WRIGHT, E. A.[1], G. G. BRUGETTE[1], R. C. WIEDEMEIER[2], C. D. PHILLIPS[1], AND R. D. BRADLEY[1]. Up the nose: multi-locus sequence typing used to detect the first report of *Mycoplasma ovipneumoniae* in Texas desert bighorn sheep and exotic aoudad.

Through phylogenetic analyses of *Mycoplasma ovipneumoniae* bacterial strains, bighorn sheep (*O. canadensis*) populations across the western US possess strains characteristic of sheep-like and goat-like *M. ovipneumoniae*. With aoudad (*Ammotragus lervia*) in sympatry with desert bighorn sheep (DBS), a pathogen spillover event is likely in the Trans-Pecos Ecoregion of Texas. Data obtained from Texas Parks and Wildlife Department personnel (R. Ditmar, DVM) indicated that *M. ovipneumoniae* was detected samples recovered from aoudad in the Chinati, Sierra Vieja, and Van Horn mountains. The Washington Animal Disease Diagnostic Laboratory (WADDL) provides a new molecular method (multi-locus sequence typing, MLST) to detect *M. ovipneumoniae* using a variety of tissue samples. MLST characterizes four loci (16S; IGS; rpoB; gyrB) to confirm the presence of *M. ovipneumoniae*. Implementation of this method in-house was confirmed using six samples of *M. ovipneumoniae*-positive Rocky Mountain bighorn sheep (RMBS) samples previously collected and archived in the Genetic Resource Collections at the Natural Science Research Laboratory. To date, we have sequenced all four genes for three DBS and four aoudad that share 100% sequence identity. An additional nine aoudad possess *M. conjunctivae*. Additional testing of DBS and aoudad and more extensive phylogenetic analyses are needed to discern the strain differences among RMBS, DBS, aoudad, and domestic sheep and goats. It is critical to identify potential causes and real-time management strategies.

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